Product Quality in Light Product Storage and Handling Operations

API RECOMMENDED PRACTICE 1640
FIRST EDITION, AUGUST 2013

AMERICAN PETROLEUM INSTITUTE

Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Users of this Recommended Practice should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations to comply with authorities having jurisdiction.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Where applicable, authorities having jurisdiction should be consulted.

Work sites and equipment operations may differ. Users are solely responsible for assessing their specific equipment and premises in determining the appropriateness of applying the Recommended Practice. At all times users should employ sound business, scientific, engineering, and judgment safety when using this Recommended Practice.

API is not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations to comply with authorities having jurisdiction

Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Contents

Contents

Product Quality in Light Product Storage and Handling Operations

1 General

1.1 Scope and Purpose

This recommended practice (RP) is intended to provide guidance on the minimum equipment standards and operating procedures for the receipt, storage blending and delivery of non-aviation light products, their blend components, and additives at distribution and intermediate storage terminals, including related operations of pipeline, marine vessel (barge or ship) and road and rail transport.

This publication is intended to provide recommended practices, rather than set rigid guidelines. Users of this publication should be aware that due consideration shall 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. Specialist advice shall be sought in these cases.

This publication should assist those involved in fuel handling at distribution and intermediate storage facilities. Every effort has been made by API to assure the accuracy and reliability of the data contained in this publication; however, API makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims 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.

This RP is intended to provide guidance on the minimum equipment standards and operating procedures for the receipt, storage, blending of light products, including but not limited to gasoline, kerosene, diesel, heating oil and their blend components (i.e. ethanol, biodiesel, and butane) at distribution and storage terminals, as well as light product shipments directly via a pipeline, marine vessel (barge or ship) or road and rail transport.

In addition, this RP provides guidance for the design, construction, operation and maintenance of light products storage and distribution terminals with the specific intent of protecting or ensuring product quality.

This document incorporates by reference a number of other standards and recommended practices. 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 in this RP are International Units (SI); US Customary (USC) units are in parentheses.

1.2 Non-Applicability

This document is not intended to cover fuels addressed in other applicable documents (i.e. aviation fuels) covered under API 1595.

This RP does not cover intermediate or residual fuels (i.e. bunker fuels, #4 oils and #6 oils).

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.

2 Normative References

The following standards, codes, publications, and specifications are cited in this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API *Manual of Petroleum Measurement Standards* Chapter 3.3, *Ethanol Density and Volume Correction Factor Tables*

API *Manual of Petroleum Measurement Standards* Chapter 8.1, *Manual Sampling of Petroleum and Petroleum Products*

API *Manual of Petroleum Measurement Standards* Chapter 11.1 *Physical Properties Data Section—Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubrication Oils*

API Bulletin 939-E, *Identification, Repair, and Mitigation of Cracking of Steel Equipment in Fuel Ethanol Service*

API Recommended Practice 652, *Linings of Aboveground Petroleum Storage Tank Bottoms*

API Recommended Practice 1626, *Storing and Handling Ethanol and Gasoline-ethanol Blends at Distribution Terminals and Filling Stations*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Standard 653, *Tank Inspection, Repair, Alteration, and Reconstruction*

API Standard 2610, *Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities*

ASTM D1835 [1], Standard Specification for Liquefied Petroleum (LP) Gases

ASTM D3244, Standard Practice for Utilization of Test Data to Determine Conformance with Specifications.

ASTM D4057, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

ASTM D4362, Standard Specification for Propane Thermophysical Property Tables.

ASTM D4650, Standard Specification for Normal Butane Thermophysical Property Tables

ASTM D4806, Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.

ASTM D6751, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels

ASTM Manual 47, Fuel and Fuel System Microbiology: Fundamentals, Diagnosis, and Contamination Control

CONCAWE [2], *Guidelines for handling and blending biodiesel*

ISO 4259 [3], Petroleum Products - Determination and Application of Precision Data in Relation to Methods of Test

EI Guidelines [4]

Title 40 Code of Federal Regulations [5]

---

1 ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
2 CONCAWE, Boulevard du Souverain 165, B-1160 BRUSSELS, Belgium, www.concawe.be.
3 International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.
4 Energy Institute, 61 New Cavendish Street London W1G 7AR, UK, www.energyinst.org.
5 The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, DC 20402.

3 Terms and Definitions

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

3.1
biodiesel
A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751.

NOTE Biodiesel is a renewable fuel for diesel engines. Made from agricultural co-products and byproducts such as soybean oil, other natural oils, and greases, it is an advanced biofuel. To be called biodiesel, it must meet the strict quality specifications of ASTM D 6751. Biodiesel can be used in any blend with petroleum diesel fuel.

3.2
biodiesel blend
A blend of biodiesel fuel meeting ASTM D 6751 with petroleum-based diesel fuel, designated BXX, where XX represents the volume percentage of biodiesel fuel in the blend.

3.3
blending into isolated tank
Blending such that the entire resulting tank is certified prior to release - where product is not moving directly into the conveyance so there is opportunity to analyze and correct prior to product being released. This includes batch mixing of components either inline or in tank, and online analytical control of the blend.

3.4
certificate of analysis
The document that contains the test results and declarations that comprise the certification of the product. Also called the certificate of quality in some locations.

3.5
certification
Declaration that the product meets specified requirements for product representation. The declaration is to be accurate and complete, conforming to regulatory, contractual and company policy requirements and traceable to a specific batch or volume of product.

3.6
corrective action
Corrective actions are improvements to an organization's processes taken to eliminate causes of non-conformities or other undesirable situations.

3.7
dedicated pipeline
A pipeline that is only used to handle one grade of fuel.

3.8
dedication
Refers to dedicated hardware, vessels and/or facilities such as pipelines, piping, tankage, and filters that are used to handle only one grade of fuel or component.

3.9
fit for purpose/fit for use
Meet or exceed equipment requirements and reasonable consumer needs.

3.10
fungible batch
A batch that may be mixed with one or more batches of product of the same grade and specification.

3.11
hydrophilic
Having an affinity for water; readily absorbing or dissolving in water.

3.12
interface
A volume of petroleum product generated in a pipeline between two adjacent volumes of non-identical petroleum product that consists of a mixture of the two adjacent products.

3.13
isolation
The act of creating a positive physical separation or barrier between products or components.

3.14
live (active) tank
A tank that is actively receiving and/or delivering product.

3.15
parameter
Used to describe an aspect of the product quality, a subset of the “total” specification for the product. For example: %vol Benzene is one parameter of a motor gasoline specification. Octane is another.

3.16
piping
A term used to describe pipework, valves and manifolds that are used to get product from a tank to a tank or conveyance (such as a Pipeline, ship, barge, tank truck) or vice versa. Normally the characteristics of piping are:

— the tankage and piping are under the control of one site,

— the volume of each batch is greater than the volume of the piping (can expect a maximum of one interface in the piping at any one time, the definition for **pipeline** for more than one interface).

3.17
pipeline
A pipeline can be considered to be a long tube, made up of one or many conduit sections that connects installations such as terminals, refineries, docks etc. that is used to transport light products and other fluids.

— The tankage, piping and pipeline are under the control of more than one site.

— The volume of the pipeline is large (can expect more than one interface in the pipeline at any time).

3.18
procedures
Procedures are documented work instructions that include scope, defined responsibility, task, frequency and reference standards.

3.19
product distribution
Refers to the shipment of a product to various locations or customers.

3.20
product release
Authorization to distribute products.

3.21
product transfer
Refers to either the movement of product from one conveyance or vessel to another, or change of title or custody.

3.22
product waiver
Product waiver is an authorized release, following full consideration of acceptable business and customer risks, of a product not meeting specification. Product waivers are limited in time, parameter, volume and geography.

3.23
Product Quality Event
All unplanned product quality variations (for those products and blendstocks covered within this RP) and actions that do not meet the expectations of this RP. This includes customer complaints, product waivers and product quality incidents.

3.24
Product Quality Incident
An incident is when product is non-conforming with either specification, fit-for-use, regulatory compliance or company policy and has passed a “perimeter” (site boundary or point of custody transfer), whether that perimeter is between an entity and a third party or between internal businesses.

3.25
renewable hydrotreated diesel
RHD
A fuel derived from 100 % hydrotreated bio-mass feedstocks that meets the registration requirements for fuels and fuel additives established by the EPA under Section 211 of the Clean Air Act and the ASTM D975 specification. RHD should not contain any fatty acid esters.

3.26
risk
Risk is the combination of the consequence and probability of failure mode scenarios.

3.27
running (live) tank
A running (live) tank is defined as any tank that is receiving and delivering product simultaneously (see Live Tank).

3.28
sampling terms and definitions

3.28.1
all-levels sample
A sample obtained by lowering the closed sampling device to the bottom of the outlet suction level, but always above free water, then opening the sampler and raising it at a uniform rate such that it is between 70 % and 85 % full when withdrawn from the product. Alternately, all levels samples may be taken with samplers designed for filling as they pass downward through the product.

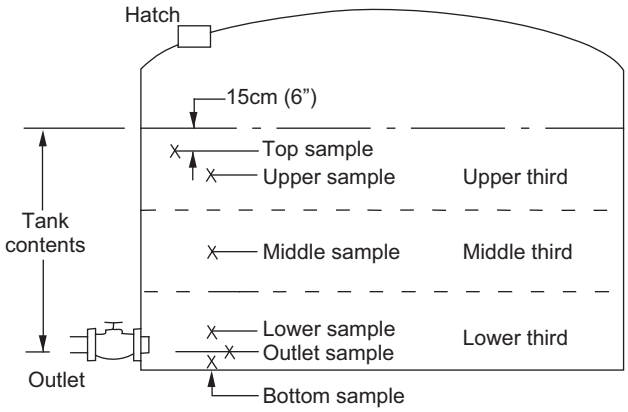
3.28.2
bottom sample
A spot sample collected from the material at the bottom of the tank, container, or line at its lowest point. In practice, the term bottom sample has a variety of meanings. As a result, it is recommended that the exact sampling location [for example 15 cm (6 in.) from the bottom] should be specified when using this term (see Figure 1).

3.28.3
bottom water sample
A spot sample of free water taken from beneath the petroleum contained in a ship or barge compartment or a storage tank.

3.28.4
dead bottom sample
A sample obtained from the lowest accessible point in a tank. This is typically directly from the floor (or datum plate) of the shore tank or the bottom of the vessel compartment.

3.28.5
lower sample
A spot sample of liquid from the middle of the lower one third of the tank's content (a distance of five sixths of the depth liquid below the liquid's surface) (see Figure 1).

3.28.6
middle sample
A spot sample taken from the middle of a tank's contents (a distance of one half of the depth of liquid below the liquid's surface (see Figure 1).



NOTE Taken from API *MPMS* Chapter 8.1, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*

Figure 1—Illustration of Common Spot Sample Positions

3.28.7
multiple tank composite sample
A mixture of individual samples or composites of samples that have been obtained from several tanks or ship/barge compartments containing the same grade of material. The mixture is blended in proportion to the volume of material contained in the respective tanks or compartments.

3.28.8
representative sample
A portion extracted from the total volume that contains the constituents in the same proportions that are present in that total volume.

3.28.9
running sample
A sample obtained by lowering an open sampling device to the bottom of the outlet suction level, but always above free water, and returning it to the top of the product at a uniform rate such that the sampling device is between 70 % and 85 % full when withdrawn from the product.

3.28.10
sampling
All the steps required to obtain a sample that is representative of the contents of any pipe, tank, or other vessel and to place that sample in a container from which a representative test specimen can be taken for analysis.

3.28.11
spot sample
A sample taken at a specific location in a tank or from a flowing stream in a pipe at a specific time (see Table 1).

Table 1—Spot Sample Requirements

Liquid Level	Number of Samples		
	Upper	Middle	Lower
Liquid level ≤ 3 m		X	
Liquid level > 3 and ≤ 6 m	X		X
Liquid level >6 m	X	X	X

3.28.12
suction sample (outlet)
A spot sample taken at the lowest level from which product is expected to be pumped from the tank (see Figure 1).

3.28.13
tank composite sample
A blend created from a single tank, as an example combining the upper, middle, and lowers samples. For a tank of uniform cross section, such as an upright cylindrical tank, the blend consists of equal parts of the three samples. A combination of other samples may also be used, such as running, all-levels or additional spot samples. For a horizontal cylindrical tank, the blend consists of samples in the proportions shown in Table 2.

Table 2—Tap Sampling Requirements

Tank Capacity/Liquid Level	Sampling Requirements
Tank capacity less than or equal to 1590 m^3	
Level below middle tap	Total sample from the lower tap
Level above middle tap-level closer to middle tap	Equal amounts from the middle and lower taps
Level above middle tap-level closer to upper tap	$^2/_3$ of total sample from the middle tap and $^1/_3$ of total sample from the lower tap
Level above upper tap	Equal amounts from the upper, middle, and lower taps
Tank capacity of greater than 1590 m^3	Obtain samples at listed in Table 1. If liquid level and taps available do not allow the proper number of samples to be obtained, additional manual samples are to be obtained, such as open hatch sampling from the top of the tank.

3.28.14
top sample
A spot sample obtained 15 cm (6 in.) below the top surface of 407 the liquid (see Figure 1).

3.28.15
upper sample
A spot sample taken from the middle of the upper one third of the tank's contents (a distance of one sixth of the liquid depth below the liquid's surface) (see Figure 1).

3.28.16
volumetric composite sample
A sample consisting of measured proportional parts from each zone if it is for a single tank. If the volumetric composite is for multiple tanks, or vessel compartments, it consists of measured proportional parts from each tank or compartment sampled.

3.28.17
zone sample
A sample taken as that part of the liquid column that is trapped within the whole height of a sampling device when it is sealed at a single spot location within a tank after having been fully flushed as it was lowered to that position.

3.29
segregated loading system
Piping from the shipping tank to loading flange, that is exclusive to product being loaded, with no connections that could introduce a possibility of cross-contamination.

3.30
segregated pipeline receipt
A batch of product that is not fungible, which is individually identified and has unique characteristics requiring special handling.

3.31
segregation
Segregation refers to provisions made such that products are positively isolated for quality control.

3.32
separation
The act of isolating distinct product or batches.

3.33
sequential blending
A blend method in which each component flows through its own meter and control valve separately and then into the common line. The two products flow sequentially one after the other, not simultaneously.

3.34
splash blending
A type of blending accomplished by metering each blend component into a tank truck separately by using different loading arms. The loading arms are changed manually by the truck driver or operator. In some cases, the components may be loaded into compartments at different locations. There is no automatic checking of the validity of the finished product blend.

3.35
transmix
A blend of fuels and/or components that does not meet the specifications for a fuel that can be used or sold, and is composed solely of any combination of previously certified gasoline (including previously certified gasoline blendstocks that become gasoline solely upon the addition of an oxygenate), distillate fuel; or gasoline blendstocks that are suitable for use as a blendstock without further processing.

3.36
wild-stream blending
Wild-stream blending is normally off rack blending of two products that supplies a blended product to the loading rack, one product uses a meter and a control valve and the second flows by demand or wild. The finished blend flows through a custody transfer meter and control valve downstream at the loading rack.

4 Health, Safety, Security, Environment

4.1 General

Guidance can be found in API 2610 for the following procedures:

— health and safety permit to work system;

— security;

— protecting the environment;

— drainage; and

— maintaining the integrity of fuel tanks and systems.

4.2 Management Responsibility and Accountability

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

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

Management at all levels shall provide a process for the early identification and mitigation of changes or upsets in the production, supply chain, or the final product use, that may result in product quality issues.

