Section 5
Emission Calculations

The following describes the calculations used to determine the emission rates associated with each emission source category included in this permit application. A summary of the proposed emissions are included in Table 1(a) at the end of this section. Detailed emission calculations are presented in Appendices A and B of this application.

The terminal will handle a wide range of crude oils and/or crude oil condensates. The Reid Vapor Pressure (RVP) of the crude and/or crude oil condensates managed at the terminal vary from month to month; however, a maximum TVP of 11 psia is the basis for the proposed emission limits.

Axis proposes to establish emission caps for loading facilities rather than individual throughput limits due to the varying nature of crude oils and crude oil condensates and customer markets at the proposed terminal. Specifically, rather than limiting throughputs, Axis proposes to manage the loading facilities included in this application such that the permitted emission limits are not exceeded. Managing to the emissions caps allows Axis the operational flexibility to respond to market changes and customer demands.

5.1 Routine Emissions

The following describes the emission calculations associated with each routine emission source category in this permit application.

5.1.1 Storage Tank Emissions

For storage tanks, the emission calculations for routine working and breathing emissions are estimated using the calculations methods in *Compilation of Air Pollutant Emission Factors: Volume I Stationary Point and Area Sources* (AP-42, Fifth Edition, US EPA, November 2006 (hereafter referred to in this application as AP-42) Section 7.1. Short-term emission rates are calculated using AP-42 Section 7 equations using maximum temperature and vapor pressure.

In addition to routine IFR storage tank working and breathing emissions, routine IFR storage tank roof-landing events occur for periods of inventory control and product changes (EPNs: T-COMB-1). Floating roof landing emissions are estimated using the methods in Subsection 7.1.3.2.2 Roof

Landings of Section 7.1 Organic Liquid Storage Tanks of AP-42. For a given roof-landing event, total landing loss emissions are therefore the sum of the filling losses and the daily standing idle losses over the entire period that the roof remained landed. Landing losses are inherently episodic in nature and must be determined each time a tank's floating roof is landed.

Landing losses occur from floating roof tanks whenever the tank is drained to a level where its roof lands on its legs or other supports (including roof suspension cables). When a floating roof lands on its supports or legs while the tank is being drained, the floating roof remains at the same height while the product level continues to lower. This creates a vapor space underneath the roof. Liquid remaining in the bottom of the tank provides a continuous source of vapors to replace those expelled by breathing (in the case of internal floating roof tanks) or wind action (in the case of external floating roof tanks). These emissions, referred to as standing idle losses (LSL), occur daily as long as the floating roof remains landed. Additional emissions occur when incoming stock liquid fills a tank with a landed roof. The incoming volume of liquid not only displaces an equivalent volume of vapors from below the floating roof, but also generates its own set of product vapors that are displaced during the filling process. These two types of emissions are collectively referred to as filling losses (LFL). The calculation methodology used of the standing loss and refilling emissions is discussed in further detail below.

Similar to breathing losses under normal operating conditions, standing idle losses occur during that period a roof is landed with product still in the tank. Emission calculation equations for these losses are from Subsection 7.1.2.2.1 Standing Idle Losses in Section 7.1 of AP-42. The quantity of emissions is dependent upon the number of days idle, tank type (IFR/EFR), type of product stored, and the time of the year. Maximum hourly VOC emissions for tanks with idle standing losses were determined by calculating the losses for one day and then dividing by twelve hours/day. Twelve hours were used since the tanks breathe out for twelve hours/day and breathe in the other twelve hours.

Similar to loading losses, refilling losses occur while a tank is being filled with product during that period of time a roof is landed. Emission calculation equations for these losses are from Subsection 7.1.3.2.2.2 of AP-42. The quantity of emissions is dependent upon the tank type (IFR/EFR), type of product stored, time of year, and fill rate. The maximum refilling loss is based on: (1) the tank re-fill rate; and (2) the month resulting in the highest emission as a function of vapor pressure (July). Maximum hourly VOC emissions were determined by dividing the filling emissions (LFL) by the maximum pumping rate. The calculation assumes that the product vapors within the vapor space under the tank roof are emitted from the tank at the same rate as the liquid coming into the tank.

Tank roof landing emissions associated with crude oils and crude oil condensates will be collected via vapor recovery equipment and routed to vapor combustion devices (EPN: T-COMB-1). Emissions from the vapor combustion device have been estimated using the methods outlined in the TCEQ's Air Permit Technical Guidance for Chemical Sources: Flares and Oxidizers, October 2002. VOC, NO_x, CO, SO_2, H_2S, and $PM/PM_{10}/PM_{2.5}$ emissions were estimated from the vapor combustion due to tank roof landing in the VCU system. VOC emissions are based on vendor guaranteed destruction efficiency of at least 99.9%. NO_x and CO emissions were based on vendor guaranteed emission factors and an estimated roof landing vapor heat content of 20,000 Btu/lb. SO_2 emissions associated with crude oil and crude condensate vapor control were based on 100% conversion of any H2S in the waste gas stream while SO_2 emissions associated with assist gas usage were based on AP-42, Section 3.2.7 emission factors. H_2S emissions were based on a max vapor space concentration of 1,000 ppm and a corresponding DRE of 98%. $PM/PM_{10}/PM_{2.5}$ emissions were based on emission factors from AP-42, Section 3.2-7.

