

Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals

API RECOMMENDED PRACTICE 1595
SECOND EDITION, OCTOBER 2012

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AMERICAN PETROLEUM INSTITUTE

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Downstream Segment

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Foreword

This recommended practice has been prepared by the API Aviation Technical Services Subcommittee with technical participation and feedback from other industry stakeholders, and is intended to provide guidance on the minimum equipment standards and operating procedures for the receipt, storage of aviation fuels at pre-airfield distribution terminals, located directly upstream of an airport, and its shipment directly via a grade dedicated pipeline, marine vessel (barge or ship) or road/rail transport to an airport.

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The guidance contained in this publication is primarily intended for civil aviation fuel handling operations. However, many of the practices and procedures are suitable for military pre-airfield storage terminals.

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

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Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals

1 Scope and Purpose

This recommended practice (RP) contains basic requirements for the design, construction, operation, and maintenance of pre-airfield storage terminals located directly upstream of the airport, hereafter referred to as “pre-airfield storage terminals.”

Mandatory requirements in this standard are designated by the word “shall.” Recommendations are designated by the word “should.” Optional items are designated by the word “may.” This standard incorporates by reference a number of other standards and recommended practices that need to be referred. The distinction between mandatory, recommended, and optional provisions in the referenced documents is not changed by nature of their reference in this standard.

The values stated for this standard are in U.S. Customary units.

2 References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[API Recommended Practice 652](#), *Lining of Aboveground Petroleum Storage Tank Bottoms*

[API Recommended Practice 1543](#) *Documentation, Monitoring and Laboratory Testing of Aviation Fuel During Shipment from Refinery to Airport*

[API Recommended Practice 2003](#), *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Publication 2013, *Cleaning Mobile Tanks in Flammable or Combustible Liquid Service*

[API Standard 2610](#), *Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities*

EI HM 50 ¹, *Guidelines for the Cleaning of Tanks and Lines for Marine Tank Vessels Carrying Petroleum and Refined Products*

EI Standard 1542 ², *Identification Markings for Dedicated Aviation Fuel Manufacturing and Distribution Facilities, Airport Storage and Mobile Fuelling Equipment*

EI Specification 1581, *Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators*

EI Specification 1583, *Specifications and Qualification Procedures for Aviation Fuel Filter Monitors with Absorbent Type Elements*

EI Specification 1590, *Specifications and Qualification Procedures for Aviation Fuel Microfilters*

¹ Energy Institute, 61 New Cavendish Street, London W1G 7AR, UK, www.energyinst.org.uk.

² Energy Institute, 61 New Cavendish Street, London W1G 7AR, UK, www.energyinst.org.uk.

3 Terms and Definitions

For the purposes of this document, the following definitions apply.

3.1

Pre-Airfield Storage Terminal

A facility equipped with receipt pipelines and /or docks, storage tanks, filtration, pumps, valves and pipelines for shipping aviation product directly to an airport either by pipeline, marine vessel or road or rail transport.

3.2

MOC

Systems shall be established for each pre-airfield distribution terminal to review potential health, safety, and environmental considerations resulting from proposed additions, modifications or other changes that may periodically occur at a terminal. The following changes should be properly managed by identifying and reviewing them before implementation:

- material or products handled,
- equipment used or installed,
- operations and procedures.

The system should ensure that designs and operating procedures are reviewed before implementation and should be revised, as appropriate, with the intent of minimizing adverse effects on safety of the community, environment and workforce. Minimum requirements for specific terminals are identified in OPS RSPA 49 *CFR* 195 or OSHA 29 *CFR* 1910.119

3.3

ullage

The height from the product level in a storage vessel to a datum point on the tank roof or gauging point.

3.4

segregated

Provision made so that tanks are positively isolated for product quality control. The inlet and outlet to each tank, as well as other possible piping connections to other grades of products shall be fitted with either:

- A double block and bleed (DBB) valve arrangement (either using a single DBB valve, or using two valves with a drain arrangement in a pipe spool between them); or
- A removable distance piece; or
- A spectacle blind.

3.5

dedicated

Tankage, piping, valves, filters, etc. that are only used to handle one grade of aviation product.

3.6

flowing line sample

When a storage tank is fitted with a sump recovery tank provision shall be installed to take a sample in a glass jar, stainless steel bucket or closed sampling system from the piping between the storage tank the recovery tank while product is flowing and to visually examine it for water and particulate and traces of red dye. This test is to check that the sump is free of water and particulate which an accumulated sample in the recovery tank can not give you.

3.7

release certificate (RC)

This document supports any transfer of product, confirming compliance with the relevant specification(s), and contains at least the following information:

- Date and time of transfer;
- Grade of fuel;
- Batch number and batch API Gravity at 60 °F (density at 15 °C) of the product in the tank(s) from which it originated. If more than one batch is being included in any shipment then the quantity from each batch is required to be stated on the release document.

NOTE 15 °C is the internationally accepted temperature, but some areas are required to use 20 °C (68 °F).

