

# Engineering Standard

---

SAES-A-102

30 November, 2002

## Air Pollutant Emission Source Control

---

### Environmental Standards Committee Members

*Al-Sharif, A.A., Chairman*

*Abed Hezam, M.H.*

*Al-Bokhedaim, Y.S.*

*Al-Kadhim, M.H.*

*Al-Said, M.M.*

*Arnold, L.P.*

*Dobinson, I.D.*

*Hagen, D.L.*

*Ngao, J.O.*

*Rehm, T.E.*

*Worrall, M.E.*

## Saudi Aramco DeskTop Standards

### Table of Contents

1	Scope.....	2
2	Conflicts and Deviations.....	2
3	References.....	3
4	Standards.....	4
5	Engineering Reports.....	4
6	Air Pollution Control Requirements.....	5
7	Performance Testing and Inspection (Stack Testing).....	15
8	Definitions, Abbreviations and Acronyms.....	16

### Table of Contents (Cont'd)

Appendix I – Ambient Air Quality Standards.....	25
Table 1 - Presidency of Meteorology & the Environment (PME) & Royal Commission Ambient Air Quality Standards	
Attachment I – Air Quality Compliance Assessment (AQCA) Form.....	26
Attachment II – Royal Commission of Jubail Boundaries.....	27
Attachment III – Royal Commission of Yanbu Boundaries.....	28
Appendix II – Source Emission Standards.....	29
Table 1 - Presidency Of Meteorology & The Environment (Pme) & Royal Commission Source Emission Standards	
Appendix III – Stack Testing Methods.....	36
Appendix IV – Stack Testing Figures.....	39

## 1 Scope

This standard specifies the minimum required air pollution control systems, process modifications, or other mitigative actions that shall be incorporated into project designs as per [SAEP-14](#), "Project Proposals" and GI-0430.001, "Waste Management" to a) minimize air pollutant emissions to the atmosphere and b) ensure the project design is in compliance with all applicable ambient air quality standards as listed in Appendix I, Table I, and applicable source emission standards as listed in Appendix II, Table I.

## 2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Material Systems Specifications (SAMSSs), Saudi Aramco Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Environmental Protection Department (EPD), Dhahran, prior to start of any work.
  - 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure, [SAEP-302](#), and forward such requests to the Manager, Environmental Protection Department of Saudi Aramco, Dhahran. Action on deviation is not allowed until approval of such requests.
-

### 3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

#### 3.1 Saudi Aramco References

##### Saudi Aramco Engineering Procedures

<a href="#"><u>SAEP-13</u></a>	<i>Project Environmental Assessments</i>
<a href="#"><u>SAEP-14</u></a>	<i>Project Proposals</i>
<a href="#"><u>SAEP-302</u></a>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>
<a href="#"><u>SAEP-340</u></a>	<i>Air Quality Impact Analysis and Assessment</i>

##### Saudi Aramco Engineering Standards

<a href="#"><u>SAES-A-104</u></a>	<i>Wastewater Treatment, Reuse and Disposal</i>
<a href="#"><u>SAES-B-005</u></a>	<i>Spacing and Diking for Atmospheric and Low- Pressure Tanks</i>
<a href="#"><u>SAES-B-054</u></a>	<i>Access, Egress, and Material Handling for Plant Facilities</i>
<a href="#"><u>SAES-B-055</u></a>	<i>Plant Layout</i>
<a href="#"><u>SAES-B-070</u></a>	<i>Bulk Plants</i>
<a href="#"><u>SAES-D-001</u></a>	<i>Design Criteria for Pressure Vessels</i>
<a href="#"><u>SAES-D-100</u></a>	<i>Design Criteria of Atmospheric and Low-Pressure Tanks</i>
<a href="#"><u>SAES-F-001</u></a>	<i>Design Criteria of Fired Heaters</i>
<a href="#"><u>SAES-F-007</u></a>	<i>System Design Criteria of Flares</i>
<a href="#"><u>SAES-J-602</u></a>	<i>Burner Management, Combustion &amp; Waterside Control Systems for Watertube Boilers</i>
<a href="#"><u>SAES-K-501</u></a>	<i>Steam Turbines</i>
<a href="#"><u>SAES-K-502</u></a>	<i>Combustion Gas Turbines</i>

##### Saudi Aramco Materials System Specifications

<a href="#"><u>32-SAMSS-022</u></a>	<i>Manufacture of Components for Flare Systems</i>
<a href="#"><u>36-SAMSS-001</u></a>	<i>Co-Generation Train</i>

---

### Saudi Aramco General Instructions

*GI-0425.000                      Refrigerant Management*

*GI-0430.001                      Waste Management*

### 3.2 Saudi Government Documents and Standards

Document No. 1409-01 and revisions, "Environmental Protection Standards", Meteorological & Environmental Protection Administration (MEPA) (Note that the name is now "Presidency for Meteorology and the Environment" or PME).

"Environmental Protection Manual" and revisions, Directorate General for Yanbu Project, Madinat Yanbu Al-Sinaiyah, Royal Commission for Jubail and Yanbu, January 1991.

"Royal Commission Environmental Regulations, "Royal Commission for Jubail and Yanbu "Directorate General for Jubail Project, Health Services Department, September 1999.

## 4 Standards

### 4.1 Ambient Air Quality Standards (AAQS)

Design requirements of air pollution control equipment for a project or facility are based on the results of air dispersion modeling and analyses as detailed in [SAEP-340](#), "Air Quality Impact Analysis & Assessment."

