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Revision Memo

- 12/01** Highlights of this revision are as follows:
- (1) References have been updated / added.
 - (2) Additional advice and resources provided for LPG loading system.
 - (3) Minor additions / corrections to write-up for Asphalt.



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SCOPE

This section covers tank truck, rail car, and marine loading of asphalt, pressurized and refrigerated LPG, and sulfur. This section is intended to supplement [Section XXIII-A](#), presenting additional design considerations which are specific to the products mentioned above. References given in [Section XXIII-A](#) are not repeated herein but generally apply to this section as well.

REFERENCES

DESIGN PRACTICES

Section II	Design Temperature, Design Pressure, and Flange Ratings
Section X	Pumps
Section XI	Compressors
Section XII	Instrumentation
Section XVI	Thermal Insulation

GLOBAL PRACTICES

GP 3-3-2	Suction & Discharge Piping for Centrifugal Pumps
GP 3-5-1	Fill & Discharge Lines, and Auxiliary Piping for Storage Tanks & Vessels
GP 3-9-2	External Steam Tracing
GP 3-10-1	Piping Selection Criteria

API STANDARDS

API 2510, *Design & Construction of Liquefied Petroleum Gas (LPG) Installations*

API 2510A, *Fire Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities*

API 2023, *Guide for Safe Storage and Handling of Heated Petroleum Derived Asphalt Products and Crude Oil Residua*

OTHER LITERATURE

1. *The Asphalt Handbook*, Asphalt Institute.
2. *Safe Storage and Handling of Asphalt*, ER&E Report No. EE.85E.83.
3. *Hot Oil and Slop Tankage, Safety Guidelines*, EEEL Report, January 1987.
4. *Asphalt and Fuel Oil Plant Design Guide*, Report MERP.4M.73.
5. *Safe Asphalt Operations Study*, ER&E Letter No. 91 ECS 3016.
6. *Rail and Truck Loading Guide for Pressurized/Refrigerated Products*, Report No. CE IE 82.
7. *Evaluation of Rail Car Petroleum and Hazardous Chemical Loading/Unloading Facilities*, ER&E Report No. EE.98E.86.
8. *Impact of API 2510/2510A Revisions on ExxonMobil LPG Standards*, ER&E Report No. EE.94E.90.
9. *Standard for the Storage and Handling of Liquefied Petroleum Gases*, NFPA No. 58.
10. *Sulfur Plant Safety Guidelines*, ER&E Report EE.69E.86.
11. *Handling Liquid Sulfur*, Data Sheet 592, National Safety Council.
12. *H₂S Hazards with Liquid Sulfur*, ER&E Letter 84 ECS3-16 Containing SOC Communication 84-4.
13. *Safe Handling of Liquid Sulfur*, Exxon Chemicals Report, August 1979.
14. *Pipe Heating Guide*, ER&E Report EE.111E.76.
15. *Solid Sulfur Handling and Storage*, ER&E Report No. EE.1EL.81.
16. *Handling and Storage of Molten Sulfur*, Texas Gulf Sulfur Report.
17. *Marine Facilities, Design, Specification and Evaluation*, Marketing Engineering Standard EE.3M.86.
18. *LHG Marine Cargo Transfer Fire/Explosion Risk Assessment Procedure*, ER&E Memorandum (93 CMS 010).
19. *Marine Dock Hose Technology and Practice Training Video with its companion Application Guide*, ER&E Report No. EE.40E.94.
20. *Purchase Specification and Inspection Guidelines for Marine Cargo Transfer Hose*, ER&E Report No. EE.76E.92.
21. *Safety in LPG Design*, EMRE Manual No. TMEE-111.
22. *LPG Safe Operations Guidelines*, EMRE Manual No. TMEE-113.



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ASPHALT

TYPES OF ASPHALT

Petroleum asphalts fall in the general classification of materials called "bitumens." **Figure 1** illustrates a typical flow plan for the manufacture of various asphalt products. As shown, the four major types of asphalt produced are **straight reduced (referred to as asphalt cement)**, **cutback asphalts**, **air blown (referred to as oxidized)**, and **emulsified**.