Detailed storage tank emission calculations are included in Appendix A, as Tables A-1 through A-4

5.1.2 Marine Vessel Loading

Loading losses are comprised of the total vapors displaced and generated by loading crude oils and/or crude oil condensate into the marine vessels. The uncontrolled loading losses have been calculated using Equation 1 from AP-42, Section 5.2:

$$L_L = 12.46\frac{SPM}{T}$$

where:

L_L = loading loss, lb/1000 gallons of product loaded.

S = AP 42 saturation factor.

P = True Vapor Pressure at maximum temperature, psia.

M = Molecular weight of gasoline vapor, lb–lb/mole

T = Temperature of product loaded, degrees Rankine.

A Saturation factor of 0.2 was used in the calculation for ship and ocean-going barge loading operations with a factor of 0.5 for inland barges. The loading loss vapors from crude oil and crude oil condensate loading will be captured and routed to vapor combustion devices (EPNs: MVCU-1 through MVCU-8) for VOC destruction. Emissions from the vapor combustion devices have been estimated using the methods outlined in the TCEQ's Air Permit Technical Guidance for Chemical Sources: Flares and Oxidizers, October 2002. VOC emissions are based on a vendor guaranteed destruction efficiency of at least 99.8%. Uncollected fugitive loading emissions are calculated based on a collection efficiency of 99.89% for inerted vessel loading (EPNs: BERTH-1 & BERTH-2). SO_2 emissions associated with crude oil and crude condensate vapor control were based on 100% conversion of any H2S in the waste gas stream while SO_2 emissions associated with assist gas usage were based on AP-42, Section 3.2.7 emission factors. H_2S emissions were based on a max vapor space concentration of 1,000 ppm and a corresponding DRE of 98%. $PM/PM_{10}/PM_{2.5}$ emissions were based on emission factors from AP-42, Section 3.2-7.

Detailed loading emission calculations are included in Appendix A as Tables A-5 through A-7.

5.1.3 Piping Equipment Fugitives

The fugitive emissions from piping components and ancillary equipment were estimated using methods outlined in the TCEQ's guidance web page for Equipment Leak Fugitives[1]. Each fugitive component was classified first by equipment type (valve, pump, relief valve, etc.) and then by material type (gas/vapor, light liquid, heavy liquid). Total emission rates were obtained by multiplying the number of fugitive components of a particular type by the appropriate Petroleum Marketing Terminal emission factor.

Detailed piping fugitive calculations are included in Appendix A as Table A-8.

5.2 Maintenance, Startup and Shutdown Emissions (MSS)

Maintenance, startup, and shutdown (MSS) activities and associated emissions will occur to support terminal operation. The following describes the calculations used to determine the MSS emissions associated with the each emission source included in this permit application. Detailed emission calculations are presented in Appendix B of this application.

5.2.1 Storage Tank Floating Roof Landing Losses

The roof-landing events occur for predictable maintenance events, periods of inventory control, and routine product changes. Floating roof landing emissions are estimated using the methods in Subsection 7.1.3.2.2 Roof Landings of Section 7.1 Organic Liquid Storage Tanks of AP-42. For a given roof-landing event, total landing loss emissions are therefore the sum of the filling losses and the daily standing idle losses over the entire period that the roof remained landed. Landing losses are inherently episodic in nature and must be determined each time a tank's floating roof is landed.

Landing losses occur from floating roof tanks whenever the tank is drained to a level where its roof lands on its legs or other supports (including roof suspension cables). When a floating roof lands on its supports or legs while the tank is being drained, the floating roof remains at the same height while the product level continues to lower. This creates a vapor space underneath the roof. Liquid remaining in the bottom of the tank provides a continuous source of vapors to replace those expelled by breathing (in the case of internal floating roof tanks) or wind action (in the case of external floating roof tanks). These emissions, referred to as *standing idle losses (LSL)*, occur daily as long as the floating roof remains landed. Additional emissions occur when incoming stock liquid fills a tank with a landed roof. The incoming volume of liquid not only displaces an equivalent volume of vapors from below the floating roof, but also generates its own set of product vapors that are displaced during the filling process. These two types of emissions are collectively referred to as *filling losses (LFL)*. The calculation methodology used of the standing loss and refilling emissions is discussed in further detail below.