### 4.2 Source Emission Standards

Facilities will be designed to comply with all applicable source emission standards listed in Appendix II, Table 1 of this document.

## 5 Engineering Reports

### 5.1 General

The Design Basis Scoping Paper (DBSP) shall not be approved by the Environmental Protection Department (EPD) without an Environmental Statement (ES). The ES is developed by EPD with assistance from FPD. The ES shall be the basis for the Preliminary Air Quality Engineering Report (PAQER) or Detailed Air Quality Engineering Report (DAQER) that are incorporated into the Environmental Impact Assessment (EIA) study for the Project Proposal. The PAQER provides preliminary information needed by EPD to determine the significance of air quality (AQ) impacts. If impacts are significant, a DAQER is required that incorporates the required Air Quality

Impact Analysis and Assessment of the project as detailed in [SAEP-340](#). Specific details for conducting the EIA are in [SAEP-13](#).

#### 5.2 Preliminary Air Quality Engineering Report (PAQER)

The Facilities Planning Department (FPD) shall prepare the PAQER and submit it to EPD with the initial Project Proposal.

EPD will review the PAQER to determine if a Detailed Air Quality Engineering Report (DAQER) is required. EPD will review and return the PAQER to the FPD with comment within 15 business days of its official submittal to EPD.

#### 5.3 Detailed Air Quality Engineering Report (DAQER)

The DAQER shall list the required ambient air quality and source emission standards to be met and detailed plans to meet these specific standards.

A detailed air emission inventory report with results of air dispersion modeling shall be included based on the guidelines of [SAEP-340](#).

EPD shall evaluate the DAQER and returned it to the PMT within 30 business days of its official submittal date to EPD with an approval or further comment / action.

## 6 Air Pollution Control Requirements

6.1 All emission control equipment will be designed to operate in compliance with the source emission standards listed in Appendix II, Table 1.

6.2 Best Available Control Technology (BACT) shall be used for new facilities and Best Available Retrofit Technology (BART) shall be used for existing facilities to control air pollutant emissions to the limits specified in Table I of Appendix II. Source specific BACT and BART information are found at the USEPA database through its website at [www.epa.gov/ttn](http://www.epa.gov/ttn).

6.3 All industrial facilities shall be designed to not discharge any toxic substances or hazardous matter in such quantities or duration as to be harmful to the health and welfare of humans, animals, or plants. Evaluation of such facilities as to adequacy of controls and/or procedures and emission potential shall be done on an individual basis by the EPD. Saudi Aramco and the Saudi Arab Government do not allow direct atmospheric releases of any known toxic substance or hazardous matter.

6.4 Perform stack testing on all regulated stacks at new facilities to establish baseline compliance with source emission standards or at existing facilities that do not comply with source emission standards.

---

*Commentary Note:*

*The frequency and number of additional stack tests required are per agreement between the regulatory agency and Saudi Aramco facility.*

- 6.5 Install continuous emission monitoring (CEM) equipment or equivalent EPD-approved stack emission monitoring technology on all regulated stacks at new facilities.
- 6.6 Site gaseous and particulate emission sources downwind and at suitable distances from sensitive areas (population areas, roads, etc.). Evaluation of such facilities as to adequacy of location, emission controls, and/or operational procedures shall also adhere to the requirements of [SAES-B-055](#), "Plant Layout" and be reviewed on an individual basis by the EPD.
- 6.7 Exhaust Stacks and Vents
- 6.7.1 Design all new exhaust stacks according to Good Engineering Practice (GEP) requirements so that the height, HS, is calculated as follows:  $HS = H + 1.5L$  where H is the height of the nearby structure and L is the lesser dimension of the height or width of the nearby structure. "Nearby" means that distance up to 5 times "L" but not greater than 0.8 kilometer ( $\frac{1}{2}$  mile). For determining compliance of this standard, stack height is limited to 91.4 meters (300 feet) for air dispersion modeling purposes. This limits the effect of height and the subsequent dilution of stack emissions alone in meeting the ambient air quality standards. However, actual stack heights can be higher than this limit if required for other reasons.
- 6.7.2 Provide stacks with two sampling ports, 90° apart, if the stack diameter is less than < 3.1 meters including the port length; or four sampling ports, 90° apart, if the stack diameter is  $\geq 3.1$  meters including the port length. Locate all sampling ports at least eight (8) stack (or duct) diameters downstream and at least two (2) diameters away from any flow disturbance such as a bend, expansion, contraction, stack opening, or visible flame if the flue gas flow is cyclonic or swirling. If the flue gas flow is not cyclonic, an alternative location may be selected at a position at least two (2) stack (or duct) diameter downstream and a half ( $\frac{1}{2}$ ) diameter upstream from any flow disturbance (refer to Figure 1 of Appendix IV for proper port locations for both conditions). Also, an alternative procedure is available for determining the acceptability of a sampling port measurement location not meeting the criteria above. This procedure of determining gas flow angles at the sampling points, and comparing the results with acceptability criteria, is described in USEPA Method 1, Section 2.5, 40 CFR 60 (refer to Appendix III).
-