4.3 Quality Assurance System

4.3.1 General

The potential commercial, consumer, and regulatory consequences of a failure to supply the correct, fit-for-use, on-specification products are such that it is essential for each organization to have an effective quality assurance system that shall be designed to ensure the following:

— expectations are communicated to all personnel who can have an impact on product quality;

— products are designed and specified to both comply with applicable regulations and be fit for purpose;

— product quality performance is evaluated and the degree to which expectations and customer requirements are met is assessed;

— clear objectives are set that demonstrate leadership and promote commitment to improving product quality performance through active and visible participation;

— employees at all levels accept responsibility for effective product quality controls, and early identification of potential customer problems;

— suppliers and contractors that can impact product quality are involved in maintaining and improving product quality performance;

— there are seamless and visible product quality improvement work processes;

— appropriate facilities and equipment for the safe and uncontaminated delivery of light products through the supply chain and ultimately to the point of custody transfer are provided and maintained; and

— there is an auditable documentary record demonstrating the correct handling, storage, blending and delivery of product at the intermediate and distribution terminal.

4.3.2 Product Quality Assurance Organization

4.3.2.1 General

The company shall have individuals nominated to carry out the following quality assurance responsibilities for each terminal. The specific details and execution of such responsibilities may vary according to the nature of the operating unit. Records shall be kept of the responsible individuals as well as the details of their experience and training received.

4.3.2.2 Site Product Quality Manager

For each site, there shall be an individual designated to fill the role of the site product quality manager. This person shall be responsible for the efficient operation of the quality assurance system at that site. At intermediate storage and distribution terminals, this role is usually taken by the terminal manager or supervisor (or operations manager of a large facility).

The Site Product Quality Manager shall be accountable for:

— implementation of correct quality control procedures;

— maintenance of satisfactory documentation;

— release of product only of satisfactory quality; and

— training of all staff at the site who are designated as Product Quality Inspectors.

4.3.2.3 Product Quality Inspectors

All staff whose duties include tasks critical to the quality assurance system shall be fully trained in such tasks and designated to fill the role of Product Quality Inspectors. This role is usually taken by the terminal operator(s). Such tasks may be performed on-site or remotely and 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 or container concerned;

— visually inspecting and conducting control checks and on-line sampling from pipelines and dock lines on incoming and outgoing material, including checking seals on vehicles (if present);

— product receipt into storage and post receipt testing;

— loading of material on marine vessels, road or rail transports, containers and pipelines; and

— maintaining appropriate records of inventory, quality, and equipment checks.

4.4 Training

Due to the nature of operations work, it is essential that all those involved understand the consequences of any lapses in maintaining and following quality control procedures. Personnel shall be fully trained to undertake all

planned quality control operational tasks and be able to respond adequately to unplanned events affecting product quality.

Common elements of a training program shall ensure that:

— training requirements for each job position are identified;

— individual needs are assessed against the identified job requirements;

— there is a documented training plan to close the identified training gaps;

— training programs linked to operating procedures are implemented according to the plan and regularly updated;

— evaluation of the competency of the individual after training is completed;

— testing and evaluation methodologies are used to document effectiveness of training programs (materials, methods and content) and counter any weaknesses by improving the programs;

— individual needs are assessed at specified intervals and refresher training carried out as needed;

— training records are kept for all identified individuals; and

— change management procedures are in place which identify changes in tasks or the scope of a job or individual responsibilities in order to allow the necessary additional training to be identified and implemented.

4.5 Risk Assessments

Receipt, storage and delivery operations shall be risk assessed to determine the frequency and depth of oversight testing. The Risk Assessment should consider:

— any previous Product Quality audit, assessment or review of the facility;

— any history of incidents at the facility or with product from the facility;

— the terminal procedures for receipt testing (abbreviated testing) and additive reconciliation;

— if blending operations are performed;

— if the operation using pipelines is discharging to working tanks (live to the rack); and

— contract volume and service of products (i.e. consider the business impact if the product is not fit for service).

For changes that have the potential to impact product quality, there shall be procedures to ensure testing or other means of validation are considered. These changes include, but are not limited to:

— blend recipe changes,

— additive changes,

— new product introduction,

— hardware and software changes, and

— basic logistic changes (i.e. product source changes, receipt or delivery mode changes and tank change of service).

4.6 Incident Management

4.6.1 General

It is the goal of incident management to:

— identify events where there is a deviation from the expected product quality;

— manage or mitigate the impact;

— learn from the incident; and

— share what has been learned to prevent future incidents.

4.6.2 Incident Management Procedures

There shall be written procedures for the management of:

— product quality incidents;

— customer complaints;

— regulatory inquiries or violations; and

— other events which can impact product quality.

4.6.3 Initial Response

There shall be a defined responsible party or group and communication plan to manage product quality incidents with designated out-of-hours backups. The goal of the initial response should be to verify the incident, determine the scope, and minimize further impact of the incident.

4.6.4 Communication

Once the incident is verified, the concerned and affected parties shall be notified as soon as possible so additional mitigation steps may be taken.

4.6.5 Investigation

An assessment of the incident shall be carried out and management shall be notified. A Product Quality Incident Investigation shall be initiated with an investigation owner.

There shall be documented procedures for product quality complaints and incidents that ensure timely and regular stakeholder communication.

There shall be documented procedures in place and followed to ensure that all incidents are recorded and investigated in a timely manner.

The investigation shall address the failure mode(s), contributing factors, root causes and corrective actions.

4.6.6 Corrective Actions

The investigation process shall result in corrective actions that address each of the failure modes, contributing factors and root causes. Each corrective action shall include: responsible personnel, implementation dates, and verification of sustainability and effectiveness.

4.6.7 Post Incident Reporting

For ongoing learning, summaries of Product Quality investigations, including an assessment of the business impact, shall be circulated according to predetermined guidelines.

5 Storage Terminals—Equipment Design

5.1 General

The observance of certain fundamental practices in the design, construction and commissioning of facilities used for the storage, handling and transport of fuels, components and additives is considered essential to ensure that product quality is maintained.

5.1.1 Segregation of Fuels and Components

All facilities utilized for handling fuels and components shall be product and grade-segregated unless each product and component is monitored and controlled, and then only provided the system is so designed to facilitate the detection and appropriate downgrading of product interfaces (see 5.3 and 9.2).

5.1.2 Materials of Construction

The materials of construction for the pipework, vessels, and tanks for light product storage and handling shall be in conformance with appropriate API standards, industry standards, specifications, and recommended practices.

The choice of construction materials and equipment components is an important factor, particularly when new or novel blend components are being introduced.

Particular attention should be paid to issues (i.e. elastomer compatibility, sulfate deposition, pitting, corrosion and stress fractures) associated with the use of some biofuels.

Changes in fuel composition have been shown to cause some seal material degradation.

Some dyes have corrosive components that may result in accelerated corrosion in dye storage tanks.

5.1.2.1 Ethanol Compatibility

As stated in API 1626, before handling, storing and dispensing gasoline-ethanol blends, consideration should be given to the design and compatibilities of all components coming in contact with the blended liquid and vapors. Blend properties that should be considered include, stress corrosion cracking of steel structures, the flammability of vapors, vapor pressure, the hydrophilic nature of ethanol, the differential solvency of ethanol (i.e. the impact on polymeric materials: swelling, extraction, permeation, and embrittlement) and the water tolerance of ethanol blends. When a new blend is introduced, evaluate these properties for every step in the supply chain to assure product quality and safe handling and storage.

Compared to gasoline and hydrocarbon fuels in general, ethanol has a high electrical conductivity and oxygen content. The chemical properties of ethanol also contribute to its ability to readily absorb water. The suspension of water within gasoline-ethanol blends enhances galvanic corrosion and rusting by providing an oxygen-rich environment that is also a good conductor of electricity. These conditions present in ethanol blend service can lead to corrosion and ultimately metal loss of various components which are not normally adversely affected by gasoline.

Ethanol is not compatible with some grades of soft metals (i.e. zinc, brass, copper, lead, and aluminum). These metals may degrade or corrode in contact with ethanol and possibly cause a component failure or affect fuel quality. Seals, gaskets and other elastomers that are not specifically intended for use with ethanol blends can lose their

integrity leading to a product leak. Before using any component in ethanol service, verify its compatibility with the manufacturer.

5.1.2.2 Biodiesel Compatibility [6]

Existing supply and distribution facilities designed for use with hydrocarbon-only diesel fuels should in general be adequate for handling diesel fuels containing biodiesel. It is recommended to review the need for hardware modifications throughout the supply chain with consideration of potential material incompatibilities and the increased risk of deposit formation. The following points should be specifically considered:

— dedicated lines may be needed for imports and exports (at terminals) in order to avoid water and other contamination;

— gaskets should be compatible with B100 including those fitted in flanges and swivel joints;

— lagged or heat traced pipelines may be appropriate depending on the ambient temperatures and the cold flow properties of the diesel blend; and

— the design of product filters should be considered as well as the frequency of change out.

It is important to recognize that biodiesel is chemically different from fuel hydrocarbons due to its chemical functionality. Because of this chemical difference, various components in the fuel distribution system may be less compatible with biodiesel (B100) than they are with hydrocarbon-only fuels. Sensitive materials may swell or lose their integrity after prolonged contact with biodiesel. They may even promote fuel degradation reactions due to their chemical composition.

Biodiesel may degrade some hoses, gaskets, seals, elastomers, glues and plastics after prolonged exposure. Biodiesel may also permeate some types of plastics (polyethylene, polypropylene) over time and they are not recommended for use in storing B100. Natural or nitrile rubber compounds, polypropylene, polyvinyl, and plasticized PVC tubing materials are particularly sensitive. Polytetrafluoroethylene, fluoroelastomers or synthetic rubber materials, and Nylon are not sensitive to biodiesel and are among the materials that can be used to update incompatible materials in equipment.

Most tanks that are designed to store diesel fuel should also be adequate for storing B100. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, polytetrafluoroethylene, and most fiberglass products.

Brass, bronze, copper, lead, tin and zinc may catalyze the oxidation of biodiesel accelerating the formation of insoluble gels and salts. Lead solders and zinc linings should be avoided, as should copper pipes, brass regulators, and copper fittings. Affected equipment should be replaced with stainless steel, carbon steel or aluminum.

Table 3 provides an overview of materials that are either recommended for use or should be avoided when handling biodiesel (B100). This list is not comprehensive and the quality of the material must be appropriate for the intended application. Suppliers of B100 products and equipment vendors should be consulted regarding the most recent findings on material compatibility for bio-component applications.

In general, diesel fuels containing much lower biodiesel concentrations should have a much smaller effect on materials used in the fuel distribution system. At 10 % v/v biodiesel or lower concentrations, the effects are not likely to be appreciable although some sensitivity of nitrile rubbers has been reported. Although this is the case with fuel system materials, the metals indicated in Table 3 should still be avoided, even for diesel fuel blends in order to minimize the potential for metal pick-up.

---

6 This section used by permission from the CONCAWE *Guidelines for handling and blending Biodiesel.*

Table 3—Material Compatibilities with Biodiesel (B100)

	Material Recommended	Not Recommended
Metals	Carbon steel	Brass
	Stainless steel	Bronze
	Aluminum	Copper
		Lead
		Tin
		Zinc
Elastomers	Fluorocarbon	Nitrile rubber
	Nylon	Neoprene
	Polytetrafluoroethylene	Chloroprene
	Fluoroelastomer	Natural rubber
		Hypalon
		Styrene-Butadiene rubber
		Butadiene rubber
Polymers	Carbon filled acetal	Polyethylene
		Polypropylene
		Polyurethane
		Polyvinylchloride
Others	Fiberglass	

5.2 Tankage

5.2.1 Working Capacity

The number and size of tanks should be sufficient to provide adequate working capacity to deal with settling, testing, tank cleaning and maintenance requirements. Allowances should also be made for the reliability of the supply, batch volumes and delivery frequency.

5.2.2 Tank Lining

All new vertical tanks or existing tanks having new bottoms installed should have at least the floor and first (bottom) 3 ft of the walls internally coated per API 652. These should be white or light colored to aid inspection. All new horizontal and small vertical (less than or equal to 30,000 U.S. gallons) should be coated internally throughout.

5.2.3 Tank Fittings

Tank fittings allow access and critical operational processes to be conducted during both static and dynamic operations. These fittings facilitate the movement of air, product, and personnel to ensure safety, and operational integrity and product quality. If not properly installed and maintained these fittings can also allow for contamination and undue degradation of the product quality.

a) *Vents*—All vents shall have screens or be designed to prevent the ingress of contaminants.

b) *Sumps and Drain Lines*—A low point sump with a drain line and a suitable valve for draining water and sediment shall be installed in all tanks.

c) *Water Draw*—The carrying of excessive water bottoms is not permitted in product tanks. All tanks shall be constructed with sufficient water draw capability, such that water can be effectively removed.

d) *Manholes, Gauging and Sampling*—Sufficient manholes shall be provided to facilitate entry for gas-freeing, inspection and cleaning. Provisions shall also be made for representative samples to be drawn at the necessary product depths, per guidelines specified in ASTM D4057 and API *MPMS* Ch. 8.1. Fill connections and gauge openings shall be provided with tightly fitting covers to prevent entry of water or solid contaminants and evaporative loss.

e) *Inlet and Outlet Connections*—All tanks shall be fitted with separate inlet and outlet pipe work. This is to ensure that the product to be dispensed originated from the tank, as opposed to untested incoming line fill.

f) *Tank Signs*—All tanks shall be prominently identified such that the product stored can be easily determined.

5.2.4 Ethanol Storage Tanks

Neat ethanol, fuel ethanol and gasoline-ethanol blends can be stored at terminals in either fixed roof tanks or tanks equipped with an internal floating roof. A major consideration when storing ethanol is to keep it from coming in contact with water.

External floating roof tanks are open to the elements and unable to prevent precipitation from running down the interior of the tank shell past the roof seals and thereby reaching the stored product. Rainwater may also be introduced into the stored product through a leaking roof drain. Therefore, tanks with external floating roofs are not recommended for ethanol or ethanol blend storage.

Ethanol is hygroscopic. It readily absorbs water and forms a homogenous solution with water over its entire dilution range. Water that gets into ethanol and gasoline-ethanol storage tanks is immediately absorbed and can contaminate fuel. In contrast, gasoline is hydrophobic and has a low solubility with water. Consequently, the presence of ethanol increases the overall solubility of water in ethanol-gasoline blends compared to base gasoline. understanding how water affects gasoline-ethanol blends and how it can be detected can help assure better fuel quality.

Water can be introduced into a storage tank by rain or snow leaking in through unintended openings in the tank shell or roof. External floating roofs are particularly prone to water entering during inclement weather. Diurnal temperature changes and humid conditions can promote the formation of condensation on the inner surfaces of tanks above the internal floating roof. With sufficient accumulation, condensation can collect and drain past the floating roof seals into the liquid product.

Stress corrosion cracking is environmental cracking in a susceptible metal or tough thermoplastic material that is produced by the simultaneous application of a tensile stress and exposure to a corrosive environment. Ethanol has the potential to create such a corrosive environment and must be considered when designing and building storage vessels.

It is recommended that API 1626 and API 939-E be referenced when preparing an operation for ethanol service.

5.2.5 Biodiesel Storage Tanks

Biodiesel (B100) should be stored at temperatures at least 6 °C higher than the cloud point. Above ground storage tanks (depending on the climate) should be protected with insulation, heating systems or other methods. Heating should be designed to minimize hotspots and prolonged exposure of the biodiesel to high temperatures. Provisions for agitation should be considered since slow agitation can prevent precipitates from building up on the tank bottom and can help to redissolve precipitates once they are present in the fuel.

5.3 Product Receipt System Design

This section refers to product receipts from pipelines, marine vessels, rail cars and trucks.

Where product is supplied to a terminal via an external source, the product receipt system shall maintain the quality of the products being transferred.

The following shall be considered:

— Interface pressures and change of pressure ratings for components (i.e. filtration equipment).

— Facilities to collect product discharged from pressure relief systems, cloudy fuel arising from pipeline pigging and other product quality issues.

— Information systems to provide the following:

  — product type,

  — flow rate,

  — volume of fuel received during a transfer,

  — product properties (e.g. density),

  — batch changes, and

  — batch timing and sequence.