4 General

4.1 Nonapplicability and Retroactivity

This recommended practice is intended to provide guidance on the minimum equipment standards and operating procedures for the receipt and storage of aviation fuels at pre-airfield storage terminals, located directly upstream of an airport, and its shipment directly via a grade-dedicated pipeline, marine vessel (barge or ship), or road/rail transport to an airport. This RP does not address in-transit or breakout storage upstream of the pre-airfield storage terminal.

The design and construction provisions of this standard are intended for application at new facilities. Application of the design and construction provisions of this standard to facilities, equipment, structures, or installations that are already in place, that are in the process of construction or that are installed before the date of this publication should be evaluated when circumstances merit. Such an evaluation should consider the site-specific circumstances and detailed accounting for both the potential and tolerance for risk, existing conditions at the installation, and overall benefit for applying the required design and construction provisions.

The operation, sampling, testing, and maintenance provisions in the various sections of this standard shall apply to both new and existing installations.

4.2 Management Responsibility and Accountability

The management of pre-airfield storage terminals is responsible for ensuring that the facility design and operation conform to acceptable industry standards and the appropriate legislative regulations with respect to health, safety, environmental protection, and security are applied.

The operating procedures for pre-airfield storage terminals shall be maintained in a manual or handbook that is readily available for reference by staff. It is desirable that conformance to agreed-upon procedures be tied in to a recommended quality assurance system like the one outlined below.

Any change to operating procedures or physical equipment changes (unless replacing like with like) to the existing pre-airfield facilities shall be supported by a management of change (MOC) process with appropriate risk assessments/hazard reviews performed by trained and experienced staff.

4.3 Quality Assurance System

4.3.1 General

The potential consequences of a failure to supply the correct, on-specification product to aircraft are such that it is essential for each organization to have an effective quality assurance system, which shall be designed to ensure the following:

- the provision and maintenance of appropriate facilities and equipment for the safe and uncontaminated delivery of aviation fuels to the airfield fuel storage facility;
- an auditable documentary record demonstrating the correct handling of aviation product at the pre-airfield storage terminal.

4.3.2 Product Quality Assurance Organization

Each pre-airfield storage terminal shall have a product quality assurance organization. The specific details of such an organization may be varied according to the nature of the operating unit. The organization shall have individuals nominated to carry out the following roles; nomenclature may vary according to local requirements. At each level of the structure, records shall be kept of the responsible individuals in the succeeding level together with details of training received.

4.3.2.1 Site Product Quality Manager

At each site that stores or handles aviation fuels there shall be a nominated site product quality manager responsible for the efficient operation of the quality assurance system at that site. At pre-airfield storage terminals, this role would usually be taken by the pre-airfield storage terminal manager (or operations manager of a large facility).

The Site Product Quality Manager shall be accountable for:

- the implementation of correct quality control procedures,
- the maintenance of satisfactory documentation,
- the release of product only of satisfactory quality,
- the training of all staff at the site who are nominated as Product Quality Inspectors.

4.3.2.2 Product Quality Inspectors

All staff whose duties include tasks critical to the quality assurance system shall be fully trained in such tasks and nominated as approved Product Quality Inspectors. Such tasks include, but may not be limited to, the following:

- checking that the documentation on incoming consignments is correct and that it corresponds to the transport/container concerned;
- visually inspecting and conducting control checks and online sampling from pipelines and dock lines (color membrane filtration test, MSEP, flash point, API, color, free water, as applicable) on incoming material, including checking seals on vehicles, if present;
- product discharge into storage;
- loading of material, including control checks on marine vessels/road or rail transports/containers and pipelines, unless these tasks are performed by non-pre-airfield terminal staff (i.e. independent inspectors, road transport

operators), to ensure that they are clean and uncontaminated and online sampling from pipelines, loading racks, and dock lines (color membrane filtration, MSEP, flash point, API, color, free water tests) unless these tasks are performed by non-pre-airfield terminal staff;

- sampling of aviation fuels;
- maintaining appropriate records of inventory/quality/equipment checks.

5 Sampling

5.1 General

At appropriate stages during the handling and storage of aviation fuels at pre-airfield terminals, fuel samples will be required for laboratory and/or visual examination to check the quality of the fuel.

5.2 Sampling

Sampling shall be undertaken by competent, trained personnel using clearly defined procedures and appropriate apparatus to ensure that the sample obtained is truly representative of the material from which it has been drawn. Sampling shall be in accordance with the latest requirements of the following procedures or their equivalent:

- a) Local, state, and national measurement standards;
- b) [ASTM D4057](#), *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*;
- c) *API Manual of Petroleum Measurement Standards (MPMS) Chapter 8, Sampling*.

For detailed sampling procedures not covered herein, reference shall be made to the aforementioned publications.