- 6.7.3 The positions of the ports shall be placed at the same elevation and separated by 90 degrees on the stack (refer to EPD for technical guidance if a sampling port location can not meet the above requirements and an alternate sampling scheme must be used). Each port shall consist of a 4-inch to 6-inch inside diameter (I.D.) opening. The sampling port shall be installed with a pipe extending approximately 6 inches beyond the outside stack wall and at 90 degrees to the stack. The pipe shall be threaded on the outside and ended with a bolted flange installed. The flange shall be capped when not in use. Install at each sampling point a hook and monorail system. This will make the movement of sampling train easy at each traverses point as well as support the sampling train during the tests (See Figures 2 & 3 of Appendix IV).
- 6.7.4 The equivalent stack diameter for square or rectangular cross-section ducts, for the purpose of determining flue gas sampling port upstream and downstream distances, shall be calculated as follows:

$$\text{Equivalent Diameter of Stack (or Duct), } D_e = \frac{2HW}{(H + W)} \quad (1)$$

where H is the height (or length) of the stack (or duct), and W is the width of the stack (or duct).

The following alternative criterion may be used:

For rectangular stacks, divide the cross-section into as many rectangular areas as possible such that the length to width ratio of each elemental area is between one and two, and then locate the traverse points at the centroid of each equal area (refer to Section 2.0, Item #O-7 "Standards of Performance for New Stationary Sources; "Test Methods and Procedures," U.S. Code of Federal Regulations (CFR), 40CFR, Part 60, Appendix A; and Section 5.0 of the [SAEP-340](#) Engineering Procedures for more detail).

- 6.7.5 Provide access to the sampling ports with work platforms 1.1 m to 1.25 m wide at approximately 1.5 meters below the installed sampling ports and capable of supporting 3 adults (250 Kg) plus 100 kg of sampling equipment. Equip the platform with a safety handrail and ensure there are no obstructions within a one-meter horizontal radius on the platform beneath the ports. The platform shall be equipped with grounded weatherproof dual 120VAC/240 VAC/30-Amp electrical service with multiple outlets at the platform and base of the stack.

- 6.7.6 Adhere to the requirements of [SAES-B-054](#), "Access, Egress, and Material Handling for Plant Facilities" to facilitate proper completion of all requirements for facility stack testing.
- 6.8 Boilers, Industrial Furnaces, Process Heaters, and Other Stationary Combustion Units:
  - 6.8.1 Design all combustion units to meet the requirements of [SAES-F-001](#), "Design Criteria of Fired Heaters," [SAES-J-602](#), "Burner Management, Combustion, & Waterside Control Systems for Watertube Boilers," and the applicable source emission standards of Appendix II, Table I.
  - 6.8.2 Design burners for low NO<sub>x</sub> emissions using BACT.
  - 6.8.3 Incorporate appropriate emission monitoring of all combustion units as per EPD direction.
  - 6.8.4 Sour gas as a fuel source is not allowed. The H<sub>2</sub>S content of any fuel gas is limited to no more than 230 mg/dscm (165 ppm dry).
  - 6.8.5 Design oil fired boilers and process heaters to operate at 10% to 15% excess air (equivalent to 2% to 3% excess O<sub>2</sub>) and gas fired boilers between 10% to 20% excess air (2% to 5% excess O<sub>2</sub>). For units with a heat input greater than 100 MMBtu/hr, provide controls for excess air including O<sub>2</sub> analyzers and automatic damper controls.
  - 6.8.6 Stack gas heat recovery is permitted only where air dispersion modeling shows no adverse impact on permissible ambient air quality ground-level concentrations (refer to Appendix I, Table I for ambient air quality limits).
- 6.9 Stationary Combustion Gas Turbines (CGT)
  - 6.9.1 Design Combustion Gas Turbines to meet the requirements of [SAES-K-502](#), "Combustion Gas Turbines," [SAES-K-501](#), "Steam Turbines," [36-SAMSS-001](#), "Co-Generation Train," and the source emission standards found in Appendix II, Table I.
  - 6.9.2 Incorporate appropriate emission control such as dry low-NOX (DLN) combustor, staged burner design, non-catalytic thermal de-NOX reaction, selective catalytic reduction (SCR), non-selective catalytic reduction (NSCR), flue gas recirculation, excess-air burner-lean fuel control, or secondary-waste vapor injection.

*Commentary Note:*

---



*Since each CGT may be subject to unique conditions, EPD must be consulted before finalizing the emission control design.*

6.9.3 Sour gas as a fuel source is not allowed. The fuel gas H<sub>2</sub>S content is limited to no more than 230 mg/dscm (165 ppm dry).

6.10 Fluidized-Bed Catalytic Cracking Units (FCCU)

6.10.1 Design FCCU catalyst regenerators to requirements of Appendix II, Table I.

6.10.2 Equip the FCCU with carbon monoxide boiler or high-temperature regeneration to reduce CO emissions to no greater than 572 mg/m<sup>3</sup> (500 ppm).

6.10.3 Deploy one of the following emission control technologies in the FCCU to reduce non-sulfate particulates (including metals) to less than 1.0 kilogram per metric tonne of coke burn-off.