— Other measures and information as appropriate and relevant to product quality.

5.4 Pipework within Storage and Distribution Terminals

5.4.1 Segregation of Fuels and Components

Each product type and grade of fuel shall be separated or segregated in the facility product system, except for pipework upstream of fuel and component tankage used for discharge of mixed cargoes, coastal and inland waterway vessels or for receipts from multi-product pipelines, or expressly designed for product and component blending.

Provisions shall be made so that lines can be positively segregated for product quality control purposes. The inlet and outlet lines to or from each tank in multi-tank storage terminals shall be fitted with either:

— a valve arrangement designed to isolate product and prevent bypass via pressure build up either by temperature changes within isolated sections of pipe or due to static head pressure;

— a removable distance piece (pipe spool and blind flanges); or

— a spade or spectacle blind; and

— double block and bleed valves where appropriate.

5.4.2 Piping Low Point Drains

Piping configuration and the flow profile that allows contaminants to accumulate shall incorporate means for drainage at low points.

5.4.3 Tank Recirculation Piping

When designing or modifying a site, the use of recirculation piping or mixing nozzles should be considered. Among other advantages, recirculation piping allows:

— product being pumped from the storage tank through a filtration train (if available);

— product being pumped through a fuel additive system to meet customer requirements; and

— mixing for homogeneity and seasonal conversion.

Recirculation piping should be designed with appropriate controls to ensure tank bottom water and sediment are not carried out with the product during delivery.

5.4.4 Pipe Work Markings

All piping work and valves on receipt and loading systems shall be clearly marked. The product name, color coding, and flow directional arrows should be indicated at all connection points and on either side of locations where the pipework is obscured from view.

5.5 Component and Fuel Blending Systems

5.5.1 General

Component and fuel blending systems shall be designed to automatically blend fuel grades or blend components at the required concentrations. The control systems shall be designed to shut down the blending operation and not issue a Bill of Lading if any of the components are outside of the established blend tolerances.

5.5.2 Terminal Metering

Precise and accurate measurement of blend components and/or finished product volumes is a crucial element in providing products that meet regulatory requirements and standard specifications. Meters can be calibrated accurately for fuel ethanol and gasoline because they have uniform properties that remain consistent. Variation in volume caused by temperature variations can be compensated for by using readily available temperature coefficient of expansion tables. Each component has its own expansion table (refer to API *MPMS* Ch. 11.1 and API *MPMS* Ch. 3.3).

Meter accuracy is also affected by the blend point location. If the smaller blend stock is introduced just upstream of the delivery meter (i.e. in sidestream blending), there may be insufficient distance for the two components to mix thoroughly before reaching the meter. Consequently, the amount of volume expansion is unknown; therefore, the meter may be measuring a stream with varying characteristics and provide an inaccurate volume measurement. To promote more accurate volume measurement, the blend point location should be a minimum of 6 ft upstream of the delivery meter.

5.6 Road and Rail Transport Loading and Unloading

Bottom loading and unloading of road and rail transports is the preferred method of product transfer.

Top loading and unloading should only be performed under cover to avoid weather hazards and the associated product contamination.

— The use of drop tube or stingers for unloading should be avoided to reduce risk of the following:

  — excessive sediment buildup on the bottom of the vessel;

— excessive remaining onboard (ROB) quantities of products; and

— volume discrepancies.

5.7 Filtration

Filtration systems are recommended to avoid particulate or other forms of foreign material contamination. These systems may be installed on truck, rail, pipeline and marine movements with the ability to sample both pre-filtration and post- filtration.

Where filtration exists, the system(s):

— shall be sized consistent with the expected flow rate and product type;

— may include two or more vessels to allow for bypassing a single vessel without interruption to operations;

— shall have a differential pressure monitoring system or equivalent to ensure system integrity;

— shall include air eliminators to reduce risk of internal fire or explosion that may affect filter integrity and product quality;

— shall be fitted with a pressure or thermal relief valve where flow is redirected such that product quality is preserved;

— shall include low-point drain ports to monitor and evacuate water from the vessel;

— may include a water defense system that would shut down flow or trigger an alarm when unacceptable water levels are detected; and

— shall ensure a minimum of 95 % efficiency for media sizes that are consistent with internal specifications, customer and regulatory requirements.

NOTE The use of filtration systems may increase the buildup of static electricity within the product. Refer to API 2003 for specific guidelines.

6 General Operating, Maintenance, Inspection and Test Requirements

6.1 Planned Maintenance, Inspection, and Testing

A system of planned maintenance, inspection, and testing shall be established and records kept for all product quality activities.

6.2 Filtration Equipment

6.2.1 Strainers and Filters

All strainers, filtration, and water separation equipment shall be checked and maintained regularly (see Section 7).

6.2.2 Filter Vessels

All in service filter vessels shall have the dates of last inspection and the last element change date documented. It is recommended that the dates be applied on the body of the vessel or physically attached on an information plate.

All in service filter vessels should have filter element and vessel bolt torque data applied on the body of the vessel or physically attached on an information plate. If data is not applied to the vessel, it shall be documented and kept on site.

6.3 Tank Movement Indicators (Level Alarms)

Indicators shall be tested at least annually to ensure all components of the system are functioning correctly.

6.4 Tank Vents

All tank vents shall be inspected annually. Damaged or corroded mesh screens shall be replaced. For pressure and vacuum vents, pressure weights shall be checked to ensure that they conform to the design pressure rating of the tank.

6.5 Tank Inspections and Cleaning

6.5.1 Inspection Frequency

When a tank is taken out of service, inspection for cleanliness shall be undertaken and thorough cleaning carried out if indicated by inspection results. If the inspection reveals microbial growth or build up of sediment exceeding approximately $^{1}/_{5}$ of the tank bottom surface, cleaning of the tank shall be undertaken. Prompt inspections shall be carried out if there are indications that fuel quality downstream of the tank is unsatisfactory (e.g. short filter lives, sediment in finished product, discolored water drainage or slimy deposits).

Inspection for internal mechanical condition shall be carried out in accordance with local regulatory requirements or per API 653.

6.5.2 Inspection Procedures

A regular inspection schedule is critical in order to provide ongoing assurance that the risk of contamination due to introduction of foreign compounds such as water, sediment, rust, etc., or operational failure leading to improper storage and handling, is prevented.

a) *Cleanliness*. Internal tank surfaces shall be thoroughly visually inspected for the presence of sediment, bacterial growth, surfactant-type contaminants, and if relevant, the condition of the lining. An assessment shall be made as to whether cleaning is necessary.

b) *External Condition*. The tank structure and all relevant fittings shall be inspected and repairs or servicing carried out as necessary. Checklists shall be prepared to ensure a thorough inspection is conducted. The following items shall receive particular attention:

   — tank base and foundation (e.g. for evidence of tank settlement or water “wash-out” damage);

   — vent valves, mesh screens, gauge hatches and gauging systems;

   — tank-side valves drain lines, sampling systems;

   — tank floor leak detection; and

   — tank grounding.

c) The internal mechanical condition inspection is intended as a thorough check of the structural integrity of the tank. For product quality, the inspection shall include, but is not limited to the following:

- suction and discharge piping,
- jet nozzles,
- mixers,
- diffusers,
- water draw,
- gauge tube and stilling well,
- roof drains,
- seals,
- floating suction,
- tank floor low point, and
- tank lining condition.

A report shall be prepared and be available for inspection at the site. Pictures should be taken to document the internal condition of the tank and documents should be updated to reflect actual tank condition.

6.5.3 Tank Cleaning

Simple flushing techniques and mopping are recommended for cleaning. No chemicals or cleaning materials shall be used unless previously approved for such purposes as they could contaminate the fuels to be stored in the tanks.

6.5.4 Inspection and Cleaning Records

Records regarding the inspection and condition of the tank shall be kept and made available for reference. The records shall clearly indicate the type (i.e. dirt, rust, sediment, and water) and amount of any contaminants found.

The dates of the most recent inspection and cleaning shall be stenciled on the tank shell or otherwise documented and stored at the facility.

6.6 Piping Systems

Guidance for piping systems can be found in API 2610.

7 Strainer and Filtration Equipment Management

7.1 Strainers

All mesh strainers shall be drained, opened and inspected twice a year at least 180 days apart. Strainers used for pump and valve protection should be opened and inspected at least annually.

7.2 Filters

7.2.1 Drain Checks

A visual check for water and sediment shall be made on a sample drawn from the filter drain with the filter under pressure. The interval shall be weekly. Frequency shall be increased when necessary to avoid:

— microbial growth,

— phase separation, and

— water carry-over.

If free water or sediment is found during draining, the draining shall continue until no free water or sediment is observed. The quantities of water and sediment and any visible signs of microbiological growth in the sump draining shall be recorded.

7.2.2 Differential Pressure Checks

Differential pressure shall be observed daily during manned operations or monitored electronically to ensure that the maximum limit is not exceeded. At weekly intervals, the observed differential pressure shall be recorded at the maximum achievable flow. A weekly graph should be prepared showing the differential pressure at, or corrected to the maximum achievable flow.

The filter used in direct-reading differential pressure gauges shall be checked and replaced as needed whenever filter vessels are inspected or filter element replaced.

7.2.3 Internal Inspection

All filter vessels shall be opened at annual intervals and inspected internally for the following:

— cleanliness of vessel;

— element appearance;

— condition of internal lining;

— proper fitting of elements, which shall include confirmation of torque settings; and

— inspection for proper operation of the vessel air eliminator and thermal relief system.

During inspection of the filter vessel, attention shall be paid to:

— any gelatinous or “slimy” contaminants or sludge;

— any “leopard spotting”, indicating the presence of microbiological growth;

— the condition of seals, gaskets, “O” rings and the torque on element securing bolts;

— the condition of ancillary equipment (i.e. air eliminators and pressure relief valves);

— any elements showing signs of mechanical damage;

— any signs of electrical static discharge.

A record shall be maintained of the results of the inspection and any repairs performed.

7.2.4 Electronic and Mechanical Water Defense System Check

All electronic and mechanical Water Defense Systems shall be checked annually for proper operation.

7.3 Element Change Criteria

7.3.1 Microfilter Elements

These shall be replaced if:

— the differential pressure reaches the maximum limit set by the manufacturer;

— element failure is indicated by a sudden drop in differential pressure;

— samples from the downstream side of the filter contain significant quantities of particulate.

7.3.2 Filter and Water Separators: Coalescer Elements

These shall be replaced:

— if the differential pressure exceeds manufacturers recommended maximum limit;

— if element failure is indicated by a sudden drop in differential pressure;

— if samples from the downstream side of the filter contain significant quantities of particulate; and

— after a maximum of three years in service.

7.3.3 Filter and Water Separator Elements

Polytetrafluoroethylene coated screens or synthetic separator elements may continue in service indefinitely provided that they satisfy the manufacturers test requirements on ability to repel water. Paper separators shall be changed out when the vessels' coalescer elements are replaced.

7.4 Filter Vessel Change Out Procedure

The filter vessel change out procedure shall address the following:

— a filter element change out shall only be performed by trained staff using manufacturer's recommended procedures and tools;

— all filtration vessel change out work shall be risk assessed, completely isolated and a work permit issued before starting inspection or maintenance work;

— the lid of the vessel securing bolts shall be torqued in place to the manufacturer's recommended settings;

— to minimize the risk of fire and explosion, all filter vessels shall be filled carefully and slowly. All air shall be bled off from the unit while filling is in progress; and

— filling shall be supervised throughout by a trained operator. After filling, all joints and gaskets shall be carefully examined for signs of leakage.

8 Sampling and Testing

8.1 General

8.1.1 Standard Practices

Sampling shall be undertaken by competent, trained personnel using clearly defined and documented procedures and appropriate apparatus to ensure that the sample obtained is truly representative of the material from which it has been drawn.

8.1.2 Samples for Certification Testing

Samples to be taken for certification testing, where the results are required to be reported to others (i.e. customers or regulators, or for the purposes of supporting claims) shall be taken in accordance with practices outlined in test method or by accepted industry practices such as:

— API *MPMS* Ch. 8.1/ASTM D4057, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*;

— API *MPMS* Ch. 8.2/ASTM D4177, *Standard Practice for Automatic Sampling of Petroleum and Petroleum Products*;

— ASTM D1265, *Standard Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method*; and

— ASTM D5842, *Standard Practice for Sampling and Handling of Fuels for Volatility Measurement*.

NOTE Specific sample types are defined in Section 3.

8.1.3 Samples for Contamination Testing

In cases where samples are taken for in-house confirmation that no unacceptable contamination has taken place, standard industry practices should be followed (see 8.1.2). Alternative measures that adequately ensure the samples are representative of the product being tested may be used.

8.2 Sampling—Basic Requirements

Before sampling, the sampling apparatus (including ropes or cords to suspend the sampler or other ancillary equipment) and containers shall be clean and free of any contaminating substance. It is good practice with light petroleum products to flush or rinse the container with the product to be sampled prior to drawing samples. Sample containers shall be free of all substances that would affect the results of the product being tested. This practice 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).

All metal sampling gear as well as ropes or cords shall be constructed from non-spark generating materials.

Sample containers should conform to the requirements listed in Table 4.

The operator carrying out the sampling shall wear clean gloves impervious to finished fuels, components, and additives to prevent contamination of the sample.

Sampling points shall be designed to prevent the intrusion of water, dirt and other foreign material.

To the extent possible, precautions shall be taken to maintain the integrity of the sample and prevent it from being contaminated by adverse weather conditions or affected by the environment including, but not limited to:

— rain,

— snow,

— heat,

— sun, and

— dust.

Sample containers shall be securely closed immediately after the sample has been taken.

Samples shall be 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.

Representative tank samples cannot be obtained through solid gauge tubes. These types of tubes are used on many external and some internal floating roof tanks. Because of the solid boundary formed by the gauge tube, there is no free flow of liquid. Thus, samples obtained through a solid gauge tube are not useful in determining the actual properties of the stored product.

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.

Samples shall be free from dirt and water except in the case of samples specifically taken to determine the presence of such contaminants.

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. 8.1.

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:

— Location (Terminal),

— Product Name,

— Date and Time Sampled,

— Sample Source (i.e. Tank No., Pipeline Batch No., Vessel name and compartment),

— Sample Type (i.e. composite, line), and

— Sampler’s Name or ID.

When samples are required from levels in a tank or bulk container, the order of sampling shall be from the top downwards.

Samples of materials that could be affected by light shall be stored in a dark place.

When a sample of gasoline or gasoline blend component is taken, especially at high ambient temperatures, care must be taken immediately after sampling and during sample transport. The container shall be examined closely for leaks to avoid the loss of light ends through the cap sealing material.

Samples shall remain protected from direct sunlight and should be kept cool to avoid the loss of light ends and excessive oxidation. The sample shall, if at all possible, be taken directly into the container and not transferred from sampler to another container.

8.3 Testing

Testing procedures shall be established to provide confidence that product has not been contaminated.

8.4 Sample Retains

Samples should be retained for investigating complaints, disputes or incidents. Retained samples are often tested to establish the actual product quality and the presence of any cause of failure at that point in the supply chain. Traceability of batches enables the investigation to focus on the samples particular to the product in question.

Due to safety and liability consequences, retained samples are of particular importance. Retained samples are also useful in establishing the extent of a Product Quality event to determine any requirements for product recall.

Retained samples are routinely taken from a number of points in the supply chain including refinery finished product tank, entry into pipeline, dock when loading a ship or barge, barge when bunkering a ship, terminal tank or pipeline on receipt of product into terminal and from trucks before delivery to customer. For all points in the supply chain, retained samples should be taken and stored for a period of time corresponding with internal company, customer and regulatory requirements. Minimum duration defined in Table 4 shall be extended as necessary based on length of time product remains in the supply chain.