Although solid or semi-solid at ambient temperatures, asphalt cement may be readily liquefied by heating, by blending it with petroleum solvents of varying volatility (referred to as cutter stock or diluent), or by emulsifying it. Asphalt liquefied by these latter methods is known as cutback asphalt and emulsified asphalt. For cutback asphalts, after completion of construction, the cutter stock will evaporate leaving behind the asphalt cement to perform its function. In the case of emulsified asphalt, the water will evaporate leaving behind the asphalt cement. Environmental regulations may restrict or prohibit the use of cutbacks in many areas.

Petroleum asphalt for use in pavements is usually called **paving asphalt or asphalt cement** to distinguish it from asphalt made for non-paving uses such as roofing and industrial purposes. Asphalt cement at ambient temperatures is a black, sticky, solid or semi-solid, highly viscous material. Because asphalt cement is sticky, it adheres to stone aggregate and is used to cement or bind them into asphalt concrete. **Asphalt cement** is classified according to standard ranges of consistency grades (viscosity). For many years these ranges were based on lab measurements of penetration (distance that a standard needle penetrates the surface of asphalt cement within 5 seconds at 140°F (60°C)). These five standard grades are 40 - 50, 60 - 70, 85 - 100, 120 - 150, and 200 - 300 which correspond to the allowable range of penetration for each grade. Grading of asphalts based on penetration has largely but not completely been replaced by viscosity. There are two series of viscosity grades by which asphalt cement is available. One consists of grades AC-2.5, AC-5, AC-10, AC-20, AC-30, and AC-40. The numerical values correspond to viscosity in hundreds of poises at 140°F (60°C). The other series consists of grades AR-1000, AR-2000, AR-4000, AR-8000, and AR-16000 with the numerical values indicating the viscosity in poises but with the viscosity being measured after the asphalt has been subjected to conditions occurring in hot mix asphalt concrete plants. The AR stands for aged residue. The various grades of asphalt cement are often obtained by refinery production of both high and low viscosity straight reduced asphalt and then blending the two base grades as required.

Cutback asphalts are classified into three types based on the relative speed of evaporation of the cutter stock. **Rapid curing (RC)** cutback asphalt is a blend of asphalt cement and a cutter stock in the naphtha boiling range. **Medium curing (MC)** cutback asphalt utilizes kerosene or similar boiling point material. **Slow curing (SC)** utilizes higher boiling point cutter stock or can also be produced directly in the refinery. **Figure 1** illustrates the various grades of cutback asphalt. The types (RC, MC, SC) indicate the relative speed of evaporation and the grades (70, 250, 800, and 3000) indicate the minimum allowable kinematic viscosity in centistokes at 140°F (60°C). One additional grade, MC-30, serves as a special priming grade in some sections of the United States. The maximum allowable viscosity for each grade is twice the minimum allowable value. The most viscous grades of RC-3000, MC-3000, and SC-3000 are only moderately less viscous than the lowest viscosity graded asphalt cement AC-2.5. The least viscous grades (RC-70, MC-30, MC-70, and SC-70) may be readily poured at room temperature and have the consistency of heavy dairy cream.

Emulsified asphalts are produced by mechanical milling of warm asphalt cement in a device called a colloid mill and mixing the very small asphalt particles in water containing an emulsifying agent. Emulsified asphalts have advantage over hot asphalt in that they can be used with cold as well as heated aggregate and with aggregate that is dry or damp. This type of asphalt is outside the scope of normal refining/terminalling operations and is, therefore, not discussed further herein.

Air blowing of asphalt cement at high temperature produces an asphalt of higher than normal softening point. Blown asphalts are used for industrial and specialty purposes rather than for paving. Because the higher softening point is the most desirable property of blown asphalts, they are usually classified in terms of softening point test rather than viscosity or penetration. Nevertheless, their overall specification includes both softening point, and penetration at three temperatures for overall quality control. The higher softening point grades of blown asphalt have very high melting points, are very viscous, and are difficult to handle except at high temperature. For this reason, oxidized asphalt is more difficult and costly to store or ship in bulk liquid form than most other commercial grades of asphalt. This provides incentive to locate asphalt oxidizer facilities at the terminal or close to its point of final destination, rather than in the refinery. Although outside the scope of this Design Practice, it should be mentioned that asphalt oxidizers should be carefully designed and operated to avoid potentially serious safety incidents. Oxidizer Safety is covered in EE.85E.83 and 91ECS 3016.