- Caustic venturi wet scrubber
- High efficiency cyclone (HEC)
- Electrostatic precipitator (ESP)

*Commentary Note:*

*A venturi-wet scrubber is preferred as its removal efficiency for particulates is between 93% and 98% and will remove SO<sub>2</sub>. In comparison, the efficiency of HEC is 90% to 95% and for ESP, it is 80% to 85%. HEC and ESP can not remove gaseous pollutants or particulates below 10 microns.*

6.11 Claus Sulfur Recovery Units (SRU) and Sulfur Loading Facilities:

6.11.1 Provide emission monitoring for each Sulfur Recovery Unit (SRU) stack to verify compliance with source emission limits. The sulfur recovery efficiency shall be monitored on a continuous basis using a continuous emission monitor (CEM) or other appropriate methods. SAPMT may opt to utilize an SO<sub>2</sub>/H<sub>2</sub>S "tail-gas ratio" analyzer to monitor the gas leaving the last condenser provided there is a mechanism in place to continuously update a program/model that would perform the material balance and calculate the sulfur recovery. The method/model used to calculate sulfur recovery efficiency should account for sulfur species in the tail-gas other than to H<sub>2</sub>S and SO<sub>2</sub>, such as carbonyl sulfide (COS), carbon disulfide (CS<sub>2</sub>), elemental sulfur vapor (S<sub>8</sub>), and entrained elemental liquid sulfur (S<sub>8</sub>). If the

tail-gas or stack gas flow rates are not measured, the model should account for the change in gas volume and mass through the process.

- 6.11.2 Design new or upgraded sulfur recovery plants to meet source emission limitations as per Appendix II, Table I.
  - 6.11.3 Use multi-stage (3-stage preferred) Claus or Super Claus process for sulfur recovery plants to achieve at least a minimum 95% total inlet sulfur recovery efficiency defined as the overall efficiency rating for the plant averaged over a year. The minimum sulfur recovery efficiency will be higher if compliance with ambient air quality standards requires it.
  - 6.11.4 In sensitive areas, sulfur plants should be designed with multiple trains having excess capacity, as per EPD direction approval, to ensure acid gas flaring is minimized or not done at all when a sulfur train is shut down. In more remote areas, multi-train sulfur plants may be designed without excess capacity if approved by EPD.
  - 6.11.5 Design incinerators to operate at temperatures above 1200°F to ensure complete combustion of H<sub>2</sub>S.
  - 6.11.6 Monitor and control air injection rate into the Claus unit to maintain proper recovery efficiency.
  - 6.11.7 Monitor and control air-to-fuel ratios to eliminate pluming from the incinerator stack.
  - 6.11.8 Provide a flame monitoring system on new SRU main incinerators to ensure continuous operation.
  - 6.11.9 Incorporate an auxiliary residual sulfur gas incinerator into the design of SRUs to ensure full incineration of residual sulfur gases immediately upstream of the unit stack.
  - 6.11.10 Stack gas heat recovery will be permitted only when air dispersion modeling shows no adverse impact on permissible ambient air quality ground-level concentrations.
  - 6.11.11 Design sulfur handling and loading facilities with appropriate emission control techniques to minimize direct atmospheric H<sub>2</sub>S, SO<sub>2</sub>, and sulfurous particulate releases.
- 6.12 Flares (Elevated and Ground-Level Types)
-

- 6.12.1 Design new flares (elevated only) to operate as "smokeless" over specific flow ranges and in accordance with [SAES-F-007](#), "System Design Criteria of Flares" and [32-SAMSS-022](#), "Manufacture of Components for Flare Systems." "Smokeless" operation is defined as the output of the flare having a maximum opacity of 20% (refer to Appendix II, Table I for details).

*Commentary Note:*

*Consult EPD as each new flare can have a unique environmental solution depending on the type of flare, design parameters, gas flow rate range, tip velocity, gas composition, and location of the flare.*

- 6.12.2 Convert existing flares to smokeless operation at the time of the upgrade. Prioritize the upgrading to smokeless operation of existing flares to populated areas first and then to more remotely-located flares secondly.
- 6.12.3 For the upgrading of existing flares, the level of smokeless operation shall be based on the maximum continuous flow rate flared by the facility during the most current three-year period. The records must show the amount of flaring (flow rates) and the duration of each flaring incident and be provided to EPD on a quarterly basis. If records are not available, EPD may require smokeless operation for higher flow rates.
- 6.12.4 Plant start-ups, unscheduled shutdowns, upsets, and emergency relief of less than 10 days are exempt from the smokeless flaring requirement. However, extended flaring beyond this period is not allowed.
- 6.12.5 Ground-level flares and burn-pits must be phased out and replaced with elevated flares during upgrading activities.
- 6.12.6 Flare height should be determined based on air dispersion modeling studies conducted for the EIA.
- 6.12.7 Design flares to operate with pilot flame(s) present at all times to ensure continuous combustion of the waste gases. Provide a thermocouple or a device to continuously detect the pilot flame and provide an automatic ignition system for the pilot. Refer [SAES-F-007](#) for details.
- 6.12.8 Design steam-assisted or air-assisted flares to operate on waste gas mixtures (including any supplemental fuel) with a flare gas heating value (net heating value) greater than 11.2 MMJ/scm (300 Btu/scf) for
-

flares. Design non-assisted flares to operate with a net heating value of the gas mixture greater than 7.45 MMJ/scm (200 Btu/scf) (Refer to Appendix VI of [SAEP-340](#) for further detail).

6.12.9 Establish visible emission (opacity) measurements using techniques specified in the USEPA Method 9 "Visual Determination of the Opacity of Emissions from Stationary Sources" (Refer to Appendix III).

### 6.13 Other Emission Sources & Discharges

6.13.1 Spent caustic discharges containing high levels of disulfides that can evaporate and cause odor problems shall be identified, collected, and thermally oxidized before release to the atmosphere.