Table 4 defines the minimum sample size, storage container type and retention time that should be followed. (Continued)

Table 4—Minimum Sample Size, Storage Container Type and Retention Time

Sample Type	Sample Location	Container Size	Container Type	Retention Time [a]
Gasoline and Components, Fuel Ethanol, Distillate, and Biodiesel (B99-100) Pipeline	Line sample during receipt	1-Quart	Glass	Until tank is approved for release
Gasoline and Components, Fuel Ethanol, Distillate and Biodiesel (B99-100) Marine Vessel	Vessel composite prior to discharge	1-Gallon	Glass [c], Epoxy-lined container or Metal Can [b]	30 days (or until next receipt if longer than 30 days)
Gasoline and Components, Fuel Ethanol, Distillate and Biodiesel (B99-100) Marine Vessel	Line sample during discharge	1-Quart	Glass	Until tank is approved for release
Gasoline and Components, Fuel Ethanol, Distillate and Biodiesel (B99-100) Live to Rack Sample	Line sample during loading	1-Quart	Glass	Retain only if test results indicate off-spec product
Gasoline and Components, Fuel Ethanol, and representative sample	Tank composite post-receipt	1-Gallon	Glass [c], Epoxy-lined container or Metal Can [b]	30 days (or until next receipt if longer than 30 days)

Table 4—Minimum Sample Size, Storage Container Type and Retention Time (Continued)

Sample Type	Sample Location	Container Size	Container Type	Retention Time [a]
Distillate and Biodiesel (B99-100) representative sample	Tank composite post-receipt	1-Quart	Glass, Epoxy-lined container or Metal Can [b]	30 days (or until next receipt if longer than 30 days)
Gasoline, Fuel Ethanol, Distillate and Biodiesel (B99-100) Marine Vessel	Vessel composite after loading	1-Gallon	Glass, Epoxy-lined container or Metal Can [b]	30 days
Additive Tank Car		1-Quart	Glass	60 days (or until tank car is empty)
Monthly Tank Composite		1-Quart	Glass	30 days
Additive Tank Truck		1-Quart	Glass	6 months (or until next receipt if longer than 6 months)
Additive Tank Bottoms		1-Quart	Glass	Retain only if test results indicate off-spec product (poor appearance)

[a] Retention times should be extended in case of product quality disputes.

[b] Soldered metal cans are not suitable for Fuel Ethanol or ULSD Samples due to potential for sulfur contamination.

[c] Where appropriate, amber glass bottles should be used.

9 Fuel Quality Control

9.1 General

To ensure regulatory compliance and customer satisfaction, it is vital that fuels are not contaminated beyond levels permitted by regulation or levels which result in off specification or non-fit-for-purpose products. The following guidelines help ensure such contamination does not occur.

9.2 Product Segregation

Product segregation is necessary to ensure product quality.

Segregation refers to provisions made such 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 should be fitted with any of the following:

— double block and bleed valve arrangement (either using single DBB valve or using two valves with a drain arrangement in a pipe spool between them);

— a removable distance piece; or

— a spectacle blind.

Dedication, which refers to tankage, piping, valves and filters that are only used to handle one grade of fuel, is a form of segregation. This is the most effective means for ensuring product isolation.

To provide confidence that product has not been contaminated nor has an unacceptable level of inter-product mixing, a documented risk assessment shall be conducted. Elements of this risk assessment should include, but not be limited to the following:

— type of segregation (i.e. blank, single valve, double block valve, double block and bleed valve, and valve interlocks);

— potential to exceed maximum design pressure differential across valves;

— potential for contaminant ingress, such as:

  — thermal relief valve venting;

  — filter failure or bypass;

  — sampling process;

  — vapor recovery unit return streams;

  — water brought in with product;

  — timing of valve opening and closing;

  — contamination due to lubricating of valve plugs; and

  — contamination resulting from mechanical work, startup or shutdown;

  — contamination due to product from static lines or static vessels.

Table 5 shall be used as guidance when evaluating the risks of co-mingling products.

9.3 Additives

Product additives are intended to be in the finished product for:

— protection and performance of distribution and user equipment

— compliance with product specification

— regulatory compliance

— marketing claims

Finished product additives include detergents, multi-functional additive packages, ignition improvers, lubricity improvers, anti-valve recession additives, flow improvers, conductivity improvers, dyes, markers, and anti-oxidants/ corrosion inhibitors that are intentionally added for product performance.

While it is intended that additive systems be tied into product lines so additives can be introduced to meet regulatory or contractual requirements related to product performance and safety, care should be taken to ensure the additives are not allowed to enter the product system unchecked. In order to ensure over additization does not occur, systems shall be installed to ensure additives are not introduced during shut down situations.

Table 5—Potential Effects of Cross Contamination of Products

CONTAMINANT or Prior Product	PRODUCT				
	Unleaded Gasolines	Kerosene	Middle Distillates	Residual or Heavy Distillate Fuels	ULSD
Leaded Gasolines	2, 3, 7	1, 2	1	1	1, 6
Unleaded Gasolines	3, 9	1	1	1	1, 6
Gasoline Base Jet Fuel (Wide-cut)	2, 3	1	1	1	1, 6
Kerosene	3, 4, 5		1,8	1, 8	6, 9
Middle Distillates	2, 3, 4, 5	2, 4, 5			2, 6
Residual or Heavy Distillate Fuels	2, 3, 4, 5	2, 4, 5	2, 6		2, 5, 6
ULSD	3, 4, 5	2, 5			9

Key
1) Flashpoint
2) Color
3) Octane value
4) Gum residue
5) Distillation end point
6) Sulfur requirement
7) Lead-free requirement
8) Viscosity
9) Seasonal Properties

9.4 Product and Component Inventory Variations

Inventory variations can provide early information about possible contamination after receipts, in storage and during loading. Any unexplained inventory variation of greater than 0.25 % shall be investigated to ensure no contamination that could degrade the product has occurred.

Possible causes of unintended product movement may include, but are not limited to:

— improper valve closure from conveyance after receipt completion;

— tank-to-tank movement due to pump or static head pressure;

— line-to-line movement due to failed check valves during loading; and

— improper tank lineups or blend component setups.

9.5 Settling

In cases where unacceptable levels of water or sediment have been identified during a product receipt, the necessary provisions shall be taken to allow tank to “settle” prior to release. During this “settling” period, the tank shall be appropriately isolated and clearly identified.

Suggested settling periods.

— *Distillates*. One hour per foot depth of fuel from the suction or outlet or 24 hours (whichever is less).

— *Gasoline*. Five minutes per foot depth of fuel from the suction or outlet.

However, where fast turnaround of product is essential (see “live to the rack” operations), special precautions shall be taken to ensure tank bottoms (i.e. water, sediment, dirt and rust) are not delivered along with the product. Procedures may be varied based on the tank bottom configuration (e.g. cone down tank bottoms are less susceptible to delivery of contaminants from the bottom of the tank).

In cases where externally controlled mixers (i.e. paddle mixers and recirculation pumps) are in use to ensure uniform product throughout the tank, settling times shall begin after the mixers have been turned off.

9.6 Post-receipt Tank Testing

9.6.1 General

Tanks should be tested after receipt according to the following guidelines:

Product	Minimum Abbreviated and Contamination Tests
Gasoline, Components, Ethanol	Density, API Gravity Visual, Appearance
Distillate, Components, Biodiesel	Density, API Gravity Visual, Appearance Flash Point Sulfur

9.6.2 Gravity and Flash Comparisons

The tank gravity after receipt values should lie between the receipt product gravity and the prior tank gravity within 0.5 °API. Flash results should lie between the receipt flash and tank prior flash within 5 °F. Calculations may require volume weighting for accuracy.

9.7 Product Release for Custody Transfer

9.7.1 General

Standard operating procedures for controlling product distribution shall be in place to ensure product quality. These procedures shall include appropriate risk management considerations. Product can only be released for shipment or pipeline delivery when product is on specification as defined by contractual agreement or regulatory requirements. When product quality is in question, formal investigation procedures should be implemented. The risks of continued delivery during the investigation period shall be considered. If the off-spec condition is confirmed, appropriate personnel shall be contacted per the standard operating procedure. If product transfer or distribution is to continue, appropriate authorization(s) must be received from affected stakeholders.

9.7.2 Waivers and Off Spec Products

The product quality procedures in this RP will help to assure that products always meet specifications and customers’ needs. It is recognized; however, that there may be occasions when products are blended or manufactured that do not fully meet all specifications. When this occurs, a waiver or other form of approval is required before the product can be transferred to the next customer in the distribution chain. Alternatively, off specification product may be re-blended, downgraded or disposed of.

The appropriate regulatory body, terminal, pipeline, customer or other involved parties shall retain waiver approval authority for all products not meeting core, minimum standards, regulatory or procurement requirements.

All waivers that have been approved by the appropriate regulatory body, terminal, pipeline, customer or other involved parties shall be documented and available for review. It is the responsibility of the individual with authority to release

the product to ensure this information is maintained. Documentation shall include the product(s), volume, specification not met, cause and reason for the waiver request.

9.7.3 Delivery from Running Tanks

In situations where a tank is simultaneously receiving product and delivering “live” to the rack, care shall be exercised to protect the quality of product being loaded. Under these circumstances, turbulence in the tank increases the chance of carry-over of water and/or sediment from the tank (see 11.7).

9.8 Oversight Testing

9.8.1 General

Oversight samples should be taken as part of a comprehensive program to assure operational processes do not compromise product integrity and to verify that the product meets specifications. (i.e. retail service station or rack samples).

9.8.2 Testing

Oversight testing or testing included as an element of Management of Change shall be included for any infrastructure or operational changes which could result in an unintended change of properties of the product handled (See Table 6). Examples include: change of service in a tank having a heel or remaining product; altering of the volume or flow paths of product displaced; altering of the sequence of product receipt and tank switching procedures. Testing for products intentionally blended is addressed in section 12.

Suggest other tests may be necessary, to mitigate regulatory risks or to ensure compliance with contractual obligations, and should be included.

All delivered products shall be sampled and tested at a time and place as to provide representative samples and results of the products delivered.

9.8.3 Oversight Testing Frequency

Products shall be sampled and tested at least once every three months or when changes to the operation dictate additional risk mitigation. See Table 6.

9.8.4 Communication of Results

Results shall be kept and made available to receiving parties upon request.

10 Receipt Procedures

10.1 Receipt—General

Petroleum products are normally distributed in bulk and hence there is opportunity for contamination by water, sediment or microorganisms, or by mixing with other products.

All marine, tank truck and rail car receipts shall be accompanied by a Bill-of-Lading (BoL) and a Certificate of Analysis (C of A). The C of A can be transmitted from the supplier at the time of delivery. If the C of A is not present or if the proper product is not listed on the BoL, the product shall not be off-loaded. Check all results on the C of A against the product specifications. Do not off-load the product if results are not on specification. Report discrepancies to local management.

Table 6—Basic Testing for Management of Change and Oversight Testing

Product	Specification	Terminal Product		
		Clear gasoline, diesel blends (DSL # 1 and # 2)	Gasoline and diesel blended with Ethanol, Biodiesel, or Biodiesel components	Butane Blending
All Products	Appearance	X	X	X
Gasoline	Octane	X	X	X
	Volatility (seasonal) – e.g. RVP, distillation, T V/L20, DI, etc.	X	X	X
	Sulfur (systems with high sulfur e.g. heating oil, jet fuel, etc.)	X	X	X
	Oxygenates		X	
Diesel and Heating Oil	Flash point	X	X	
	Biodiesel Content		X	
Diesel	Sulfur (systems with high sulfur e.g. heating oil, jet fuel, etc.	X	X	
	Cetane # or Cetane Index	X	X	

To provide confidence that product has not been contaminated nor has an unacceptable level of inter-product mixing, a documented risk assessment shall be conducted.

This risk assessment and subsequent mitigation strategy shall consider, but not be limited to the following:

— Likelihood of contamination or inter-product mixing from:
  — supplier,
  — transport,
  — off-loading (i.e. manifold),
  — prior product compatibility,
  — thermal relief valve venting,
  — filter failure or bypass,
  — sampling process,
  — vapor recovery unit return streams,
  — water brought in with product,
  — timing of valve opening and closing,

  - contamination due to lubricating of valve plugs,
  - contamination resulting from mechanical work, startup or shutdown, and
  - the likelihood of water, microbial growth.
- Homogeneity.
- Phase separation.
- Likelihood of degradation due to instability of product.
- Likelihood of receiving incorrect product.
- Degree to which the product is segregated from other products:
  - types of separation: blank or blind, single valve, double block valve, double block and bleed valve and valve interlocks; and
  - potential to exceed maximum design pressure differential across valves.
- Product Quality event history for the facility and industry learnings.
- Operations upstream and downstream of the facility:
  - range of products,
  - types of interfaces, and
  - contamination testing and controls.
- Other existing site controls, interface management and contamination testing.
- Business impact if the product becomes contaminated, such as:
  - the contingency for continuity of supply of product,
  - the volume of contaminated product,
  - intended use of product,
  - regulatory implications, and
  - cost and feasibility of corrective actions (including product recall).
- Communications processes between the operations at either end of the product movement.

Based on the output of this risk assessment, standard operating procedures shall be developed and implemented to ensure effective mitigation of the identified risk(s).

A sampling and testing protocol shall be developed, practiced and documented. This may include in-line and automated monitoring and testing equipment.

Product receipt tanks should be isolated from release whenever practical during and after the receipt. Isolated product should not be released until acceptable confirmation test results have been obtained.

Acceptance standards (including test methods and acceptable results) for each parameter may be defined by:

— an absolute maximum or minimum;

— an allowable variation from the original certified value; and

— a pass and fail criteria (i.e. for visual inspection).

The API gravity should be compared against reported values within 0.5 °API.

The flash point should be compared against reported values within 5 °F.

The design of the receipt testing protocol should consider:

— the likelihood of contamination or inter-product mixing;

— the likelihood of microbial growth or other degradation due to instability of product; and

— the consequences of contamination and inter-product mixing (e.g. regulatory and customer requirements including need for defense during claims resolution).

The allowable variation within confirmation test results should be no more restrictive than the acceptance limit defined by ASTM D3244 or ISO 4259 (0.59R).

The value of the parameter for the tank heel should be prorated with the original certified value of the new volume to determine the expected value for the parameter in the tank.

The tank gravity after receipt values should lie between the receipt product gravity and the prior tank gravity within 0.5 °API. Flash results should lie between the receipt flash and tank prior flash within 5 °F.

Water can also enter the tank if it is entrained in the ethanol supplied by the manufacturer. Water can be present in the ethanol if it has not been kept dry during transit or it was not completely removed during the manufacturing process. Test periodically to ensure that ethanol receipts are on-specification for water content. If water in ethanol is detected, the source should be investigated and eliminated to prevent further fuel contamination.

Typical information that should be obtained prior to receipt includes:

— tank inventories;

— tank water levels;

— available safe fill level (Ullage or Outage);

— volume to be received;

— product specific data including properties (i.e. gravity and flash point) may also include product grade variation during receipt; and

— receipt arrival and delivery time confirmation.

The minimum parameters to be included in the receipt testing are shown below.

Product	Minimum Receipt Tests
Butane, Propane (Note 2 and Note 5)	Density, API Gravity
Gasoline (Note 1)	Density, API Gravity Visual, Appearance
Ethanol (Note 2)	Density, API Gravity Visual, Appearance
Distillate (Kerosene, Diesel, Biodiesel blends, Heating Oil, Marine Gasoil) (Note 3)	Density, API Gravity Visual, Appearance Flash Point
Biodiesel (Note 4)	Density, API Gravity Visual, Appearance
Additives (Note 4)	Density, API Gravity Visual, Appearance
NOTE 1 It is also recommended that samples be tested for vapor pressure during seasonal volatility control periods.	
NOTE 2 Ethanol, Butane and Propane should be accompanied by a C of A. C of A's and BOL's should be compared to the purchase specification and ASTM D4806, D4650, D4362 and D1835. Random samples of ethanol, butane, and propane are acceptable if received from a consistent supply source with dedicated transport.	
NOTE 3 It is also recommended that ultra low sulfur product samples be tested for sulfur content where contact with higher sulfur products may have occurred.	
NOTE 4 Additives, Biodiesel should be accompanied by a C of A. C of A's and BOL's should be compared to the purchase specification and/or ASTM D6751.	
NOTE 5 Density/API Gravity is recommended, not required.	