The specific gravity of asphalt at 60°F (15.6°C) ranges from about 0.93 to 1.05.

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ASPHALT (Cont)

GENERAL

The most common asphalts handled at ExxonMobil plants are asphalt cement and cutback asphalt. Emulsified asphalt is generally not handled. Air blown (oxidized) asphalt is handled at a limited number of locations.

Loading systems are provided for tank truck, rail tank car, and marine transport of liquid asphalt. In addition, asphalt is also handled in solid form after drums are filled. Drum filling and loading are not covered by the Design Practices.

Asphalt is also used as fuel within the refinery where advantageous or necessary to do so. Fuel Systems are covered in [Section XXV](#). The information contained in [Section XXIII-A](#), *Basic Loading Systems*, should be referred as it is not repeated herein. Similarly, [Section XXII-B](#) of the Design Practices, *Atmospheric Storage*, and [Section XV-B](#), *Minimizing the Risks of Fire, Explosion, or Accident*, contain information pertinent to asphalt storage.

Safety issues related to asphalt handling are covered in Design Practice Sections XV-B and J.

MODES OF PRODUCT LOADING

Asphalt is top loaded into trucks and rail cars through open hatches without emissions control. The loading arm must be restricted (e.g., by rods or chains) to prevent movement due to reaction forces.

Asphalt trucks are uncompartmented and range up to approximately 5,000 gal (20 m³) per tank. Some are equipped with heaters. When they are not equipped for heating, in-line loading heaters may be required to compensate for heat losses on long hauls.

Rail cars are also uncompartmented and range up to about 10,000 gal (40 m³). These are usually provided with steam heating coils which can be placed in service at the final destination prior to unloading. Rail cars have traditionally been equipped with internal steam coils that heat the contents of the car directly. Some cars have external steam coils that heat the tank shell or are equipped with thermostatically controlled electric immersion heaters. Asphalt trucks and rail cars are top loaded through open hatches. The loading arm or hose should be equipped with a locking device to insure the arm cannot pull out of the hatch.

Heated barges and tankers are also used for asphalt transport. Barges are generally single cargo shipments in the 10 to 20,000 barrel (1,600 to 3,200 cu m) range. Tanker shipments of asphalt are often combined with fuel oil movements although dedicated tankers ranging in size from 5,000 to 30,000 DWT are in service. Parcel size is dependent on logistics considerations.

Prior to loading, the receiving container/vessel should be inspected to confirm that it is free of water, light hydrocarbon liquids or any other material that will vaporize when filled with hot asphalt. Low initial loading rates should be used to detect frothing which usually occurs due to residual water or light hydrocarbons in the tank. Loading temperatures should be limited to avoid excessive vapor evolution. These vapors may contain toxic concentrations of H₂S. Splash loading of asphalts in tank cars and trucks is permissible since asphalts are not static accumulators. In contrast to large storage tanks, the space within tank car and truck compartments is small enough so that formation of a charged mist is not a concern. Grounding of tank cars and trucks is not necessary. However, from a general safety standpoint, loading operations should minimize misting. The considerations given in [Section XXIII-A](#) regarding loading rates apply to asphalt as well.

CONTAMINATION AND PRODUCT SEGREGATION

Contamination is the most common reason for asphalts failing to meet specification. Conditions such as low flash point, low viscosity, and high penetration are typical of solvent type contamination. For example, experiments indicate that 0.1% diesel oil in asphalt cement can lower the flash point by up to 50°F (28°C). Flash point of asphalt is an important safety related specification.

Positive separation of piping systems for penetration grades and cutbacks/blending solvents is required by eliminating or not introducing interconnections. If this is not practical, blinds are required to prevent contamination that could lead to product degradation and safety problems involving volatile components and hot asphalt.

STORAGE AND LOADING TEMPERATURE

Even in hot climates, asphalts are stored and loaded at temperatures above ambient to facilitate handling. [Table 2](#) of [DP](#), [Section XV-B](#), provides guideline temperatures for the storage and handling of asphalts. The source of this information is API Publication 2023, *Guide for Safe Storage and Handling of Heated Petroleum Derived Asphalt Products and Crude Oil Residua*, the Asphalt Handbook issued by the Asphalt Institute, and ER&E Letter No. 91 ECS 3016, *Safe Asphalt Operations Study*.