5.2.1 Basic Requirements

- a) Before sampling, the sampling apparatus (including ropes or cords to suspend the sampler or other ancillary equipment) and containers shall be dry and free of any contaminating substance. All metal sampling gear shall be constructed from non-spark-generating materials.
- b) Sample containers shall conform to the requirements listed in 5.2.3.
- c) The operator carrying out the sampling shall have hands free from any contaminating material. Clean gloves impervious to aviation fuels shall be worn to protect the operator from any health hazards.
- d) Sampling points for drain samples shall be fitted with dust caps, chained to the sample connection, and the sampling pipes shall be of a material unaffected by the product and not susceptible to oxidation/corrosion (i.e. stainless steel or other suitable material). Sampling points shall be covered by dust caps at all times except while a sample is being drawn.
- e) During sampling operations, the material being sampled shall be protected, as far as possible, from the effects of rain, sun, blown dust, etc. Sample containers shall be securely closed immediately after the sample has been taken.
- f) It is important that samples are truly representative of the material being sampled. Samples from tanks shall be taken from a gauge hatch or other suitable opening that gives unrestricted access to the bulk of the liquid or from a suitably designed piped sampling system.

- g) Prior to sampling, apparatus for sampling liquids including the sample container shall be flushed and rinsed at least three times thoroughly with the product to be sampled and allowed to drain before use. An alternate method is filling the can with product to be sampled and allowing the can to soak for 24 hours then disposing of the fuel prior to taking the sample to be tested.

This requirement shall not apply when such flushing and rinsing would nullify the purpose for which the sample is being obtained or by the nature of the material being sampled, e.g. drain samples for water and dirt content.

- h) If it is suspected that a sample or set of samples is not fully representative, a further sample or set of samples shall be taken.
- i) Samples for laboratory testing shall be free from dirt and water except in the case of samples specifically taken to determine the presence of such contaminants.
- j) No sample container shall be completely filled with liquid. The ullage space required for certain samples and testing can be found in [ASTM D4057](#) or API *MPMS* Ch. 8.
- k) Records shall be maintained of all samples taken. Sample containers shall be clearly labeled for identification and sealed immediately after sampling. The following information shall be available as appropriate, either on the label or on associated documentation.

Sample No:	Date:	Time:
Taken By:	Sample Type:	Tank:
Batch No.:	Grade:	Vehicle/Vessel:
Test Required:	Sample Quantity:	Quantity in Tank or Represented:

- l) When samples are required from levels in a tank or bulk container, the order of sampling shall be from the top downward.
- m) Samples of materials that could be affected by light or heat shall be stored in a cool, dark place.
- n) When a sample of aviation gasoline is taken for laboratory analysis, especially at high ambient temperatures, care must be taken immediately after sampling and during sample transport. aviation gasoline samples must remain cool and protected from direct sunlight to avoid the loss of light ends. It is also recommended that aviation gasoline samples be taken in containers protected from direct light. The sample shall, if at all possible, be taken directly into the container, and not transferred from sampler to container. The container shall be examined closely for leaks, so as to avoid the loss of light ends through the cap sealing material.

5.2.2 Sampling Terminology

The most common sample types used in aviation fuel handling are as follows.

- a) Bottom Sample:

A sample obtained from the material on the bottom surface of the tank or container at its lowest point.

- b) Drain Line Sample:

Samples obtained from the water draw-off or drain point of a storage or vehicle tank or filter body.

- c) Line Sample:

A sample obtained from a line sampling point, preferably drawn while the product is flowing.



d) Lower Sample:

A sample obtained from the middle point of the lower third of the tank contents.

e) Middle Sample:

A sample obtained from the middle point of the tank contents.

f) Multiple-Tank Composite Sample (Ships, Barges, etc.):

A mixture of individual composite samples from the several compartments each of which contains the same grade of product. The mixture is blended in proportion to the volume of product in each compartment.

g) Retention Sample:

A sample taken and stored in a retention sample container for the purpose of laboratory analysis at a later date in the event that the quality of the original product needs to be verified.

h) Single-Tank Composite Sample:

A sample obtained by blending upper, middle and lower samples. For a vertical tank of uniform cross section, the blend consists of equal parts of the three samples.

i) Upper Sample:

A sample obtained from the middle point of the upper third of the tank contents.

j) Top Sample:

A sample obtained from just below the surface of the liquid in the tank.

k) All Level Samples:

A sample obtained by submerging a stopped beaker or bottle to a point as near as possible to the draw-off level, then opening the sampler and raising it at a rate such that it is approximately $\frac{3}{4}$ full as it emerges from the liquid.

5.2.3 Sample Containers

a) Laboratory Sample Containers:

Metal containers that are internally lined with an epoxy coating suitable for aviation fuels shall be used for the carriage/storage of samples for laboratory testing (see [ASTM D4306](#)). One (1) quart and 1 U.S. gallon sample container shall be used for Jet A/A1 and 1 or 5 U.S. gallons for aviation gasoline. These shall be suitable for air transport when used with the associated transit packaging materials.

b) Field Sample Containers:

- 1) Clear glass jars of one (1) quart minimum capacity with wide necks and screw caps shall be used for product examination in accordance with the visual check procedure. These shall be kept in an outer protective wire cage to facilitate easier handling. Sample bottles may be removed from the wire cage to enhance the visual check performed on the sample.

or

- 2) Stainless steel buckets, which shall be internally coated with white porcelain or epoxy and equipped with a bonding cable and clip.

c) Retention Sample Containers:

Laboratory sample containers as described in 2.2.3 a) shall be used for containing product for retention purposes. If necessary, the product can then be transported by air without the need to be transferred to another container, eliminating the associated potential for contamination.

d) Packaging for Air Transport:

Containers for the transport of samples by air shall be of an International Civil Aviation Organization (ICAO) approved design and shall be dispatched in accordance with the latest edition of the ICAO *Technical Instructions for the Safe Transportation of Dangerous Goods by Air*.