10.2 Receipts from Pipeline

Fuels and components shall only be received through light product pipelines. It is preferable that gasolines and distillates be received through their own segregated line. Where this is not the case, interface handling procedures shall be developed and documented to maintain product integrity.

During receipt of product and components, samples should be drawn from the incoming pipeline at the receiving terminal. At a minimum, samples should be drawn at the beginning and end of the transfer.

It is also recommended that samples be taken at the middle of the receipt if the batch size exceeds 25,000 bbl or 4 hours. These samples should be taken as close to the middle of the receipt as manning or technology allows. If the time for a middle sample occurs during unmanned hours, it should be taken either prior to the unmanned period or when manning resumes.

Pipeline receipt samples should be retained at least until the receiving tank has been released.

10.3 Receipts from Ocean Tanker Coastal and Inland Waterway Vessel

10.3.1 General

Receipts of product via marine vessel have a significant potential for contamination. There are many sources of contamination (i.e. off-specification product in vessel compartments, off-loading the wrong sequence of compartments when multiple products are aboard, and off-loading of water or ballast during product transfer).

The following quality requirements contain the recommended standards for distribution terminals. Based on established protocols, these procedures may be carried out by terminal personnel or by third party inspection services.

— Each vessel should arrive with a C of A or similar document listing test results.

— Upon arrival of the vessel, verify the product and grade in each compartment.

— Document the products and compartment disposition.

— During gauging, note any water present in the compartments, bringing any water quantity present to the attention of management.

— Sampling for each vessel shall conform to contractual agreements:

  — for example, take 1-quart all-levels or composite samples from each compartment and prepare a 1-gallon composite for each product;

  — for vessels with more than one compartment of any given product, a volumetric composite should be made; and

— individual compartment samples shall be checked for appearance prior to making the composite.

Test composite as noted below. Record the results and compare to the specifications. These results should be compared against the specifications prior to off-loading. For vessels loaded from a single shore tank and for vessels with a reported composite gravity, the API gravity should be compared against those reported on the loading papers within 0.5 °API.

Vessel composite samples shall be retained for 30 days after supply is exhausted or after the next receipt, barring any other agreements or regulatory requirements.

Multiple shore tanks are often used for loading. Reported compartment gravities are often different. In this case, a weighted-average loading gravity should be calculated and compared to the composite gravity. The terminal supervisor or appropriate personnel must be notified if the deviation exceeds 0.5 °API.

At the beginning of discharge, a 1-quart line sample shall be taken. For vessels with more than one product aboard, repeat line sampling and testing every hour or at least once per compartment. For vessels with one product aboard, line sampling shall be repeated at the middle and near the end of vessel off-loading.

The following tests are typical for line samples:

Gasoline and BOB	Distillates	Biodiesel	Ethanol
Appearance API Gravity	API Gravity Haze Rating or Appearance Flash Sulfur	API Gravity Haze Rating or Appearance Flash Sulfur	API Gravity Appearance Water Content

If any off-specification product is detected during testing of the line samples, product transfer from the vessel must be stopped and the terminal supervisor or appropriate personnel shall be notified.

Upon completion of the receipt, the receipt tank shall be tested and gauged for water. If the water in the receipt tank has increased significantly due to the marine receipt, management shall be notified. Tracking excessive water off-loaded from marine vessels is important for the prevention of future occurrences.

10.3.2 Ethanol Marine Receipts

For marine terminals that receive neat ethanol, fuel ethanol or gasoline-ethanol blends by tanker, ship or barge, a prime concern is the possible introduction of water during transport and transfer. Special precautions and procedures should be in place to assure and verify safety, cleanliness and product integrity during transport. Establish whether the vessel is in dedicated ethanol service, and if not, confirm the previous product carried and its compatibility with

ethanol. Compartments should be clean and drained before loading. Receipts from vessels with visual signs of damage, leaks or water ingress should not be accepted. Single hull vessels or vessels that use product tanks to carry ballast water should generally not be used. Any possible exposure of ethanol to water during transport and transfer shall be avoided.

Some regulations require that flammable cargo compartments have the headspace filled with an inert gas to reduce the potential for fire or explosion. Flue gas from the exhaust of vessels should not be used as the source of the inert gas because it gives a misleading acidity test results and the water vapor in the exhaust gasses can condense and contaminate the load. In addition, the carbon dioxide in the flue gas can potentially be absorbed into the ethanol and increase its acidity.

10.4 Receipt by Truck or Rail Car

10.4.1 General

If applicable, the seals, release certificate and grade plates shall be checked on arrival.

In cases where the risk assessment defined in 10.1 indicates the need for sampling and testing, drain samples shall be drawn from each compartment and confirmation testing performed prior to off-loading. The API gravity should be compared against reported values within 0.5 °API. The flash point should be compared against reported values within 5 °F.

The following quality requirements contain the recommended standards for distribution terminals. Based on established protocols:

— upon arrival, verify the product and grade in each compartment;

— document the products and compartment disposition; and

— note any water present in the compartments and bring any water quantity present to the attention of management.

Test product, record the results and compare to the specifications and reported values.

The following tests are typical for drain samples:

Gasoline and BOB	Distillates	Biodiesel	Ethanol	Additives
Appearance	API Gravity	API Gravity	API Gravity	Gravity and Density
API Gravity	Haze Rating Appearance	Haze Rating Appearance	Appearance	Appearance
	Flash	Flash		
	Sulfur	Sulfur		

If any off-test drain samples are detected, product transfer from the truck or rail car shall not commence without notification and approval of appropriate personnel per standard operating procedures.

In cases where receipts occur during unmanned hours or are made on a regular basis multiple times during each shift, C of As and seals may be left in a designated location at the site for review as soon as practical.

10.4.2 Ethanol Truck or Rail Receipts

Tank trucks or rail cars are common modes of transporting ethanol from production plants and distribution hubs to terminals.

Selection of tank trucks or rail cars shall conform to contractual agreements. Contractual requirements specific to product quality should include:

— transports used for neat ethanol and fuel ethanol should be dedicated to that service;

— if a dedicated transport is not available, a transport used for gasoline or gasoline-ethanol blends may be used;

— prior to loading ethanol, transport compartments should be clean and drained of water and any residual product retained from the previous load; and

— do not use transports that have carried other materials unless they have been cleaned, dried and free of incompatible material.

Before offloading an ethanol shipment, visually inspect the transport for signs of damage during transit that could allow water ingress. Compartments showing evidence of product contamination should not be unloaded.

All ethanol receipts shall be accompanied by a Bill-of-Lading (BoL) and a Certificate of Analysis (C of A). The C of A can be transmitted from the supplier at the time of delivery. If the C of A is not present or if the proper product is not listed on the BoL, the product shall not be off-loaded. Check all results on the C of A against the product specifications. Do not off-load the product if results are not on specification. Report discrepancies to local management.

10.5 Other Receipts

Representative samples (and retains) should be taken from all other storage vessels not otherwise covered in this section. These samples should be tested against contract or regulatory requirements.

10.6 Interface

Limits for acceptable inter-product mixing shall be established and procedures shall be documented to avoid unacceptable inter-product mixing of any product by interfaces created when dissimilar products are moved via common pipework (transmix).

Procedures for receiving multi-product cargoes or pipeline receipts shall be clearly defined and documented, and rigorously followed to ensure that interface contamination is minimized. All grade interfaces, both leading and trailing, shall be diverted into slop tanks or the lower grade product tank at a concentration that ensures the product and component tank remains on specification and fit for use.

11 Storage Procedures

11.1 Routine Checks

11.1.1 Static Stock

Light products that have remained in storage for an extended period of time may degrade. This degradation may impact specification compliance and fitness for use.

Product quality should be verified on a routine basis, considering seasonal changes, environmental conditions, static period and product history.

Full recertification testing shall be carried out on all grades of fuels remaining in storage over six months after the date of the last replenishment and prior to release. If the test results are unsatisfactory, the tank shall be quarantined until the matter is resolved.

Product left in piping (i.e. product storage tank recirculation lines or tank transfer lines) for less than six months may be flushed back to storage. If the line contains fuel left unused longer than six months, has not been recertified, and it is flushed back to a storage tank, the tank shall be recertified after the transfer prior to being released for use. Alternatively, a line sample may be taken and checked for quality prior to flushing back to storage. Appropriate seasonal specifications shall be considered during the recertification testing.

11.1.2 Microbial Growth

Microbial growth can be a significant product quality issue when water is present in light products. Microbial growth will typically occur at the hydrocarbon-water interface, but may also be found on tank walls and on the exterior of tanks around vents and pressure relief valves. Testing for microbiological contamination shall be carried out for each tank. Samples may be collected from tank bottoms or water draws. If unable to collect water from the bottom of the tank via the tank water draw, other means of obtaining water samples (i.e. bacon bomb samples) should be used. This testing shall be conducted at a minimum on an annual basis. More frequent testing should occur when appropriate samples indicate microbiological activity or when downstream microbiological growth is reported. Acceptance criteria shall be clearly defined in standard operating procedures.

The cause of any unsatisfactory results shall be investigated. Remediation may include:

— water removal (see 11.7),

— biocide, and

— tank cleaning.

Removal of microbial contamination is a complex process. Subject matter experts should be consulted to ensure effective remediation.

Additional guidance on the subject of microbiological contamination can be found in the ASTM Manual 47: *Fuel and Fuel System Microbiology: Fundamentals, Diagnosis and Contamination Control* and the Energy Institute (EI) document *Guidelines for the Investigation of the Microbial Content of Petroleum Fuels and for the Implementation of Avoidance and Remedial Strategies.*

11.2 Storage Tank Changes

11.2.1 Change of Service

Converting tankage to different products depends upon which products are involved, tank design and applicable regulations. It can be as simple as receiving the new product on top of the old and rebranding the tank heel to the new product. In the other extreme, it may involve the emptying and cleaning of the tank prior to receiving the new product.

Limits for levels of inter-product mixing shall be established. Procedures and Management of Change (MOC) shall be documented to ensure product meets specification and is fit for use after a tank service change. Refer to Table 5 for guidance.

NOTE Extreme care should be taken when converting from gasoline to distillate. A very small amount of gasoline may significantly impact flashpoint.

Once the physical conversion has been completed samples should be taken to confirm the tank has been converted as planned and product is suitable for intended use.

Distillate tanks may be converted to gasoline by emptying the tank, drawing the heel out of the water draw and then filling the tank with gasoline.

Refer to API 2003 (current edition) for guidelines related to the protection against ignitions arising out of static and stray currents.

11.2.2 Change of Grade

Converting tank inventory to different product grades depends upon which grades are involved, tank design and applicable regulations (i.e. Regular gasoline to Premium gasoline).

Procedures and Management of Change (MOC) shall be documented to ensure product meets specification and is fit for use after a tank service change. Refer to Table 5, 9.6 and 9.8.2 for guidance.

Once the physical conversion has been completed, samples should be taken and tested to confirm the tank has been converted as planned and product is suitable for intended use.

11.2.3 Change of Season

Converting product inventory for seasonal change depends upon which products are involved, tank design and applicable regulations. Procedures and Management of Change (MOC) shall be documented to ensure proper transition of the entire tank inventory to appropriate seasonal requirements.

11.2.3.1 General

Items to consider include the following:

— existing product inventory, volumes and properties, and number, volume and properties of projected receipts;

— throughput forecast;

— downstream conversion date requirements;

— communication channels for conversion delays, and unplanned inventory variations;

— contingency plans.

Large inventories, substantial property differences between inventory and receipts, and limited number and volume of receipts, can increase the difficulty in converting products. As a general rule conversions can be achieved more rapidly with the use of multiple small deliveries rather than a few large deliveries, unless the receiving tank can be completely drawn down before the receipt. A complete draw down of inventory is often not possible due to limited tank availability and the need to maintain supply.

An additional concern is introduced when the conversion is to substantially different volatility grades, i.e. RVP variation of 2 psi or greater can make it nearly impossible to convert the upper layer of the receipt tank unless substantial turbulence can be created ether by increased delivery rates and/or tank mixers. Additional turbulence created by increased product flow rates or the use of mixers also introduces additional concerns of water and sediment being delivered from a tank where sufficient settling time has not been provided.

A complete understanding of the receipt and delivery forecast is necessary to optimize the conversion process and ensure the conversion is completed within the necessary time frame. In order to fully understand the throughput forecast, clear open communication channels with both suppliers and customers is critical to ensure the process goes smoothly.

In the event of a change to throughput plans due to internal or external factors, contingency and communication plans must be in place to ensure the entire supply chain can work together to minimize the impact of any supply interruption.

11.2.3.2 Seasonal Changeover Processes

The quality of fuels must be appropriate for the time of year. In all states there are legislated refinery, terminal and/or service station dates for seasonal gasoline specification conversions.

Retailers need to ensure, in conjunction with refineries and the entire supply chain that they can meet their legal requirements to market on-specification product at the service stations at all times.

While not all states have regulatory conversion requirements for both gasoline and diesel, for states that do additional consideration should be given to the differences between critical and non-critical conversions. Some seasonal changeovers will require a detailed management process, while others may be simpler. Since winter grade diesel should meet summer grade diesel requirements, the winter to summer diesel changeover period is non-critical from a seasonality standpoint. However, summer grade diesel will typically not meet winter grade diesel requirements, the summer to winter diesel changeover is critical. Similarly, the summer to winter gasoline is non-critical while the winter to summer gasoline conversion is critical.

11.2.3.3 Planning & Management

Seasonal changeover requires careful management since there is a significant time lag between supply of a new seasonal grade by the refinery and adequate turnover of stocks, firstly at fuel terminals and subsequently at service stations. Dependent upon the quality of the incoming product and the quantity of product in tanks prior to receipt, a number of deliveries may be required before product in a given tank meets the specification of the forthcoming seasonal grade. The smaller the quantity of product in a tank prior to receipt and/or the larger the quality giveaway (margin between supplied and legally-specified qualities), the fewer the number of deliveries required for quality changeover. As noted above, large variations in volatility may increase the conversion difficulty.

Retailers must coordinate closely with their suppliers during the planning and implementation of seasonal grade changes. For each changeover, all members of the supply chain need to agree on the product specification at the rack and timing, based on time to turnover service station tanks, well in advance of the changeover period to enable the service stations requirements to be met.

Responsibilities should be documented for the following steps.

- Communication of the following.
    - Stock management that can realistically be achieved during the changeover period.
    - A plan for managing the changeover will ultimately be agreed by the customers/marketers.
    - Specific timing.
    - A schedule for testing product as a measure for verifying the effectiveness of seasonal changeover and take actions appropriate to the results observed (e.g. communication of unplanned conversion issues additional receipts, tank to tank transfers to expedite conversion). This testing will be in advance of the legal date to allow any necessary action to be taken in advance of the required compliance date.

Once the physical conversion has been completed, terminal tank samples should be taken to confirm the tank has been converted as planned and product is suitable for intended use.

11.3 Storage of Biodiesel

11.3.1 Storage temperature

Biodiesel (B100) should be stored at temperatures at least 6 °C higher than the cloud point. Therefore, most underground storage facilities are adequate; however, above ground storage (depending on the climate) should be protected with insulation, heating systems, or other methods. This precaution includes piping, tanks, pumping equipment, and trucks used to transport biodiesel. Heating can be achieved by any of the common heating methods, but should be designed to minimize hotspots and prolonged exposure of the biodiesel to high temperatures.