6.13.2 H<sub>2</sub>S discharges to the ambient air from wastewater lagoons and ponds are controlled as per design parameters found in the [SAES-A-104](#) engineering standard. [SAES-A-104](#) provides a guide for how much H<sub>2</sub>S is allowed in industrial and sanitary effluent for various impoundment sizes and flow rates. This guide must be followed to minimize ambient air quality impacts from these sources.

6.13.3 Emissions from Pressurized Storage Tanks shall be designed to the requirements of [SAES-D-001](#), "Design Criteria of Pressure Vessels" and shall be operated with the appropriate vapor recovery systems to minimize unnecessary release of product to the atmosphere.

6.13.4 Crushers to be located on Saudi Aramco property shall be located at a minimum distance of 4 kilometers from major highways and public areas to avoid visibility and nuisance-related problems, and the operator of the facility shall take all the necessary mitigative measures to reduce particulate emissions from the crusher and associated equipment. This can include the installation of baghouses, filtration systems, and water spraying techniques.

### 6.14 Burnpits

6.14.1 Use of burnpits is restricted to the following non-routine situations:

- a) Burning liquids during process upsets, emergency shutdowns, or from pipelines during emergency blowdown.
  - b) Burning liquids and gases from shut-in oil wells being brought back into production.
  - c) Burning liquids and gases generated during the cleanout of an existing well or pipeline.
-

- d) Burning gases from a flare to allow shutdown of the Main Flare System for maintenance or inspection work.
- 6.14.2 Alternate means of control and disposal, such as sealed ponds, API separators, and reclamation / recycling techniques, shall be utilized in lieu of burnpits for new project designs wherever possible.
- 6.15 Open Burning Sources
- 6.15.1 Open burning is the intentional combustion of any material for the sole purpose of disposal or recovery of specific products, and which produces air pollution that cannot be controlled.
  - 6.15.2 Open burning is prohibited within Saudi Aramco properties and facilities.
- 6.16 Non-Pressurized Storage Tanks
- 6.16.1 Design storage tanks to comply with [SAES-D-100](#), "Design Criteria of Atmospheric and Low pressure Tanks," and the applicable source emission standards found in Appendix II, Table I.
  - 6.16.2 All floating roof tanks shall have seal inspections at the initial fill and at least once per year thereafter. Initial inspection reports of new tanks shall be provided to EPD.
- Commentary Note:*
- [SAES-B-005](#) requires that any flashing liquid including a "gassy" crude oil with a TVP greater than 13 psia cannot be stored in a floating or cone roof tank due to safety reasons. The [SAES-B-005](#) standard applies to all Company tanks regardless of location.*
- 6.16.3 Any product with a TVP greater than 11 psia (570 mm Hg) at maximum anticipated ambient temperature shall require vapor recovery as part of the design of the storage tank.
  - 6.16.4 Slotted guide gauge poles shall not be used on storage tanks containing VOC material having a TVP of greater than 78 mm Hg unless the poles are equipped with a gasketed sliding cover, or fabric sleeve seal and a gasketed float.
- 6.17 Bulk Loading and Product Transfer Operations
- 6.17.1 New facilities shall be designed as per [SAES-B-070](#) and to meet the applicable source emission limitations as per Appendix II, Table I.
-

- 6.17.2 New facilities to be located within 5 kilometers of residential areas shall include vapor recovery systems in the design for the operations of loading/unloading product.
  - 6.17.3 New facilities shall incorporate vapor recovery, pressurized tanks, or equivalent systems for petroleum transfer facilities that handle products having a TVP in excess of 11 psia (570 mm Hg), regardless of the storage capacity of the tank involved.
  - 6.17.4 For new facilities, vapor emissions of more than 80 grams hydrocarbon per cubic meter (1000 liters) of loaded product (or product transferred) is not permitted.
  - 6.17.5 Use of bottom loading or submerged loading techniques for gasoline tanker trucks is required at all facilities.
  - 6.17.6 Existing facilities shall a) vent vapors at a safe distance from the worker areas or b) install thermal oxidizers to burn off the HC and VOC vapors from the loading operations.
- 6.18 Marine Terminals and Transit Operations
- 6.18.1 New tanker ships shall be equipped with emission control systems to minimize the loss of product to the atmosphere. Acceptable systems include "submerged" loading techniques, vapor balance systems, and vapor recovery systems.
  - 6.18.2 Atmospheric discharges from tankship operations shall be controlled through proper operation and maintenance of the tanker ships.
  - 6.18.3 New terminals located within 5 kilometers of residential areas shall be equipped with emission control equipment or vapor recovery systems for gas-freeing, inerting operations of cargo holds, and ballasting compartments.
- 6.19 Fugitive (Non-Point Source) Emissions
- 6.19.1 Fugitive emissions in VOC service or organic HAP service shall comply with Appendix II, Table I.
  - 6.19.2 For design purposes, identify and reduce the number of leak-prone components and relocate difficult-to-maintain critical components.
  - 6.19.3 A Leak Detection and Repair (LDAR) or Fugitive Emission Monitoring (FEM) plan to control fugitive emissions of VOC's and other gases such as H<sub>2</sub>S shall be prepared and implemented by the
-

facility upon approval by EPD. The plan shall include the following minimum elements:

- 6.19.3.1 A master list all components that have the potential to leak, including pumps, pressure-relief valves, compressors, sampling connectors, flanges, component number, service, and location within the facility and/or process unit area.
- 6.19.3.2 Components that can be replaced with "leakless" technology.
- 6.19.3.3 Components that need additional monitoring with the appropriate monitoring technique(s) specified.
- 6.19.3.4 Fugitive emission controls or strategies to be deployed at the facility.
- 6.19.3.5 A training program for facility staff to perform visible inspections, leaks determinations, and component tagging.
- 6.19.3.6 A maintenance program that involves the repair / replacement of identified leaking components. The master components list shall be periodically updated to include all maintenance-related work performed on the affected components.
- 6.19.3.7 Incorporation of the requirements of GI-0425.000, "Refrigerant Management," which addresses CFC emissions, and GI-0430.001, "Waste Management" which addresses general air pollutant emissions from industrial operations.