5.2.4 Aviation Fuels

The aviation fuels covered by this recommended practice are summarized in the two tables below. These list the major specifications in use together with the usual nomenclature for the products concerned.

5.2.5 Aviation Turbine Fuels (Jet Fuels)

Fuel Grade Name	Description	Specification
Jet A	Kerosene type fuel Freezing point -40°C maximum Flash point 38°C minimum	ASTM D1655
Jet A	Kerosene type fuel Freezing point -47°C maximum Flash point 38°C minimum	ASTM D1655
Jet A/A-1/FSII	Kerosene type fuel Freezing point (see above) Flash point 38°C minimum containing 0.1 % to 0.15 % DiEGME	ASTM D1655
JP-8	Kerosene type fuel Freezing point -47°C maximum Flash point 38°C minimum containing 0.1 % to 0.15 % DiEGME and approved CI/LI additive	MIL-DTL-83133 (U.S.)

5.2.6 Aviation Gasoline

Fuel Grade Name	Description	Specification
Aviation Gasoline 80	Gasoline with maximum 0.14gPb/l, dyed RED	ASTM D910
Aviation Gasoline 100	Gasoline with maximum 0.85gPb/l, dyed GREEN	ASTM D910
Aviation Gasoline 100LL	Gasoline with maximum 0.56gPb/l, dyed BLUE	ASTM D910
Aviation Gasoline 91	Gasoline with maximum 0.56gPb/l, dyed BROWN	ASTM D910
Aviation Gasoline 100VLL	Gasoline with maximum 0.45gPb/l, dyed BLUE	ASTM D910

Aviation gasolines (Avgas) are identified in specification by their minimum antiknock engine ratings. Two ratings are established out: a “lean mixture” and a “rich mixture” rating. The full description of the grade uses both numbers, e.g. Avgas 100; the lower (lean mixture) rating is used for the shortened grade name as above.

The use of an incorrect grade can have serious results in terms of engine performance and aircraft safety. In order to differentiate between grades, dyes are added to the fuels in accordance with an internationally agreed-upon color code to impart a distinctive color.

[paragraph deleted]

5.3 Sampling and Testing

5.3.1 Release Certificates

5.3.1.1 Release Certificate

This document supports any transfer of product and contains at least the following information:

- date and time of loading,
- grade of fuel,
- batch number and batch API Gravity (at 60°F) of the product in the tank from which it originated,
- certification that a representative sample has passed a visual check.

The release certificate shall be dated and signed by an authorized representative of the issuing pre-airfield storage terminals (see Annexes A, B, and C for example documents).

5.3.2 Test Requirements

5.3.2.1 Visual Check

A visual check is conducted to confirm the acceptability of products where the grade is known and no cross-grade contamination is possible. To be acceptable, fuel shall be of the correct color and be visually clear, bright and free from particulate solid matter and undissolved water at normal ambient temperature. Samples for a visual check shall be drawn into clean, clear-glass jars, closed sampling devices (utilizing a transparent collection container) or a stainless steel bucket shall be manufactured with internally coated white porcelain, or other suitable material, and equipped with a bonding cable and clip.

The results of the visual check shall be judged as follows:

- **Color**—The various grades of aviation gasoline are dyed to aid recognition, while the color of aviation turbine fuels may vary from water white to straw color. When potential contamination from red dyed nonaviation fuels during receipt is possible, use a stainless steel bucket, which shall be internally coated with white porcelain or epoxy and equipped with a bonding cable and clip. (If there is a dispute if red dye contamination has occurred, then use the referee visual test method for determination, which is contained in the Boeing Service Letter, dated 22 November 1996, “Aircraft Use of Dyed Fuels.”)
- **Clear and bright**—The term “clear” refers to the absence of sediment or emulsion. The term “bright” refers to the sparkling appearance of the fuel having no cloud or haze. These terms are independent of the fuel’s natural color.
- **Solid matter**—Solid (particulate) matter generally consists of small amounts of rust, sand, dust, scale, etc. suspended in the fuel or settled out on the bottom of the sample container. (Acceptable standards will vary according to the point at which the sample has been drawn. A few specks of dirt are often found in samples

drawn from the sumps of unlined tanks and transports and unlined pipe low points, and these do not constitute a test failure.) Sampling through unlined carbon steel tank gauge pipes can be the cause of high particulate, which is not representative of the fuel. Consideration of this shall be taken when obtaining samples from the storage tank.

- *Undissolved water*—Undissolved water (free water) will appear as droplets on the sides or bulk water on the bottom of the sample container. It may also appear as a cloud or haze (suspended water).