If the temperature does drop and precipitates begin to form, the precipitates should dissolve if the fuel is warmed up, although residual mono-glycerides and sterol glucosides may be difficult to dissolve. This dissolving process can be slow especially if the fuel only warms marginally or very slowly. Precipitates formed in biodiesel or in diesel blends can also settle to the bottom of the tank and begin to form a gel layer.

Caution—Once precipitates have formed, it can be extremely difficult to remove or resolubilize these deposits.

Slow agitation can prevent precipitates from building up on the tank bottom and agitation can also help to redissolve precipitates once they are present in the fuel. If the biodiesel product has gelled completely, it is advisable to raise the temperature up to 40 °C to 60 °C in order to melt the most saturated biodiesel components, especially if the biodiesel needs to be used right away. Lower warming temperatures can be used for the biodiesel to reach its equilibrium cloud point if enough time is available.

During colder seasons, B100 is sometimes pre-blended with low cloud point diesel fuel in order to prevent precipitation. Preblends vary depending on environmental conditions. Pre-blends are prepared before blending into the diesel fuel. The recommendations for biodiesel also apply to these diesel blends.

NOTE Pre-blends are biodiesel components blended with petroleum diesel prior to final blending.

11.3.2 Storage duration

Due to the inherent instability of biodiesel, inventory should be turned over as often as practical. It is recommended to limit the storage of biodiesel to no more than six months.

NOTE Comingling different types of B100 feedstocks may negatively affect stability and cold flow properties.

Because biodiesel ages in storage, the acid number tends to increase, the viscosity can increase and gums and varnish can form. To monitor biodiesel quality during storage, oxidation stability, acid number, viscosity, water, and sediment may all be used as indicators to ensure that the biodiesel complies with ASTM D6751.

When oxidized or aged biodiesel is blended with diesel, data suggest that some of the sediments and gums that are soluble in the B100 become insoluble in the diesel blend and form sediments. For this reason, biodiesel that does not comply with ASTM D6751 shall not be used for blending.

Good fuel stock management practices and frequent product turnover should minimize stability concerns for most applications.

11.3.3 Minimum Headspace

As a fuel tank is emptied, air will enter through the vent pipes to displace the fuel that was in the tank. The extra air drawn into the tank may lead to more oxidation, particulate contamination and increased water levels. These contaminants will affect the quality of the biodiesel.

In order to limit the effects of air in the tanks, it is recommended that biodiesel and diesel blends are not stored for long periods of time in partially empty tanks without the use of oxidation stabilizing additives.

11.3.4 Water Contamination

Biodiesel is susceptible to water-related problems. Desiccant filters on breathing vents should greatly reduce water condensation in the storage tank and are highly recommended. Sump drains are also recommended where they are practical. Both free and dissolved water accelerate corrosion and fuel degradation. Free water may enter bulk fuel tanks by condensation, by carry-over from the fuel distribution system, or by leakage through the fill cap, spill containment valve or piping.

In addition to accelerating the degradation of the fuel product, water also provides a suitable environment for microbial growth. Poor tank design can make it almost impossible to completely remove free water once it is present; therefore, it is important to take steps to prevent water from entering the fuel storage vessel.

11.3.5 Biocides

The preferred approach to prevent microbiological contamination is a good tank housekeeping program. If microbiological problems are encountered, a biocide shock treatment can be used as a temporary measure. Following such an incident, the details of the housekeeping practices should be reviewed and adjusted as necessary in order to avoid another occurrence.

The continuous application of biocide does not compensate for the introduction of water, and is therefore not a suitable preventative measure against water related problems.

The regular use of biocides may even increase the resistance of micro-organisms to treatment.

The regular use of biocides also has some drawbacks that can and must be properly managed (e.g. biocides are toxic chemicals and produce bio-sludges that shall be removed).

Regulations may restrict the use of biocides. Properly dispose of water from tanks treated with biocides. Consult a subject matter expert on biocide treatments.

11.4 Storage of Ethanol

Ethanol is hydrophilic. It readily absorbs water and forms a homogenous solution with water over its entire dilution range. Water that gets into ethanol and gasoline-ethanol storage tanks is immediately absorbed and can contaminate fuel. In contrast, gasoline is hydrophobic and has a low solubility with water. Consequently, the presence of ethanol increases the overall solubility of water in ethanol-gasoline blends compared to base gasoline.

Understanding how water affects gasoline-ethanol blends and how it can be detected can help assure better fuel quality.

Small amounts of water can cause gasoline ethanol blends to separate (phase separation) resulting in an ethanol rich water phase and lower octane gasoline phase, neither of which meet specification, are fit for use or comply with regulations. Water can also transport and aid in the growth of microorganisms resulting in plugged filters, corrosion and degraded gasoline performance.

Water can be introduced into a storage tank by rain or snow leaking in through unintended openings in the tank shell or roof. External floating roofs are particularly prone to water entering during inclement weather. Overnight temperature changes and humid conditions can promote the formation of condensation on the inner surfaces of tanks above the internal floating roof. With sufficient accumulation, condensation can collect and drain past the floating roof seals into the liquid product.

11.5 VRU Procedures

The vapors from vapor recovery units can change the properties of the gasoline to which it is directed. The vapor pressure in particular can be raised, sometimes beyond contractual or legal limits. For some Vapor Recovery Units, a stream of gasoline is used to transport the vapors to a tank. Therefore, it is very important to properly manage these systems.

Condensate from the vapor recovery unit is typically directed to a high throughput gasoline tank. Special care should be taken where the recovery tank is low on product or is not turned over frequently. Testing and measurement of the product in these tanks should be considered to ensure necessary compliance.

NOTE Glycol carry-over from the VRU into finished product has been observed in improperly operated VRUs.

11.6 Product Returns

Product returns may include:

— off-site return by customers,

— broken blends at the truck loading rack,

— product from meter proving,

— retains on board, and

— product recalls.

Regulations may apply to the handling and return of product. Care should be taken to comply with all applicable regulations. Any unadulterated product may be returned to a tank with the same product and grade. For adulterated product, pumping back to storage tanks with finished products or certified blend components should be avoided. However, when product that is not fit for use cannot be slopped or otherwise disposed of, returning to a product tank must be carefully managed to assure that product specifications and regulations are not compromised.

— Gasoline and mixed gasoline pumpbacks should be directed to the tank containing the lowest octane grade of unleaded gasoline.

— Distillate pumpbacks should be directed to a comparable distillate tank.

— When pumping back any off-spec, mixed or contaminated product, care should be exercised to ensure the pumpback line is not common to the line moving product to the rack.

In the following situations, if specific procedures are not available, consult management for guidance:

— dirty product,

— mixed (gasoline and distillate) product,

— product which was oxygenate blended at the terminal,

— large amounts of product,

— product which does not represent the current RVP season, and

— product which does not represent the current oxygenate blend.

11.7 Water Management

The presence of water in light product storage tanks can be a significant contributor to product quality incidents. A water management program shall be developed and documented to ensure pre-defined maximum allowable levels are not exceeded. These allowable levels must be established to ensure unacceptable levels of free water are not delivered downstream with the product under all delivery conditions. Water management considerations may include:

— “live to rack” operations,

— floating suction,

— maximum flow rates,

— outlet height (above water level),

— floor design,

— mixers, and

— distance from inlet to outlet.

It is recommended that tanks be gauged or checked for water before and after product receipt. If the water level is above 2 in., water should be drained. If no fixed water drain system is available, initiate process or steps to drain the water as soon as practical.

NOTE The 2 in. draining requirement is measured at the side gauge or datum plate near the outlet of the tank. Draining shall remove as much water as possible given the physical constraints of the tank.

All product tanks shall be checked for water at least once per month. In any case, where the tank configuration does not allow for the above required measurements of the water level, the water should be drained.

Water bottom checks shall be recorded including volume, appearance and any noticeable changes from prior samples. Significant changes shall be investigated.

All water should be drained from a tank before stripping and emptying (i.e. during RVP seasonal change or changing tank product service).

If water is present in the tank and cannot be drained or if the absence of water cannot be confirmed a sample shall be taken at a point downstream of the tank and after the tank begins to discharge product. In the situation where the tank is “live”, the sample shall be taken as the tank is simultaneously receiving and discharging product.

Terminals should ensure that the sample is representative of the tank, taking into account appropriate line fill volumes. Some possible sample points are the following:

— loading rack,

— sample port at rack pumps,

— loaded truck,

— pipeline manifold, and

— marine manifold.

12 Product Blending

12.1 General

Product blending may include:

— mid-grade gasoline blending,

— seasonal distillate blending,

— transmix blending,

— oxy-blending,

— biodiesel blending,

— additive injection, and

— butane blending.

The proper blending of components at the terminal should always be controlled as closely as possible. This control shall be designed to ensure the applicable specifications and regulatory requirements are always met. Whenever changes to blending operations are made (i.e. new blending operations, component changes, meter calibrations, hardware repairs and upgrades), it is recommended that Management of Change (MOC) be performed to ensure the change was made as intended. MOC should include increased inventory verifications, downstream testing, independent verification of changes and documentation reviews.

12.2 Product Blending (in-tank)

It is imperative to maintain product quality during in-tank blending operations. The following factors shall be considered:

— homogeneity,

— sample types,

— blend component properties,

— component ratios,

— injection failure alarms,

— additives,

— product grades,

— finished product specifications,

— flow rates,

— contamination sources:

  — valve line-ups,

  — valve types,

  - dead legs,
  - manifolds,
  - line-fills, and
  - heels and priors.
- filtration,
- pipe diameter,
- minimum component size,
- tank-to-tank transfer,
- testing capability,
- tank considerations:
  - diameter,
  - volume,
  - distance between inlet and sample point,
  - circulation: mixer and diffuser, and
  - sampling: sample access and sample points (i.e. slotted gauge tube, side taps and roof hatch).

12.3 Ethanol Blending

It is recommended that ethanol mixed fuels be blended at terminal loading racks using ratio (in-line) or sequential blending methods. These methods are safer than other blending techniques and produce the highest level of fuel quality.

Splash Blending—Splash blending on trucks is acceptable as an interim solution until a fixed blending system can be installed. The use of splash blending should be limited due to the safety concerns of increased tank compartment flammability and the increased chance of blend errors from human involvement.

Wild-stream Blending—Wild-stream blending is not recommended. It provides less control over finished fuel quality because both blending streams are not metered.

Batch Blending—Batch blending of fuel ethanol and gasoline directly in Above-ground Storage Tank (AST) while possible at some larger terminals is not recommended. The difficulty of achieving a correct blend, the potential for insufficient receipt velocity to avoid component stratification in the tank, the increased opportunity for water contamination of the finished product and the difficulty of correcting blend errors are significant risks with this method. Once an off-specification blend is in the tank, it is difficult to correct.

Batch blending of neat ethanol to create fuel ethanol in aboveground storage tanks is the accepted method of denaturing ethanol. This is a common practice at water and marine supplier terminals. With sequential blending, the blend is complete only after the total batch is finished. A load rack shutdown during the blending sequence shall result in an out-of-specification product in the truck.

Sequential Blending—A disadvantage of sequential blending is that mixing of the blend components may not be complete. Complete blending in the truck relies on the turbulence generated by the introduction of the second, and if required, third components to make a homogeneous mix. Depending on the loading rate and the volume, mixing may be incomplete. Incidental mixing may occur in the truck as the blend is driven to the delivery location and when it is loaded into the delivery tank, but the blend components may still remain stratified. Because of these concerns, sequential blending increases the chances of incomplete mixing and an off-specification blend.

NOTE Sequential Blends of less than 1,000 gallons may result in broken (failed) blends.

12.4 Biodiesel Blending

12.4.1 General

Due to the chemical composition of biodiesel, there are a number of product quality issues that must be considered and addressed when handling and blending biodiesel. The main concerns are:

— poorer fuel stability;

— an increased risk of deposit formation;

— poorer cold temperature handling, filterability and operability;

— increased solvency;

— greater potential for microbiological contamination;

— poorer water shedding;

— different material incompatibilities;

— increased foam decay times; and

— impact on fuel additive performance.

When biodiesel is blended into a diesel basestock at terminal locations, the properties of the hydrocarbon basestock must also be considered in order to ensure that the finished diesel fuel is on specification after blending with biodiesel.

12.4.2 Cold Temperature Handling, Filterability, and Operability

There are two different cold temperature performance concerns: handling and operability. Handling, including filterability, is the ability to store, blend and pump B100 or the resulting diesel blend. Operability refers to the use of the diesel blend in a vehicle's fueling system or in other equipment intended to be used with diesel fuel.

Several factors can impact the cold temperature handling and operability performance of biodiesel. The first is the type of feedstock used to produce the biodiesel. As shown in Table 7, the cold flow properties of biodiesel vary with the fatty acid composition of the feedstock and typical values for esters produced from single feedstocks are shown in the table. Feedstock selection also determines whether undesirable impurities must be removed during processing in order to improve the cold temperature performance (see Table 7).

Because individual biodiesel products have different cold flow properties, it is obvious that they can also impact the cold flow properties of the final diesel blend. This impact must be understood, especially when biodiesel is blended into a diesel basestock at terminal locations where options to correct the cold temperature properties may be limited.

Table 7—Typical Handling Properties for Biodiesel Manufactured from Different Feedstocks

Feedstock	Cloud Point (°C)	CFPP (°C)	Viscosity (mm^2/s at 40 °C)
Rapeseed	–5	–18 to –12	5.0
Sunflower	–1 to +3	–7 to –3	4.4
Soybean	–7 to +3	–6 to –2	4.0
Coconut	+9 to +12	8	4.8
Palm	+13 to +16	+5 to +11	4.3 to 5.0
Tallow	+10 to +20	+9 to +14	4.8

It is recommended that biodiesel used for fuel blending should not contain any additives other than antioxidants used to improve the oxidation stability. This helps to avoid problems that could be caused by incompatibility of the biodiesel with the cold flow or performance additive package that is typically used in the final diesel blend.

12.4.3 Blending Strategies

12.4.3.1 General

Biodiesel is fully compatible with petroleum diesel so the blending of biodiesel is not particularly difficult. Regardless of the blending strategy; however, it is important to understand some of the significant characteristics of biodiesel that can impact blending.

— Biodiesel typically has a higher density and viscosity compared to diesel fuel. If blend components are added sequentially into a blending tank, the higher density component should be added first in order to avoid the formation of an unmixed bottom layer.

— When blending into a storage tank, documented procedures should be established to create and validate a homogenous blend. These procedures must be controlled under management of change.

— Biodiesel has a higher cloud point than diesel. If different components are added into the blending tank, the temperature of all of the components should be well above the biodiesel cloud point to ensure easy flow and prevent formation of precipitates that may be difficult to redissolve.

Several blending strategies can be used to achieve proper mixing:

— in-tank sequential blending;

— in-line blending into a tank;

— in-line ratio blending at the loading rack; and

— splash or sequential blending at the loadrack.

12.4.3.2 In-tank Sequential Blending

The required volumes of biodiesel and diesel fuel are pumped separately into a tank. Proper mixing shall be achieved and tested prior to releasing the diesel blend.

12.4.3.3 In-line Blending Into a Tank

The biodiesel and other blend components are pumped simultaneously under flow control into a common product line to a product storage tank. The turbulent flow conditions at the injection points and in the line promote mixing, but the use of a static mixer is also recommended.

12.4.3.4 In-line Ratio Blending at the Loading Rack

Biodiesel is injected continuously into the diesel fuel stream under flow control during truck loading. Alternatively, the biodiesel can be added in small slugs or in pulsed quantities spread evenly throughout the time that the truck is being loaded. This is similar to the way most additives are blended into diesel fuel at the loading rack.

12.4.3.5 Splash or Sequential Blending at the Loading Rack

Splash or Sequential biodiesel blending is not recommended at terminal loading racks.

This is an operation where the biodiesel and diesel fuel are sequentially loaded into a truck or other vessel. In this case, relatively little mixing occurs as the fuels are loaded into the vessel. After the fuels are in the truck, driving down the road is sometimes considered to be sufficient agitation to allow the biodiesel and diesel fuel to be mixed in transit. This blending strategy is not recommended, particularly when the ambient temperature is low, because there is some risk that the product may not be homogeneous, and therefore subject to low temperature effects of the biodiesel component, when it arrives at the delivery point.