Oxidized asphalt is produced at a temperature of about 425°F (218°C). The storage and loading temperature should be limited to 425°F (218°C) maximum for oxidized asphalt. All other asphalts are handled at lower temperatures as shown in [Table 2](#). All metal loading arms are recommended for hot asphalt service.

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ASPHALT (Cont)

TEMPERATURE MAINTENANCE AND CONTROL

- Asphalt systems are predominantly heated by steam, circulating hot oil, or a combination thereof. Electric heating is rarely used on a plant wide scale, but may be considered in remote locations where fuel gas or steam may not be available. Fired heaters utilizing combustion heating are also used occasionally. These heaters can be located at the storage tank, in the suction line to the loading pump, or in the pump discharge line enroute to the loading rack. Because these heaters fire fuel, and are generally located in dispersed and relatively remote areas rather than one centralized location, they may be a safety concern. Where used, this type of heater must be provided with a safety shutdown system. The choice of heating media (steam, hot oil, or fired heater) is determined on the basis of the heat requirements for the overall storage, blending, and loading system. As winter tank heating loads are generally much greater than loading system requirements, overall system considerations most often determine the type of heating used for loading line tracing. Overall system considerations include temperature requirements of asphalt, heat duties, availability and characteristics of steam, safety, and economics. Hot oil heating of asphalt storage is inherently safer than steam heating because of the hazards associated with steam/condensate vaporization in the event of heater leakage within the tank. If natural circulation within the tank is not adequate, consider use of forced circulation to provide relatively uniform temperature & prevent stratification.

Hot oil systems are composed of a furnace(s) with associated fuel system firing controls and safeguards, and a hot oil circulation system with associated pumps. Separate pumps are usually required for storage tank and line tracing circulation. The hot oil is circulated to and from heating coils within each tank as well as the line tracing system. Hot oil flow to each tank is set by the temperature controller. A hot oil system is of higher investment than a comparable steam heating system where steam is readily available. The hot oil facilities also introduce another set of operating and maintenance complexities. Nevertheless, site specifics may require that hot oil be used rather than steam.

Line tracing is of the external type. Internal steam tracing is not permitted for safety and maintenance reasons per **GP 3-5-1**. Steam jacketing is seldom justified. Heat tracing media should be limited to 500°F (260°C) maximum. Long loading lines are difficult to heat effectively particularly when the steam source is from one end only. Localized use of electric tracing is sometimes used at the end of a long run in order to eliminate local cold spots.

In order to minimize the risk of asphalt setup, long lines are often air blown into tankage to clear the line. This may be necessary during periods of extreme cold or in areas where the seasonal nature of the asphalt business will idle the system for extended periods. Lines may also be blown in systems which include a common line for multiple products. Compressed air of nominal 100 psig pressure is expanded into the loading line at the tank truck or marine berth location in order to blow the line contents into the appropriate storage tank. Precautions to be followed in connection with asphalt line blowing are covered in **Section XXII** of the DPs, *Storage Facilities*, **Section XV-B**, *Minimizing the Risks of Fire, Explosion, or Accident*, and **GP 3-5-1**.

PUMPS

Both centrifugal and positive displacement pumps have been successfully used in asphalt service. Pump selection should be based on the criteria given in **Section X** of the DPs, *Pumps*. Viscosity, solids content and temperature are key asphalt characteristics for assessing pump applicability and performance. The need for pump warm-up facilities per **GP 3-3-2**, steam jacketing, and facilities for purging the pump of asphalt with a lighter material immediately prior to idle periods should also be evaluated.

Per **GP 3-5-1**, pumps and piping manifolds must be located outside of diked areas, however, pumps may be located within the diked area to limit the suction line pressure drop of heavy viscous stock. In such cases, remote shutoff facilities must be provided outside the diked area.

PRODUCT MEASUREMENT

Both weigh scales and positive displacement meters (PDM) are each acceptable for product measurement and billing purposes. Local requirements or practices such as road and rail transport regulations often set the preferred alternative.

Because of the relatively high viscosity of asphalt, the maximum capacity of the PDM must be derated and a greater pressure drop should be considered as a result. Air eliminators in high viscosity service must be physically very large to be effective and are, therefore, usually not installed for this reason.