The visual check, especially the examination for solid (particulate) matter, is best carried out by swirling the sample in the container to form a vortex. Any solid (particulate) matter and water droplets will tend to concentrate at the center of the vortex.

5.3.2.2 Control Check

This is a visual check plus fuel API Gravity determination. This check is frequently made to confirm the correct grade and unchanged quality of fuel stocks by comparison of the result of the API Gravity determination with the relevant batch API Gravity. If the temperature corrected API Gravity differs by more than 0.7 API degrees, a possibility of contamination exists and the matter shall be investigated further before the product is accepted for aviation use. It may be necessary to carry out further testing before such acceptance can be given.

5.3.2.3 Chemical Water Detector

This test is the recommended method for the detection of small concentrations of suspended water in jet fuel.

A number of methods exist for the detection of suspended water at low concentrations, e.g. the Velcon Hydrokit, Shell Water Detector, and the Gammon Aqua-Glo ([ASTM D3420](#)).

5.3.2.4 Membrane Filtration Tests (Gravimetric and Colorimetric)

These tests (often referred to as “color membrane filtration test”) shall be carried out and evaluated in accordance with test methods [ASTM D2276](#)/EI 216.

5.3.2.5 Conductivity Test

This test shall be carried out in accordance with procedures set out in ASTM.

5.3.2.6 Soak Test

Soak testing is carried out after construction work on a fuel system to ensure that there are no potential fuel contaminants present in the form of solvents from coatings/linings, welding flux, valve grease, or other general debris. Such contaminants are unlikely to affect the bulk properties of the fuel so only limited testing is carried out using the tests most sensitive to contamination.

At the end of the soak period, representative samples are taken from the fuel system being commissioned and a selection of laboratory tests are carried out to determine the quality of the fuel used in the soak test. The fuel properties tested shall be compared with the specification limits for the grade of fuel used and with the presoak test results for the fuel used in the soak test. If there is any doubt that the test certificate results are representative of the fuel used, it is recommended that the retention (presoak) sample is analyzed in parallel with the postsoak sample. A successful result requires that all tested properties are within the specification limits and within the tolerance limits established for recertification. If any test result does not fully comply with the applicable specification or falls outside the allowable variances, the product shall be resampled and retested. If the fuel is found to be unsuitable for use, then the reason shall be investigated and the fuel removed (and downgraded to nonaviation use or disposed of), the system refilled with on-specification fuel and the soak test repeated until a satisfactory result is obtained. The relevant fuel supplier shall be contacted for advice in the event of any problems with the soak test. The laboratory tests include those in Table 1.

Table 1—Laboratory Tests

	Jet Fuels	Avgas	Test Method	
			ASTM	IP
Appearance	X	X	D4176	
Existent Gum	X	X	D381	540
Water Reaction		X	D1094	289
MSEP	X		D3948	
Conductivity	X		D2624	274
Saybolt Color	X		D156	
Thermal Stability (JFTOT)	X		D3241	323
Distillation	X	X	D86/D2887	123/406
Flash Point	X		D56	170

Summary

Table 2 and the accompanying notes provide a summary of the soak test requirements for storage tanks, piping, and ancillary equipment.

Table 2—Summary of Soak Test Requirements

	Storage Tanks			Pipelines	Ancillary Equipment	
	Fully Lined	Partially Lined	Unlined	Supply	Pumps, Valves, Meters, etc.	Filter Vessels
Duration	Four days (Note 1) (seven days max)	Four days (seven days max)	Four days (seven days max)	Four days (seven days max)	(Note 2)	
Minimum Fuel Volume	Enough product to cover the floating or fixed suction and the receipt nozzle to allow circulation of product without pump cavitation	Normal fill level ^a	Normal fill level ^b	Fill lines completely		
Lab Testing	Jet fuel: Appearance, existent gum, MSEP, conductivity, Saybolt, JFTOT, distillation, flash Avgas: Appearance, existent gum, water reaction, distillation					
Sample Volume	Jet fuel: 5 liters or 1 U.S. gallon Avgas: 5 liters or 1 U.S. gallon (20 liters or 5 U.S. gallons required for a full specification test)					

^a Normal fill level is recommended however by agreement, soaking may be limited to the lined surfaces and roughly similar area of the unlined tank wall.

^b Normal fill level is recommended however by agreement, soaking may be limited to a depth of one meter. This would be a severe test due to the relatively high surface to fuel volume ratio.

— **Hoses**—Fuel shall be drained after the 8 hour soak period and visually inspected for appearance, discoloring, and solid matter.

NOTE 1 The four day soak period applies to equipment (fully, partially or unlined storage tanks, pipelines, ancillary equipment, and vehicles) where the lining material used is an approved epoxy (EI 1541) and is covered by a 10 year joint material and applications warranty from the manufacturer. Use of equipment where the lining material is not a fuel supplier approved epoxy and is not covered by a 10 year material and application warranty shall be subject to approval by the fuel supplier prior to use. Additional sampling and testing may be imposed to mitigate the potential risks of using an unapproved lining.