Similar to breathing losses under normal operating conditions, standing idle losses occur during that period a roof is landed with product still in the tank. Emission calculation equations for these losses are from Subsection 7.1.2.2.1 Standing Idle Losses in Section 7.1 of AP-42. The quantity of emissions is dependent upon the number of days idle, tank type (IFR/EFR), type of product stored, and the time of the year. Maximum hourly VOC emissions for tanks with idle standing losses were determined by calculating the losses for one day and then dividing by twelve hours/day. Twelve hours were used since the tanks breathe out for twelve hours/day and breathe in the other twelve hours.

Similar to loading losses, refilling losses occur while a tank is being filled with product during that period of time a roof is landed. Emission calculation equations for these losses are from Subsection 7.1.3.2.2.2 of AP- 42. The quantity of emissions is dependent upon the tank type (IFR/EFR), type of product stored, time of year, and fill rate. The maximum refilling loss is based on: (1) the tank re-fill rate; and (2) the month resulting in the highest emission as a function of vapor pressure (July). Maximum hourly VOC emissions were determined by dividing the filling emissions (LFL) by the maximum pumping rate. The calculation assumes that the product vapors within the vapor space under the tank roof are emitted from the tank at the same rate as the liquid coming into the tank.

Once a tank is drained, tanks storing products with true vapor pressures greater than 0.5 psia are degassed and the vapors removed from the vapor space under the floating roof are routed to vapor combustor until the VOC concentration in the vapor space is less than 5,000 parts per million by volume (ppmv) after which the tank may vent to atmosphere. Blowers are used to ventilate the tank and force out any residual volatile organic compound (VOC) material. Emissions from cleaning, refilling and degassing of VOC concentrations higher than 5,000 ppmv are routed to vapor combustor for control. Emissions from the vapor combustion device have been estimated using the methods outlined in the TCEQ's *Air Permit Technical Guidance for Chemical Sources: Flares and Oxidizers, October 2002.* VOC, NO_x, SO_2, $PM/PM_{10}/PM_{2.5}$ and CO emissions were estimated form the vapor combustion due to tank roof landing. VOC emissions are based on vendor guaranteed destruction efficiency of at least 99.9%. SO_2 emissions associated with crude oil and crude condensate vapor control were based on 100% conversion of any H2S in the waste gas stream while SO_2 emissions associated with assist gas usage were based on AP-42, Section 3.2.7 emission factors. H_2S emissions were based on a max vapor space concentration of 1,000 ppm and a corresponding DRE of 98%. $PM/PM_{10}/PM_{2.5}$ emissions were based on emission factors from AP-42, Section 3.2-7..

Detailed floating roof storage tank roof landing MSS emissions are included in Appendix B as Tables B-2, B-3, and B-5.

5.2.2 Equipment Venting

Equipment venting includes, but is not limited to, liquid draining, venting to control, venting to atmosphere post control and refilling emissions during startup. The equipment venting emissions are calculated using the ideal gas law using the volume of the equipment and the material properties of the VOC material contained in the equipment. Short-term and annual emissions are based on an assumed number of simultaneous events and annual events per year, respectively. The equipment venting calculations are included to determine the contribution to the MSS cap purposes only. These emission calculations are not to be considered enforceable representations as to the magnitude, duration, and/or frequency of individual activities.

Equipment with isolated volumes equal to or less than 50.27 ft3 will be vented to the atmosphere uncontrolled while equipment with isolated volumes greater than 50.27 ft3 will first be degassed to a portable vapor control device so to attain a VOC concentration below 10,000 ppmv. VOC, NO_x, SO_2, $PM/PM_{10}/PM_{2.5}$ and CO emissions were estimated form the vapor combustion. VOC emissions are based on vendor guaranteed destruction efficiency of at least 99.8%. SO_2 emissions associated with crude oil and crude condensate vapor control were based on 100% conversion of any H2S in the waste gas stream while SO_2 emissions associated with assist gas usage were based on AP-42, Section 3.2.7 emission factors. H_2S emissions were based on a max vapor space concentration of 1,000 ppm and a corresponding DRE of 98%. $PM/PM_{10}/PM_{2.5}$ emissions were based on emission factors from AP-42, Section 3.2-7..

Detailed equipment venting emission calculations are included in Appendix B as Table B-4.

5.2.3 Vacuum Truck and Frac Tank Loading

Emissions from the use of air movers and frac tanks are estimated using the loading loss equation from AP-42, Section 5.2.

Detailed vacuum truck and frac tank loading emissions are included in Appendix B as Table B-6.

5.2.4 Pipeline Pigging Emissions

Pigging may be required to clean and maintain the product pipelines. Emission associated with pigging maintenance are calculated by employing the ideal gas equation and multiplying by the maximum number of hourly and annual pigging events anticipated. Emissions resulting from pigging activities will be controlled by carbon canister. Carbon canister emission are estimated based on vapor flow rates and a carbon breakthrough concentration of 100 ppmv.

Detailed pipeline pigging emission calculations are included in Appendix B as Table B-7.