12.4.4 Biodiesel Blending and Additive Performance

Diesel performance additives (i.e. cold flow improvers or cetane boosters) should be injected into the diesel fuel stream during blending. The additive dosage in biodiesel blends may be different from hydrocarbon-only diesel fuels in order to achieve the same level of performance. Additive dosages that should be rechecked include cold flow, cetane improvers, lubricity enhancers, conductivity improvers, performance packages and antifoam additives.

Blending biodiesel into diesel fuel, even at low concentration can increase the lubricity of the diesel blend. The amount of biodiesel required to achieve adequate lubricity depends on the properties of both the biodiesel and the hydrocarbon-only diesel. Evidence suggests that about 2 % v/v biodiesel may provide sufficient lubricity. Some batches of biodiesel have been identified which cannot sufficiently improve lubricity to meet specification at any concentration. Consequently, testing should be conducted to confirm the effectiveness of the biodiesel as a lubricity improver.

12.5 Transmix Blending

12.5.1 General

The goal of transmix blending is to provide for the disposition of mixtures of typically incompatible fuels. The possibly unknown impact of these mixtures dictates some level of oversight to ensure the final product is compliant with both regulatory and product quality requirements.

Transmix includes gasoline and distillate mixtures produced through normal pipeline operations (i.e. interface) and through normal terminal operations (i.e. draining pipe or from the discharge of an overpressure safety relief valve). Transmix also consists of gasoline and distillate mixtures that are unintentionally combined in a tank (i.e. an incorrect line-up that causes an off-spec tank, including from service stations tanks or unintentional combining gasoline and distillate in a tank truck or incorrect blend ratios of ethanol and gasoline in a tank truck).

12.5.2 Regulatory Requirements

12.5.2.1 The Environmental Protection Agency (EPA) rules provide guidance and testing requirements for transmix processors and transmix blenders to assure compliance while providing additional flexibility. (See 40 *CFR* 80.84 and 80.104.)

12.5.2.2 EPA requires that transmix blenders maintain a quality assurance program designed to ensure that the endpoint of transmix-blended gasoline does not exceed 437 °F, and that the transmix-blended gasoline complies with the downstream standards for conventional or reformulated gasoline. As a part of this quality assurance program, transmix blenders must sample and test transmix blended gasoline at certain frequencies to determine the end-point of the gasoline**.**

12.5.2.3 Procedures must be in place to ensure the source of the transmix and the storage facilities are controlled so that no foreign or unapproved compounds are allowed to contaminate the transmix.

12.5.3 Minimum Requirements

12.5.3.1 Oversight—A transmix blending oversight program shall ensure the regulatory and contractual distillation endpoint is not exceeded. This particular test should be sufficient to protect product quality in most cases.

— Consideration shall include other specifications (i.e. sulfur content, oxygenate content, benzene content, octane and distillation residue may also be affected).

— Consideration should be given to the fact that some products may contain additives and undocumented blending components (i.e. biodiesel) which may affect properties such as oxidation stability.

12.5.3.2 Procedures shall be documented and in place to ensure the transmix blended homogeneously with the gasoline or gasoline blendstock.

12.5.3.3 Transmix shall not be blended with distillate unless appropriate operational control and testing is in place to ensure homogeneity and full compliance with industry standards, customer requirements and all applicable regulations.

13 Delivery Procedures

13.1 General

To provide confidence that product has not been contaminated nor has an unacceptable level of inter-product mixing, a documented risk assessment shall be conducted.

This risk assessment and subsequent mitigation strategy shall consider, but not be limited to the following:

— Likelihood of contamination or inter-product mixing from:

  — terminal operations,

  — shipping manifold,

  — thermal relief valve venting,

  — filter failure or bypass,

  — vapor recovery unit return streams,

  — timing of valve opening and closing,

  - contamination due to lubricating of valve plugs,
  - contamination resulting from mechanical work, startup or shutdown, and
  - the likelihood of water, microbial growth.
- Homogeneity.
- Phase separation.
- Likelihood of delivering incorrect product.
- Degree to which the product is segregated from other products:
  - types of separation: blank and blind, single valve, double block valve, double block and bleed valve interlocks; and
  - potential to exceed maximum design pressure differential across valves.
- Product quality event history for the facility and industry learnings.
- Other existing site controls:
  - business impact if the product becomes contaminated including cost and feasibility of corrective actions.
- Communications processes between the operations at either end of the product movement.

Based on the output of this risk assessment, standard operating procedures shall be developed and implemented to ensure effective mitigation of the identified risk(s).

13.2 Documentation

All transfers of product from storage terminals shall be supported by the appropriate Product Transfer Documentation (PTD).

Where applicable, the PTD may include the following items:

- clear and unambiguous product identification,
- volume,
- additives and concentration,
- date and time,
- origin,
- destination(s),
- shipper,
- carrier,
- customer,
- required regulatory language,

— required test results, and

— seal numbers.

13.3 Product Delivery from Running Tanks

A running (live) tank is defined as any tank that is receiving and delivering product simultaneously. Terminals should avoid delivery of product from a running tank whenever possible. Appropriate steps for ensuring product quality during delivery of product shall be taken. Terminals are encouraged to adopt additional checks for this type of operation; some suggestions are as follows:

— sample incoming receipt at a specified frequency;

— provide sight glasses at loading arms to allow monitoring of product during loading operations; and

— see other recommendations in 9.8. for testing of product at the loading rack. When collecting rack samples, it is important to ensure the line from the tank has been fully flushed with product from the tank before samples are taken.

13.4 Product Transfer

13.4.1 Release Testing of Conveyances (i.e. vessel, truck and pipeline).

13.4.1.1 Contractual agreements shall determine responsibility for the following.

— Inspecting the shipping conveyances to ensure cleanliness and suitability for loading. See Table 8 and Table 9.

— Compliance with Table 8 and Table 9 for all forms of transports.

— Sampling and release testing of loaded products are detailed in Table 10. This should be accomplished prior to release of the conveyance to ensure that the correct products are loaded without contamination from the loading system or the conveyance. For marine vessels, see 13.4.1.4. The results of such release testing shall be recorded and retained.

13.4.1.2 The release testing requirements outlined in the attached tables are the minimum requirements for all shipping locations. These requirements assume a typical multi-product loading system of similar grades of products.

For example, release testing may not be required for pipeline shipments if the shipping line is dedicated (segregated) from the on-specification shipping tank to the point of custody transfer to the pipeline. Locations with multi-product loading systems of dissimilar grades of products should carefully review their loading configurations and procedures and may require additional testing to ensure that the correct products are loaded without product mixing or contamination.

Segregated loading system is defined as piping from the shipping tank to loading flange that is dedicated exclusively to product being loaded with no interconnecting lines present. If interconnecting lines exist, a single gate valve shall not be relied upon. A twin seal valve with a bleed valve checked periodically is acceptable for segregated loading systems. However, gate valves shall be supplemented with either a blind flange or by another gate valve with a bleed valve (between the gate valves) checked periodically.

13.4.1.3 The specification ranges and limits for each of the release testing requirements in the attached tables are subject to contractual and regulatory requirements (e.g. API Gravity, Flash, and Appearance may be compared with the shipping tank certification to check for variation that could indicate product mixing or contamination that should be investigated further prior to release).

13.4.1.4 For marine shipments of the same product, multi-compartment composite samples may be used for release testing. Individual compartment samples should be checked for appearance in the field prior to compositing. If the multi-compartment composite sample fails, individual compartment samples should be taken.

NOTE Vessel is not required to wait at loading port for composite test results. However, results shall be at destination location prior to off-loading.

13.4.1.5 For each pipeline shipment or for multiple contiguous pipeline shipments from the same tank, the shipping location shall take periodic shipping line samples as close to the point of custody transfer as possible to ensure that the correct product is released on-specification.

For pipeline shipments with dedicated (segregated) shipping lines, samples are not required. Each location shall develop procedures for line displacements and line sampling and testing to ensure that product released meets the contractual specifications and applicable regulatory requirements.

13.4.2 Minimum Cleaning Requirements

Table 8 and Table 9 provide minimum cleaning requirements. Table 10 provides recommended oversight testing.

Table 8—Minimum Cleaning Requirements for Tank Trucks and Tank Cars

	Scheduled Cargo							
Previous Cargo	**Gasoline/ Components**	**LSD #1 Kero**	**ULSD #1**	**LSD #2**	**ULSD #2 (HVO and RHD) [a]**	**HSD #2 Heating Oil/ Fuel Oil**	**Ethanol**	**Biodiesel**
Jet A, JP-5, JP-8	D	A	D	A	D	A	D	D
Avgas	D	D(1)	D(1)	D(1)	D(1)	D(1)	D	D
Gasoline Components	A	D(1)	D(1)	D(1)	D(1)	D(1)	D	D
Kero, LSD #1	D	A	D	D	D	A	D	A
ULSD #1	D	A	A	A	A	A	D	A
LSD #2	D	A	D	A	D	A	D	D
ULSD #2 (HVO, RHD) [a]	D	D	A	A	A	A	D	A
HSD #2, Heating Oil and Fuel Oil	D	D(2)	D(2)	D(2)	D(2)	A	D	D
Ethanol	D	D(1)	D(1)	D(1)	D	D(1)	A	D
Biodiesel(3)	D	D	D	D	D	D	D	A

Key

A – Add new product with negligible quantity of previous cargo remaining in compartment. “Negligible quantity” defined as no standing product.

D – Drain compartments and lines completely. If this is not possible, i.e. “drain dry” trucks, compartments and lines shall be flushed with product to be loaded.

NOTES:

(1) – Give particular attention to safety precautions for prevention of static electricity.

(2) – Visually inspect complete system to ensure no residual red dye.

(3) – Biodiesel compartments may require special inspection and cleaning because of the tendency to accumulate residual impurities and oxidative products.

[a] DIESEL NOTE:

HSD ≤5000 ppm Sulfur

LSD ≤500 ppm Sulfur

ULSD ≤15 ppm Sulfur

HVO: Hydrogenated Vegetable Oil

RHD: Renewable Hydrotreated Diesel

Table 9—Minimum Cleaning Requirements for Marine Vessels

	Scheduled Cargo							
Previous Cargo	**Gasoline/ Components (1)**	**LSD #1 Kero**	**ULSD #1**	**LSD #2**	**ULSD #2 (HVO/ RHD) [a]**	**HSD #2 Heating Oil (Dyed)**	**Ethanol**	**Biodiesel**
Jet A, JP-5, JP-8	D	A	D	A	D	A	D	C(2)
Avgas	S	C(2)	C(2)	C(2)	C(2)	C(2)	D	C(2)
Gasoline Components	A	C(2)	C(2)	C(2)	C(2)	C(2)	D	D
Kero, LSD #1	D	A	D	A	D	A	D	A
ULSD #1	A	A	A	A	A	A	D	A
LSD #2	A	A	D	A	D	A	D	D
ULSD #2 (HVO/RHD) [a]	A	A	A	A	A	A	D	A
HSD #2, Heating Oil (Dyed)	S	S(3)	S(3)	S(3)	S(3)	A	D	D
Ethanol	D	D(2)	D(2)	D(2)	D(2)	D(2)	A	C(2)
Biodiesel (B100) (4)	D	D	D	D	D	D	D	A

Key

A – No cleaning required. Commingle new product with negligible quantity of previous cargo. “Negligible Quantity” is defined as a cargo tank whose bottom is dry at the gauging standpipe.

D – Drain lines and thoroughly strip compartments. On barges, use tank vacuuming procedures. Essentially liquid-free.

C – Machine wash lines, pumps, and compartments thoroughly after draining or stripping. Systems shall be free of water, dirt or other material. Inspect for cleanliness and dryness.

S – Steam or hot water wash lines, pumps and compartments thoroughly after draining or stripping. Systems shall be free of water, dirt or other material. Inspect for cleanliness and dryness.

(1) – Oxygenated gasoline and oxygenated components are to be treated as motor gasoline for loading on top of previous cargo issues and cleaning requirements.

(2) – “D” is for inerted tanks. Non-inerted tanks should also ensure compliance with appropriate safety guidelines for switchloading.

(3) – Visually inspect complete system to ensure no residual red dye.

(4) – Biodiesel compartments may require special inspection and cleaning because of the tendency to accumulate residual impurities and oxidative products.

TABLE NOTE Review Table 8 and Table 9 for further information regarding responsibilities for compliance of minimum cleaning requirements and inspection. For cargoes not listed, management should be consulted.

[a] DEISEL NOTE:

HSD ≤5000 ppm Sulfur

LSD ≤500 ppm Sulfur

ULSD ≤15 ppm Sulfur

HV: Hydrogenated Vegetable Oil

RHD: Renewable Hydrotreated Diesel

Table 10—Recommended Oversight Testing

Product	Tank Cars and Tank Trucks (3)	Pipeline Shipments	Marine Shipments
Heating Oil and Diesel #2	None	Appearance (sediment and particulate, water and haze) API Gravity Color Flash Sulfur	Appearance (sediment and particulate, water and haze) API Gravity Color Flash Sulfur
Kerosene and Diesel #1	None	Appearance (sediment and particulate, water and haze) API Gravity Color Flash Sulfur	Appearance (sediment and particulate, water and haze) API Gravity Color Flash Sulfur
Gasoline Component	None	Appearance (sediment and particulate, water and haze) API Gravity Vapor Pressure, Volatility requirements during regulatory control periods	Appearance (sediment and particulate, water and haze) API Gravity Vapor Pressure, Volatility requirements during regulatory control periods

NOTE 1 ASTM, EI or appropriate industry consensus standard test methods shall be used as required by contract or regulatory requirements.

NOTE 2 Sulfur and Volatility are US regulatory requirements and may vary depending on location and jurisdiction.

NOTE 3 Refer to specific requirements in 9.7.3 if delivering from running tanks.

14 Transportation Equipment from Storage Terminals

14.1 General

The use of a dedicated single grade transport is preferred for transportation of products covered in this Recommended Practice. Grade changing and/or switch loading of products should be avoided whenever possible. Position holders should be advised as to the appropriate cleaning requirements for their carriers in accordance to 13.4.2.

The use of seals on compartments on marine vessels, railcars and truck transports provides confidence that the integrity of the product load has not been compromised. On pipelines, efforts should be made to minimize the number of interfaces and avoid interfaces between products that cannot be easily downgraded to one product or the other.

14.2 Pipelines

14.2.1 Screening

There shall be a process that ensures the pipeline is suitable for carrying the product and the operating organization has the necessary controls, training, experience, skills and awareness to assure product quality. Roles and responsibilities for the process shall be clearly defined.

14.2.2 Preparation and Product Compatibility

Sequencing of product into pipelines and the line-clearing of terminal pipelines and terminal pipeline spurs prior to commencing of transfers shall be consistent with interface management strategy per 10.6.

14.3 Waterborne Vessels

14.3.1 Screening

There shall be a process that ensures the ship and barge is suitable for carrying the product and the operating organization has the necessary controls, training, experience, skills and awareness to assure product quality. Roles and responsibilities for the process shall be clearly defined.

14.3.2 Verification

When a vessel arrives at a port where there is custody transfer of product, there shall be responsibility defined for verification that the vessel is the one that was screened and approved and the required minimum vessel preparations have been carried out. This responsibility may rest with employees of the offloading facility or with independent inspectors.

14.3.3 Preparation and Product Compatibility

For loading to owned or chartered ship or barge, the vessel tanks shall be prepared according to 13.4. There shall be procedures for communicating the preparation requirements to the ship operator and (if applicable) to the third party inspector and for ensuring that the requirements have been met.

For both loading of and discharge from ship, there shall be procedures to ensure the product loading and discharge sequence is agreed between the terminal and ship prior to commencing product movement.