## **7 Performance Testing and Inspection (Stack Testing)**

- 7.1 Source emission testing or stack testing shall be performed within 60 days of achieving the maximum production rate of the process, but not later than 180 days from the date of initial startup to evaluate the performance of a new unit. Conduct stack tests, as listed in Appendix III on all regulated units to demonstrate compliance with applicable source emission standards. A written test report shall be provided to EPD within 60 days thereafter summarizing the results of the stack test. A new facility shall not be considered in environmental compliance until the initial stack test results have been accepted by EPD.
  - 7.2 Any stack test that fails to follow the procedures of the applicable testing method shall be considered invalid and shall be repeated.
-

- 7.3 Modify process, or emission controls, and/or, de-rate output capacity of the facility and repeat any stack test that shows an emission source to be in non-compliance with applicable standards until the source is shown to be in compliance.
- 7.4 If required by the regulatory agency, the appropriate continuous emission monitoring (CEM) or approved equivalent system shall be installed.
- 7.5 CEM reports for each source/stack shall be available to EPD at all times but officially will be submitted to EPD once per year. CEM reports shall include but not be limited to a) the emission rate figures for each regulated pollutant, b) the number of exceedances of the applicable source emission standard(s), c) explanations for the occasions when the emission standards are exceeded, d) what correction actions were taken to prevent further exceedance, e) the duration of any start-ups, shutdowns, or malfunctions in the operation of the source or emission control equipment, and f) the periods when the CEM was inoperative.

## 8 Definitions, Abbreviations and Acronyms

### 8.1 Definitions

**Air Dispersion Modeling:** the technique of predicting ground-level concentrations by mathematical relationships that govern the dispersion and diffusion of gaseous pollutants in the atmosphere.

**Air Pollutant:** any substance emitted to the atmosphere that causes or has the potential to produce adverse impacts on human health or the environment in general.

**Air Quality (AQ):** the temporal and spatial distribution of pollutant concentrations in the air.

**Air Quality Compliance Assessment:** An Air Quality Compliance Assessment (AQCA) form is used to document and track exceedances and violations of the applicable ambient air quality pollutant standards caused by Saudi Aramco facilities. This form is included in Appendix I, Attachment I. The information on the form is based on actual air monitoring data collected by the AMMNET program. This form is completed, on a monthly basis, for any facility showing exceedances of one or more of the ambient air quality standards. The form is signed by the General Supervisor, Environmental Engineering Division (EED) of EPD and then forwarded to the specific facility requesting, within one month, an explanation of the non-compliance status of the facility and what steps have been taken to correct the problem and prevent any reoccurrence.



**Ambient Air:** The portion of the atmosphere that causes or has the potential to produce adverse impacts on human health or the environment in general.

**Ambient Air Quality Standards (AAQS):** The maximum concentration limits of regulated pollutants permitted in the ambient air which, allowing for a degree of safety, present no hazard to human health or the environment. PME, RCJ, and RCY set acceptable ambient pollutant concentration limits based on this criterion. Saudi Aramco facilities shall be designed to be in compliance with all applicable AAQS. Compliance with these AAQS is determined by reviewing the monitoring data obtained by the Saudi Aramco real-time, continuous ambient air quality monitoring network called AMMNET. Results of this monitoring program are reported when exceedances of the AAQS occur at a facility. Additionally, an annual data report is released summarizing the results of the AMMNET program for the prior calendar year (January 1 through December 31). This report is distributed to all facilities and departments. The AAQS are referenced in Appendix I, Table 1 of this document.

**Ambient Air Quality Concentration Averages** (as applied to AAQS):

**1-Hour Average** - the smallest discrete averaging period that is used to determine the other concentration averages such as 8-hour, 24-hour, and 1-year.

**8-Hour Average** - computed as a running 8-hour average; any exceedances will be determined based on running averages that do not share the same hours. The 8-hour standard only applies to carbon monoxide.

**24-Hour Average** - computed as the daily average, not as a running 24-hour average.

**Annual Average** - computed as 12-month Gregorian average (January 1 - December 31).

**Best Available Control Technology (BACT):** The best available pollution control technology (with field-proven reliability) for new or upgraded facilities. BACT technologies may consist of field-proven emission control equipment, process modifications, process monitoring, operational and maintenance procedure changes, or a combination of these as found acceptable by EPD. All new or upgraded facilities must incorporate BACT as part of the facility design.

**Best Available Retrofit Technology (BART):** The best available pollution control technology (with field-proven reliability) for existing. BART technologies may also consist of field-proven emission control equipment, process modifications, process monitoring, operational and maintenance

---

procedure changes, or a combination of these as found acceptable by EPD. In many cases, BART and BACT can be the same however the two terms differentiate the type of facility to be controlled. Existing facilities found to be in non-compliance with source emission standards must incorporate BART.