NOTE 2 Newly installed ancillary equipment (e.g. pumps, filter vessels, valves, pit valves, control valves, meters, sense tubing, water drain lines, etc.) should be soak tested during the system-wide soak test. Replacement or repaired equipment is not typically soak tested prior to use since the ratio of total surface area to fuel volume is very small diluting any contaminants below harmful levels. However, it is important to confirm that the replacement or repaired equipment does not contain detrimental materials, e.g. preservative oil or rust inhibitor coatings, which could contaminate the fuel and render it unfit for use. As a general rule, if new lining material is applied to an existing tank or pipe then soak testing shall be undertaken if the new lining material covers more than 5 % of the tank's coated surface area or surface area of existing piping. Participants may agree on different criteria depending on local circumstances.

5.3.2.7 Recertification Test

Recertification Test Certificate (RTC)

Where aviation product is transferred to an installation under circumstances which could in any way allow the possibility of contamination, then before further use or transfer, recertification is necessary. Recertification testing is carried out to verify that the quality of the aviation fuel concerned has not changed and remains within the specification limits, e.g. after transportation in ocean tankers or multiproduct pipelines, etc. The RTC (see Annex A) shall be dated and signed by an authorized representative of the laboratory carrying out the testing. The results of all recertification tests shall be checked to confirm that:

- the specification limits are met, and
- no significant changes have occurred in any of the properties.

The results of such tests shall be compared to the expected calculated results from a weighted average of the previous tank recertification and the receiving batches RQC or COA as well as reviewed for compliance with the specification limits. If any test results indicate that the sample does not comply with applicable specifications or is outside the allowable variance, the product shall be immediately quarantined and remain under quarantine until further testing has established that the quality is acceptable for aviation use. If more than three new batches are received into a tank, the comparison becomes difficult and possibly meaningless, and therefore the contents of the tank shall be tested against all the requirements of the specification.

If the incoming product is not accompanied by an RQC or COA or one is not available, then full COA laboratory testing is required to verify that the fuel is still within the limits of the fuel specification. In this case the amount and usage of approved additives in the fuel is unknown.

Any further additization should be performed in a manner consistent with the relevant specifications ([ASTM D1655](#), [ASTM D910](#)).

5.3.2.8 Hydrometers and Thermometers

Hydrometers and thermometers used for API Gravity (or density) quality control checks shall meet the requirements of the relevant standards:

- hydrometers—[ASTM E100](#) or ISO 649-1,
- thermometers—[ASTM E1](#) or EI Appendix A,
- thermo hydrometers for Jet A/A-1 designated ASTM 255H and 55HL,
- thermo hydrometers for aviation gasoline designated ASTM 258H and 58HL,
- Anton Paar DMA 35N handheld densitometer (intrinsically safe model).

Hydrometers and thermometers must not be left in direct sunlight or near heating appliances. Hydrometers shall be stored vertically.

Before each use, hydrometers shall be carefully examined to ensure the following.

- a) The etched line on the hydrometer stem corresponds to the arrow (or line) at the top of the paper scale. A fingernail can be used to detect the etched line position.
- b) The weighting material has not dislodged. This would cause the hydrometer to float in a nonvertical plane.

- c) The glass is intact.
- d) The scale markings are legible.

Before each use, a thermometer shall be visually inspected to confirm that there are no gas bubbles trapped, or separation of the liquid column in the mercury column or the bulb, the mercury column is unbroken, and there are no mercury globules above the top level of the mercury column. The thermometer's scale markings shall be clearly visible.

If a measurement of temperature or API Gravity is suspected of being inaccurate, the accuracy of the thermometer and hydrometer shall be checked. These checks shall be carried out by means of one of the following options:

- a) transporting to laboratory or a central point,
- b) holding a reference set of instruments on site or at a number of "hub" sites,
- c) using a standard API Gravity reference fluid held at each site or sent to each site from a central point or a laboratory,
- d) avoiding the need to recalibrate by disposal and repurchase before recalibration becomes due,
- e) checking against other instruments in service (most operations will have more than one of each).

6 Pre-Airfield Storage Terminals Equipment Design

6.1 General

The observance of certain fundamental practices in the design, construction, and commissioning of facilities used for the storage, handling, and transport of aviation fuels is considered essential to ensure that health and safety of staff, environmental protection, and product quality are maintained.

6.1.1 Segregation of Aviation Fuels

All facilities utilized for handling aviation fuels shall be fully grade segregated (grade separated) and shall also provide segregation between batched (aviation product in storage that has been assigned a unique batch number and has been subject to a recertification test) and unbatched (aviation product in storage that has not been assigned a unique batch number and/or has been subject to a recertification test) product. This requirement may be relaxed only in the case of pipework upstream of aviation fuel storage tanks used for the receipt of multiple products from ships/barges or pipelines, and then only provided the system is so designed to facilitate the detection and appropriate downgrading of product interfaces.

6.1.2 Materials of Construction

The choice of construction materials is an important factor, particularly in the case of aviation turbine fuel systems, where product thermal stability can be degraded by the presence of very low concentrations of copper or by finely divided particulate matter.