14.4 Road Vehicles and Rail Tank Cars

14.4.1 Screening

There shall be a process that ensures the road vehicle or railcar is suitable for carrying the product and the operating organization has the necessary controls, training, experience, skills and awareness to assure product quality. Roles and responsibilities for the process shall be clearly defined.

14.4.2 Preparation and product compatibility

Road tankers and railcars shall be prepared for loading according to Table 8.

Road and rail tank vehicles should be bottom loaded. All top manhole and gauge point covers shall seal completely against the ingress of water or dirt. The use of grade dedicated equipment should be considered to reduce the opportunity of product contamination during shipment.

14.5 Grade Change Procedures for Road Tankers and Railcars—Switch Loading

Switch loading may present significant product quality issues. Small quantities of low flash point products (approximately 0.1 % or less) can negatively impact the flash point of higher flash point products and render the latter off specification or unfit for use. See 13.4.

NOTE Flash point does not blend linearly.

Storage terminals shall have policies regarding switch loading as part of carrier training and authorization.

To address safety concerns with switch loading, refer to API 2003 for further guidance.

14.6 Transport and Delivery of Biodiesel Blends

Throughout the supply chain, good housekeeping practices that apply to diesel fuel handling should also be used for biodiesel blends. These practices are even more important for biodiesel blends in view of the more hydrophilic nature of biodiesel.

The handling of neat biodiesel and/or biodiesel blends requires that adequate measures are taken to prevent the contamination of biodiesel-sensitive fuels. Residual biodiesel or trailback of biodiesel in piping or pipelines can render aviation fuels unfit for use. This specifically applies to jet fuels where a maximum limit of biodiesel is defined by industry standards. Supply chains for jet fuels, heating oil and marine gas oil should be carefully reviewed for potential contamination due to handling of biodiesel or biodiesel blends.

If biodiesel blends are transported through a pipeline system, more frequent cleaning and inspection may be required due to the potential for biodiesel blends to pick up dirt and water throughout the system.

In principle, the transport and distribution of biodiesel blends by barge, road truck and rail should be done in the same way as hydrocarbon-only diesel fuel. Transport vessels should be clean and should not contain residuals from a previous load that may not be compatible. Precautions should be taken to avoid contamination with water, dirt and rust.

15 Fuel Additives, Dyes, Markers

15.1 General

Fuel additive blending systems shall be designed to automatically blend additives at the required concentrations. The system shall be designed to shut down the blend and not issue a Bill of Lading if any of the components are outside of the established blend tolerances.

— For third-party additives the following requirements shall be subject to a contractual agreement between customer and service provider.

— For proprietary additives the following requirements apply.

There shall be documented additive injection instructions for all proprietary and third party products for which the facility conducts the additive operation. Injection instructions shall include a regulatory and manufacturer minimum, maximum and target dosage. Applicable products and volume to which the dosage applies (per gallon, batch, truckload, weekly) must also be defined. The minimum, maximum and target shall be set via agreement between the operating organization and the customer and shall take into account any legal requirements.

15.2 Receipt and Storage

15.2.1 General

All additive receipts shall be accompanied by a Bill-of-Lading (BoL) and a Certificate of Analysis (C of A).

The C of A can be transmitted from the supplier at the time of delivery. If the C of A is not present or if the proper additive is not listed on the BoL, the additive shall not be off-loaded. Check all results on the C of A against the product specifications. Do not off-load the additive if results are not on specification. Report discrepancies to local management.

One sample shall be taken from each receipt. Use a clear, 1-quart glass bottle. Any of the following three methods are acceptable for taking an additive sample:

— from the discharge port of the vehicle prior to off-loading;

— from a compartment of the delivery vehicle prior to off-loading; and

NOTE This option cannot be used if opening of domes on loaded vehicles is prohibited by local or state regulations.

— from line fill or off-loading manifold prior to off-loading truck into additive tank.

15.2.2 Drums and Totes

For terminals receiving additive in drums or totes, a 1-quart sample from each lot or batch shall be taken.

15.2.3 Railcar and Road Vehicles

For terminals receiving additive in railcar or road vehicle, obtain a 1-quart bottom sample upon arrival and prior to unloading. Label the sample with the date and carrier information. Record appearance and color and retain records for a minimum of one year.

15.2.4 Additive Testing

At a minimum, test the samples described above for API Gravity (density) and appearance. Compare the results to those reported on the C of A. Report variations of more than ±0.5 °API Gravity or product that is not clear and bright to local management. Record and retain the results for a minimum of one year.

15.2.5 Sample Retains

Retain additive receipt samples in an appropriate and controlled environment out of the light. The sample should be retained for a minimum of 60 days after the inventory has been depleted.

The condition of all additive retain samples should be monitored at least quarterly for sediment, phase separation, and atypical changes in color. Record appearance and presence and absence of sediment and report any unusual observations to local management.

15.2.6 Multiple Additives

At terminals receiving multiple additives, procedures shall be established to prevent delivery of the additive into the wrong tank. Some key elements to consider in the procedures are:

— clearly label all tanks, pumps, and off-loading lines;

— secure each additive receipt line to prevent unsupervised off-loading of additives; and

— supervise all additive off-loading.

15.2.7 Storage

Additive tank bottoms shall be checked for excessive water, sediment and emulsions on a quarterly basis. Bottoms samples can be obtained either by using a bacon bomb or using a tank bottom draw. If no top hatch or bottom port is available, a line sample may be substituted.

Record appearance and presence and absence of sediment. Report any unusual observations (sediment, phase separation, extreme changes in color) to local management. Retain the sample if anything unusual is noted. Clear and bright samples can be returned to the additive storage tank.

15.3 Additive Transloading

The following operating procedures apply to loading truck transports from a tank car:

— a dedicated hose should be used;

— visually inspect each truck and obtain certification document from the carrier regarding cleanliness and prior load;

— top-loading transfer hose (if used) should be submerged in the additive to reduce emissions;

— after loading, cap the dedicated hose; and

— a copy of the supplier's C of A shall accompany each transport shipment.

15.4 Check Valves and Recycle Systems

In order to ensure over additization does not occur, check valves and recycle systems shall be installed.

15.5 Inventory Control

Physical inventory reconciliations shall be used to assess compliance with agreed targets, minimums and maximums unless an alternative measurement scheme has been risk assessed and endorsed by the local management. The frequency of reconciliation should be determined in consultation with the customer, but shall be no greater than monthly. Procedures shall be documented to ensure that additives do not exceed the manufacturers' recommended shelf life during storage or in use.

NOTE This information may also be required per applicable Volumetric Additive Reconciliation (VAR) regulations (40 *CFR* 80.170).

Inventories in excess of two years shall be sampled and sent to the additive supplier for testing and confirmation of compliance with manufacturer's specifications and continued suitability for use.

16 Butane Blending

16.1 General

Regulatory controls associated with butane blending require the terminal to be registered as a "refiner".

See 40 *CFR* 80.82 for these and additional requirements. Product quality assurance is important because butane affects the properties of blended gasoline.

16.2 Butane Quality Oversight

16.2.1 General

Each receipt of butane shall be designated as commercial or non-commercial (per 40 *CFR* 80.82) and accompanied by a COA containing the following minimum property concentration information:

— Butane purity,

— Olefins,

— Aromatics,

— Benzene, and

— Sulfur.

For any receipt or combination of receipts without the preceding quality information, the appropriate testing must be conducted on butane prior to blending with gasoline to ascertain these qualities and ensure compliance.

16.2.2 Oversight Program Additional Requirements

A “refiner” that blends butane shall conduct a quality assurance program of sampling and testing the butane obtained from each separate butane supplier. The frequency of sampling and testing for each supplier shall be one sample for every 500,000 gallons of butane received or one sample every three months, whichever is more frequent.

In addition to regulatory requirements for butane oversight testing a risk assessment shall be conducted to determine when and if more frequent testing is warranted. Risk assessment shall consider items, such as:

— supplier performance,

— history,

— received volumes,

— changes in carrier, and

— operational changes.

16.3 Quality Oversight of Gasoline Blended with Butane

16.3.1 General

At terminals blending butane into gasoline, the methods of determining blending ratios for each lot or batch of base gasoline may vary. In some cases, on-line mechanical and electronic units are used to analyze the gasoline stream and calculate the volume of butane that is automatically blended.

Another method is to sample an isolated gasoline tank and analyze the volatility properties (i.e., vapor pressure, distillation, vapor liquid ratio) and calculate the volume of butane that can be blended into any given tank. Bulk butane is then transferred into the gasoline tank(s) in predetermined volume(s) where it is mixed and integrated into the gasoline.

Butane injection impacts several critical parameters:

— Reid Vapor Pressure (RVP),

— 10 % evaporated distillation temperature (T10),

— 50 % evaporated distillation temperature (T50), and

— temperature for vapor and liquid ratio of 20 (TV/L=20),

— sulfur,

— driveability index

— other volatility specifications may also be affected.

The test parameter controlling the butane injection is the gasoline property which reaches its maximum permissible value with the least volume of butane injected. Oversight testing should include both verification of the accuracy of the analyzers and compliance with all applicable federal, state and local volatility requirements.

16.3.2 Analyzer Verification

Due to variation in products, specifications and analyzers (i.e. drift and calibration errors) periodic analyzer verification is required.

A sample should be obtained from the sample port of the on-line analyzer and tested manually using the approved method for measurement of RVP and distillation. The time that this verification sample is pulled shall be recorded. If the on-line analyzer is testing product with ethanol, then the oversight sample shall be tested on the independent devices with the same ethanol-blended product. The independent test results shall then be compared to the on-line analyzer results produced at the time the verification sample is pulled. Analyzer verification should be performed weekly.

16.3.3 Blended Product Oversight

A sample of the blended product should be tested once per tank batch or daily for the controlling volatility parameter used to set the butane injection rate (RVP, distillation or TV/L=20). Typically, the sample is obtained from the tank or at the truck loading rack prior to the addition of ethanol. The testing of the other volatility parameters should be performed weekly. At terminals which have Reformulated Gasoline or a state specific requirement, the testing should be done on samples with ethanol.

NOTE Butane blending regulations vary between reformulated and conventional gasolines.

17 Documentation

17.1 Records

The results of all significant checks and testing shall be recorded on documents that are readily available and kept up-to-date. Records of all daily, weekly and monthly checks shall be retained for at least one year for reference purposes and to allow any seasonal trends to be observed. Longer record retention times may be necessary to meet regulatory requirements. (e.g. ULSD sulfur testing results need to be retained for five years).

All records shall be signed by the person who carried out the checks and inspections. In the case of electronic data systems, it shall always be possible to identify the originator of the records.

17.2 Records—Construction and Commissioning

Each storage terminal shall have readily available the following, maintained and up to date.

— A schematic process flow diagram or piping and instrumentation diagram for fuel systems and drainage systems identifying key items of equipment and valves.

— Drawings for area classification (hazardous areas), electrical power supplies, control systems, fire prevention, emergency shutdown and alarm systems, detailed piping layouts (in particular buried pipes), tank layouts, tank drainage, and cathodic protection. Records of any modifications shall be reflected in updated ‘as-built’ drawings.

Each storage terminal should have readily available the following, maintained and up to date:

— Equipment specifications for all pieces of equipment that affect product quality, including suppliers' or manufacturers' drawings, operations and maintenance instructions and other relevant literature and documentation.

— Design and sizing calculations, including design year and ultimate design capabilities (which should be specified in the statement of requirements).

17.3 Records—Quality Control

Each storage terminal shall have readily available the following, maintained and up to date:

a) Inventory stock data including:

— daily product gauges,

— details of incoming and distributed quantities, and

— review of gains and losses.

b) Receipt quality data, examples include:

— relevant quality certificates,

— pipeline tickets,

— bills of lading, and

— product transfer documents.

c) All testing results including internal facility and third party test data.

d) Batch records and release documentation.

e) Calibration and verification records for all inspection, measurement and testing equipment.

f) Additive registrations (per 40 *CFR* 79 - Registration of Fuels and Fuel Additives).

g) Draining records for tanks, filter vessels, and low points shall include, but are not limited to the following:

— observation of solids (i.e. clean, slight, particulate, and heavy),

— water content (i.e. bright, hazy, cloudy, and wet),

— microbiological growth, and

— free water quantity.

17.4 Volumetric Additive Reconciliation (VAR)

Volumetric Additive Reconciliation (VAR) is required by the Environmental Protection Agency (EPA) and other regulatory agencies for detergent additive in gasoline. Other regulatory agencies may have similar additive reconciliation requirements for gasoline or other additives and products.

EPA requirements may be found in 40 *CFR* 80.170 – VAR, equipment calibration and record keeping requirements.

In recognition of the fact that often, no further testing subsequent to additive addition is performed, similar processes shall be developed to track and document all additive and dye throughput volumes and in support of product quality assurance.

For each product and additive, the following must be recorded:

— manufacturer and commercial name of the additive package;

— the additive concentration specified including minimum and maximum:

  — additive concentration is often expressed in terms of gallons of additive per thousand gallons of product (gtg) calculated to four decimals;

— total volume of product to which the additive has been added;

— total volume of additive which was injected;

— volume of additive injected into total volume of product (treat rate);

— the starting and ending dates over which the injection rate applies; and

— the signature or electronic equivalent of the creator of the record and a certification of correctness by the creator of the record.

NOTE Date of certification shall also be shown.

17.5 Records—Maintenance

Each storage terminal shall have readily available the following, maintained and up to date:

— tank inspection and cleaning records,

— filter and strainer differential pressure and element change records,

— floating suction check records, and

— routine checks on other fixed equipment relevant to product quality (e.g. meter calibration, level alarms, mesh strainers and hoses).

EXPLORE SOME MORE

Check out more of API's certification and training programs, standards, statistics and publications.

API Monogram™ Licensing Program

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: certification@api.org
Web: www.api.org/monogram

API Quality Registrar (APIQR™)

- ISO 9001
- ISO/TS 29001
- ISO 14001
- OHSAS 18001
- API Spec Q1®
- API Spec Q2™
- API Quality*Plus*™
- Dual Registration

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: certification@api.org
Web: www.api.org/apiqr

API Training Provider Certification Program (API TPCP®)

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: tpcp@api.org
Web: www.api.org/tpcp

API Individual Certification Programs (ICP™)

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: icp@api.org
Web: www.api.org/icp

API Engine Oil Licensing and Certification System (EOLCS™)

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: eolcs@api.org
Web: www.api.org/eolcs

Motor Oil Matters™

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: motoroilmatters@api.org
Web: www.motoroilmatters.org

API Diesel Exhaust Fluid™ Certification Program

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: apidef@api.org
Web: www.apidef.org

API Perforator Design™ Registration Program

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: perfdesign@api.org
Web: www.api.org/perforators

API WorkSafe™

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: apiworksafe@api.org
Web: www.api.org/worksafe

API-U®

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: training@api.org
Web: www.api-u.org

API eMaintenance™

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: apiemaint@api.org
Web: www.apiemaintenance.com

API Standards

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Email: standards@api.org
Web: www.api.org/standards

API Data™

Sales: 877-562-5187
(Toll-free U.S. and Canada)
(+1) 202-682-8041
(Local and International)
Service: (+1) 202-682-8042
Email: data@api.org
Web: www.api.org/data

API Publications

Phone: 1-800-854-7179
(Toll-free U.S. and Canada)
(+1) 303-397-7956
(Local and International)
Fax: (+1) 303-397-2740
Web: www.api.org/pubs
global.ihs.com

AMERICAN PETROLEUM INSTITUTE

1220 L Street, NW
Washington, DC 20005-4070
USA

202-682-8000

Additional copies are available online at www.api.org/pubs

Phone Orders:	1-800-854-7179	(Toll-free in the U.S. and Canada)
	303-397-7956	(Local and International)
Fax Orders:	303-397-2740	

Information about API publications, programs and services is available on the web at www.api.org.

Product No. A164001