**Bottom Loading:** The loading of product via piping connected to fittings on the bottom of the truck or railcar.

**Burn Pit:** Any ground-level combustion area that is designed to burn off liquid and/or gas flows caused by emergencies that exceed the capacity of the primary smokeless flaring system.

**Claus Sulfur Recovery Plant:** A process unit which recovers sulfur from hydrogen sulfide by a vapor-phase catalytic reaction of sulfur dioxide and hydrogen sulfide.

**Coke Burn-Off:** The carbonaceous solid (containing primarily carbon, hydrogen, sulfur, and heavy metals) that is removed from the surface of the fluid catalytic cracking (FCC) unit catalyst by combustion in the catalyst regenerator.

**Continuous Emission Monitoring (CEM):** The system(s) that are used to sample, condition, and analyze in-stack gas streams; and provide a permanent record of emissions or process parameters.

**Criteria Pollutant:** An air pollutant for which an air quality standard has been established by the Saudi Arabian government based on specific health criteria. These pollutants include sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (less than 10 microns in diameter or PM-10), hydrogen sulfide, and fluoride. For Royal Commission areas, they also include lead, ammonia, and chlorine.

**Emission Source:** Any facility, process, or operation that releases air pollutants to the atmosphere.

**Exceedance:** A Ground Level Concentration (GLC) value greater than the limit specified by the government for a specified averaging time (i.e., 1-hour, 3-hour, 8-hour, 24-hour, monthly, 3-month, or annual).

**Facility:** Any installation or industrial activity expected to be a source of pollution or cause an adverse environmental impact.

**Flaring:** The controlled burning of gas as part of the routine operations of oil & gas production or processing.

**Fuel Gas:** Any gas generated at a Saudi Aramco facility that is used to sustain a combustion process to generate power, steam, or additional heat for other

processes. Fuel gas includes natural gas that is combined and combusted in any proportion with another gas generated at a Saudi Aramco facility.

**Fugitive (Non-Point) Emissions:** Emissions to the atmosphere from such sources as pumps, valves, flanges, seals, and other process points not vented directly through a stack. This also includes emissions from area sources such as storage tanks, settling ponds, wastewater lagoons, landfills, cooling towers, sulfur stockpiles, Materials Supply stockpiles, Reclamation Chemical Storage & Handling Facilities (RCSHF), and other stockpiles.

**Good Engineering Practice (GEP) Stack:** The stack height (as measured from the ground-level elevation at the base of the stack) below which emissions from the source are influenced by the aerodynamic downwash of nearby buildings or other structures. The GEP stack height,  $HS$ , is calculated as follows:  $HS = H + 1.5L$  where  $H$  is the height of the nearby structure and  $L$  is the lesser dimension of the height or width of the nearby structure. "Nearby" means that distance up to 5 times " $L$ " but not greater than 0.8 kilometer ( $\frac{1}{2}$  mile). It should be noted that compliance with this condition does not relieve the PMT or Facility of ensuring ambient air quality standards are met. For determining compliance of these standards, stack height is limited to 91.4 meters (300 feet) for air dispersion modeling purposes. This limits the effect of height and the subsequent dilution of stack emissions alone in meeting the ambient air quality standards. For safety purposes,  $HS$  must also meet the requirements of [SAES-B-055](#), Appendix F-1 that states "the top of the furnace stack shall be at least 3 meters higher than any working platform within 60 meters horizontally of the stack."

**Ground Level Concentration (GLC):** The actual measured ambient concentration of the specified pollutant at ground-level, or the predicted concentration based on air dispersion modeling techniques in parts per million (ppm) or equivalent micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), referenced to standard temperature and pressure (STP) conditions.

**Ground-Level Flare:** Any flaring system that is designed to continuously combust excess gases at ground level, inside or outside of a burnpit area. Ground-level flares can be configured as a combination of horizontal or vertical, multi-jet, multi-tip, or multi-stage type flares.

**Hazardous Air Pollutant (HAP):** Any air pollutant that is toxic to humans and/or causes specific illnesses or diseases.

**Industrial Area:** the area inside a facility's officially recognized property line that excludes non-employees or other unauthorized personnel.

**Inhalable Particulates (IP):** Any particle dispersed to the atmosphere in solid or liquid form that has an aerodynamic size of 10 microns or less. Realistic determination particle behavior in any environment must consider the size, shape, and density of the particle. The technique best able to accomplish this is aerodynamic sizing. The aerodynamic diameter of a particle is defined as the diameter of a sphere having the same resistance to motion as the particle (**Note:** The PME definition is 15 microns or less; however, the internationally recognized cut-off size for IP is 10 microns and this is used by the Royal Commission and Saudi Aramco).

**PME / Royal Commission Limit:** The 1-hour, 8-hour, 24-hour, or 12-month (annual or yearly) GLC for the specified pollutant.

**PME / Royal Commission Standard:** The allowable number of exceedances within a specified measurement period for the pollutant.

**Modified (Upgraded) Facility:** See definition of Upgraded Facility.

**New Facility:** Any facility designed and constructed as a wholly new facility. All new facilities must meet all current and anticipated environmental standards and regulations.