The use of copper or copper alloys shall be eliminated wherever possible by the use of alternative materials such as stainless steel or aluminum. Zinc and cadmium are two other metals that adversely affect product quality. Zinc-rich (galvanized) coatings, cadmium alloys, and cadmium plating shall not be used for applications in contact with aviation fuels.

Pipework, vessels and tanks shall be fabricated from either carbon steel, internally epoxy-lined carbon steel, or from stainless steel.

6.2 Tankage

6.2.1 Working Capacity

The number and size of aboveground tanks (underground tanks require specialist advice not covered in this recommended practice) shall be sufficient to provide adequate working capacity to deal with peak demands of each product grade handled, with due allowance for settling, testing, and tank cleaning requirements. Allowance shall also be made for the reliability of the method of supply, batch volumes, and delivery frequency.

6.2.2 Vertical Tanks

- a) Newly constructed vertical tanks shall be fixed-roof type with a downward sloping conical floor (slope shall be 1:30) to a central drain sump. Where lap welds are used in floor construction they shall be designed such that the laps do not impede the flow of water to the drain sump.
- b) Existing vertical tanks in aviation grade service or existing tanks being converted to aviation grade product shall be inspected to ensure existing sumps are located in the low point(s) of the tank to ensure water/sediment removal via the tank water drain(s).
- c) Existing vertical tanks in aviation grade service or existing tanks being converted to aviation grade product where a replacement double bottom is to be installed shall be designed with the maximum slope mechanically allowed for the design (not greater than 1:30) and low point sump(s) installed in the low point(s) of the tank to ensure water/sediment removal via the tank water drain(s).

6.2.3 Horizontal Tanks

Horizontal tanks shall be installed on foundations that will ensure maintenance of a minimum 1:50 positive slope to a drain sump at the lower end.

6.2.4 Tank Lining

All new vertical tanks, existing aviation grade vertical tanks having new bottoms installed, or existing tanks being converted to aviation service shall have at least the floor and first (bottom) 3 ft of the walls internally coated per [API 652](#) meeting performance requirements of API 1541. This shall preferably be white or light colored to aid inspection. All new horizontal and small vertical (less than or equal to 30,000 U.S. gallons) shall be coated internally throughout.

6.2.5 Tank Fittings

a) Vents:

i) Jet Fuel Tank

All jet fuel tanks shall be free vented unless local legislation specifies that pressure/vacuum valves (P&V) shall be used. All vents shall have screens to prevent the ingress of contaminants.

ii) Aviation Gasoline Tanks

The vents of all horizontal and small vertical aviation gasoline tanks shall be fitted with P&V valves. Large vertical tanks shall be equipped with an internal floating pan/blanket and a fixed cone roof.

b) Sumps, Drain Lines, and Sampling Systems:

A low point sump with a drain line and a suitable valve for draining water and sediment shall be installed in all tanks. The drain line shall preferably be a nonrusting material, selected to avoid galvanic action created by dissimilar metals (i.e. stainless steel lines shall only be used in internally lined storage tanks and internally/externally coated mild steel in unlined tanks) of approximately 2 inches in diameter and fitted with an inline sampling valve.

In the case of aboveground tanks, the drain line shall lead to one of the following tank sump drain systems.

- i) A large capacity stainless steel, aluminum or internally lined carbon steel sample sump recovery tank, provided with a quick acting valve at entry, a cone down bottom with a drain valve, and a suitable motor driven return system back into the tank through a separate return line. The sump recovery tank shall be at least 50 U.S. gallons capacity. The lid shall be removable to view the contents of the sump recovery tank. There will be instances where it will need to be significantly larger depending on, for example, the storage tank size or mode of delivery of product to the storage tank. The design shall ensure that it is not possible for water to accumulate in the drain lines (where it could freeze and prevent draining in cold weather conditions).
- ii) A filtration system that operates at a flow rate equivalent to draining the tank sump into a sump recovery tank as described in Item i) above. The system will send removed water from the tank sump to a disposal system and return clean and dry fuel to the tank through a separate return line. Provisions shall be designed into the system to allow visual examination of the fuel, both before and after filtration.
- iii) A system that will allow safe and efficient draining of the storage tank through the sump that allows visual examination of the sumped fuel throughout the draining process.

Provisions shall be made in any of the three systems described above for taking a flowing line sample from the tank drain between the tank and the sample receiving system. The running sample shall be taken into an open container (such as a glass jar or stainless steel bucket, which shall be internally coated with white porcelain or epoxy and equipped with a bonding cable and clip) or a suitable closed circuit sampler using a transparent collection container. A pipe site flow indicator (site glass) shall not be used for this purpose.

c) Manholes/Gauging and Sampling Hatches:

Sufficient manholes shall be provided to facilitate entry for gas freeing, inspection, and cleaning. Provision shall also be made for representative samples to be drawn at all product depths. Fill connections and gauge openings shall be provided with tightly fitting covers to prevent entry of water and/or solid contaminants and evaporative loss.

d) Inlet and Outlet Connections and Floating Suctions:

All tanks shall be fitted with separate inlet and outlet pipe work. This is to ensure that only fully batched product is dispensed from storage for delivery to the airport.

For all aviation fuels the outlet should be via a floating suction arm with a minimum clearance between the arm inlet opening and tank floor plates of 9 in. or the diameter of the arm inlet, whichever is less, but in no case must the clearance be less than 4 in. or the manufacturer's recommendation. A simple buoyancy check device (check cables or position indicators) shall be fitted to the floating suction. Restraining wires shall be used to prevent the unit from rising above an angle of approximately 70 degrees to the horizontal or hitting the tank roof structure.

If no floating suction is provided, the inlet to the suction shall be placed at a suitable height above the tank floor. In a vertical tank this shall be 16 inches. In all cases where a floating suction is not present, the suction point shall be turned up from the bottom so as to not draw fuel from the bottom of the storage tank.

e) Positive Segregation:

Provision shall be made so that tanks can be positively segregated for product quality control purposes. The inlet and outlet to each tank in multiaviation tank storage terminals and the inlet (or at some other location on the segregated receipt line to the single storage tank) in single tank storage terminals shall be fitted with either:

- a “double block and bleed (DBB)” valve arrangement (either using a single DBB valve, or using two valves with a drain arrangement in a pipe spool between them);
- a removable distance piece (pipe spool and blind flanges); or
- a spade or spectacle blind.

NOTE These requirements are set for quality control purposes to isolate the tank from uncertified or nonaviation products; separate arrangements approved by an authorized person will be made to make the tank safe for any personnel entry into the tank.

f) Overfill Protection:

Storage tanks shall have provision for overfill protection using two independent sensors as per [API 2610](#).

g) Tank Signs:

All tanks shall be prominently numbered and clearly marked with the grade stored as described in [API 1542](#) and provisions made for the dates of the last cleanliness inspection and tank cleaning (see 10.7) to be added. Aviation gasoline tanks and tanks that have in the past contained leaded product shall be permanently marked with suitable signs to that effect.

h) Water Bottoms:

The carrying of water bottoms is not permitted in aviation product tanks. In an emergency, due to a real or suspected tank bottom leak, a water bottom may be used only to allow for time to remove the aviation product from the storage tank in a timely manner so the tank can be repaired.

6.2.6 Tank Dike/Dike/Bunds

Guidance can be found in [API 2610](#).

6.3 Pipelines (Used for the Transfer of Fuel to an Airport or Another Pre-Airfield Distribution Terminal)

6.3.1 Integrity Measures

For all pipelines, the following integrity measures shall be provided.

- For all buried pipelines a means of isolating the pipe section(s) and performing a pressure (leak) test(s) shall be provided. For longer (cross-country or feeder) pipelines, an automatic leak detection system shall also be provided.
- Wherever practicable, all pipelines shall be designed to accommodate cleaning or “intelligent” pigs.

6.3.2 Links with the Receiving Pre-Airfield Storage Terminals

Where a pipeline supplies tankage in pre-airfield storage terminals, the interface between the two shall be arranged to ensure the integrity of both. For instance, the following measures shall be considered:

- interface pressures and change of pressure ratings for components, such as filtration equipment;
- relief of thermal and surge pressures;
- facilities to collect product discharged for thermal or pressure relief systems and cloudy fuel arising from pipe pigging;
- automatic shutdown of the pipeline in the event of a tank high-high level, or if an emergency stop button is activated;
- information on the total flow rate and volume of fuel received during a transfer (especially if from more than one source at the same time).

6.4 Pipework Within the Pre-Airfield Storage Terminals

6.4.1 Separation and Segregation of Aviation Fuels

Except for pipework upstream of aviation fuel tankage used for discharge of mixed cargoes, coastal/inland waterway vessels, or for receipts from multiproduct pipelines, each grade of aviation fuel shall be handled in a grade-separated system or grade-segregated system, with no interconnecting lines between pipelines handling different products. Pipelines that handle tested and untested products shall be capable of providing positive segregation between tested and untested product.

Receipt system grade separation and batch segregation shall be achieved by “positive segregation,” meaning in conjunction with designated operational procedures:

- an approved DBB valve arrangement (either using a single DBB valve, or using two valves with a drain arrangement in a pipe spool between them);
- a removable distance piece (pipe spool and blind flanges); or
- a spade or spectacle blind.

NOTE These requirements are set for quality control purposes; separate arrangements approved by an authorized person will be made for maintenance isolation.

6.4.2 Piping Low Point Drains

Long pipelines should install low point drains at points where water/particulates can accumulate.

6.5 Tank Recirculation Piping

The advantage of recirculation piping, which allows product to be pumped from the storage tank through a filtration train (if wet or dirty fuel is expected) or through a fuel additive system to meet customer requirements, should be reviewed to see if it offers advantages during design or modification of a site.

6.6 Static Relaxation Design Considerations

Static relaxation shall be incorporated into the loading terminal design as outlined in [API 2003](#).