**Opacity:** The degree to which emissions reduce the transmission of light and obscure the view of an object in the background; the percent of opaqueness of the exhaust gas of a stack or flare. (**Note:** the higher the opacity number, the darker or more opaque the exhaust gas). Opacity measurement techniques are specified in USEPA Method 9 - refer to Appendix III).

**Particulate Matter:** Any finely divided solid or liquid material, other than uncombined water, as measured by the USEPA reference or equivalent measurement method.

**Performance Testing:** The testing of new units to determine if such units conform to the approved design. Performance testing includes stack testing of process emissions to determine if all applicable source emission standards are met.

**Point Source:** An emission source that releases pollutants from a limited opening, such as a stack or vent.

**Process Gas:** Any gas except fuel or process upset gas that is produced by a Saudi Aramco facility.

**Regulatory Agency:** Presidency for Meteorology & the Environment (PME), Royal Commission of Jubail, and Royal Commission of Yanbu.

**Regulated Stack:** any stack that has its emissions specifically controlled by one or more PME or Royal Commission regulations.

**Royal Commission for Jubail and Yanbu:** The jurisdictional authorities that administer industrial activities within the Madinat Jubail Al-Sinaiyah and Madinat Yanbu Al-Sinaiyah areas.

**Smokeless Flare:** Any elevated or ground level flaring system that is designed to continuously combust excess gases without exceeding the visible emission standard of 20% opacity during routine continuous operation. Routine, continuous operation of a smokeless flare system does not include startups, shutdowns, malfunctions and emergency relief, or other unplanned or unintentional upsets.

**Source Emission Standards (SES):** The maximum amount of a particular pollutant that can be discharged from a source. Source emission standards are given for specific pollutants and specific sources and can specify technologies and/or strategies to control the quantity and/or release rate of air pollutants from a facility. Source emission standards are used to limit adverse impacts to the ambient air quality. SES's must be met regardless of facility location and ambient air quality levels. SES's are found in Appendix II, Table 1.

**Stack:** Any specific opening used directly or indirectly for discharging pollutants to the atmosphere.

**Stack Testing:** The manual sampling and analysis of stack gases during normal operation to determine the emission rates of specific pollutants. Stack testing is part of the performance testing required at the initial start-up of a new process and may be required periodically thereafter if mandated by the regulatory agency.

**Sulfur Plant Efficiency:** The amount of sulfur recovered as a percent of the total sulfur that could be incinerated and released to the atmosphere in the form of sulfur dioxide (SO<sub>2</sub>). The minimum PME sulfur recovery efficiency is 95% however the final sulfur recovery efficiency figure may be higher if ambient air quality standards are violated at the 95% level. Air dispersion modeling is used to determine the AAQS impacts.

**Submerged Loading:** The transfer of a product using a loading arm that provides product freefall of 30 centimeters or less.

**Tankship Operations:** All ship operations that may release fumes and gases to the ambient air due to loading, discharging, tanks inerting/venting activities, tube cleaning, sounding, manifold/loading arms connecting and disconnecting, and tanks topping procedures.

---

**True Vapor Pressure (TVP):** The equilibrium partial pressure exerted by a liquid as defined by the ASTM. For storage tanks, the TVP is based on the highest anticipated ambient temperature.

**Upgraded (or Modified) Facility:** Any modification or addition to an existing facility that directly or indirectly increases air pollutant emissions to the atmosphere from the facility. Upgraded or modified facilities must meet all current and anticipated environmental standards and regulations.

**Violation:** exceeding the allowable number of GLC exceedances for the specific Standard.

**Volatile Organic Compounds (VOC):** Any organic compound that is involved in atmospheric photochemical reactions.

## 8.2 Abbreviations and Acronyms

AMMNET	Air Quality Monitoring and Meteorology Network
AAQS	Ambient Air Quality Standard
AQ	Air Quality
AQCA	Air Quality Compliance Assessment
BACT	Best Available Control Technology
BART	Best Available Retrofit Technology
Btu	British thermal unit
CFC	Chlorofluorocarbons
CGT	Combustion Gas Turbine
DAQER	Detailed Air Quality Engineering Report
DBSP	Design Basis Scoping Paper for Projects
dscf	Dry standard cubic foot
dscm	Dry standard cubic meter
ESP	Electrostatic precipitator
FCCU	Fluidized-bed catalytic cracking unit
FPD	Facilities Planning Department
GEP	Good Engineering Practice
GLC	Ground-level concentration
HAP	Hazardous Air Pollutant
HC	Hydrocarbons

---

HEC	High efficiency cyclone
HHV	High heating value
IP	Inhalable particulates
J	Joule, unit of energy
kg	1000 kilograms (1 metric tonne)
LDAR	Leak Detection and Repair program
LHV	Lower heating value; also called net heating value
LPD	Loss Prevention Department
MMBtu	Million British thermal units
PME	The Meteorology and Environmental Protection Administration of the Kingdom of Saudi Arabia (now called the Presidency for Meteorology & the Environment)
MSL	Mean sea level
mt	Metric tonne, equal to 1,000 kilograms or 2,200 English pounds
mg/m <sup>3</sup>	milligrams per cubic meter
MMJ	Million Joules
mps	meters per second
MSDS	Manufacturer's Material Safety Data Sheet
NMHC	Non-methane hydrocarbons, normally measured as propane
NSCR	Non-selective catalytic reduction
PAQER	Preliminary Air Quality Engineering Report
PME	Presidency for Meteorology and the Environment
PM <sub>10</sub>	Particulate matter less than 10 microns in diameter (same as IP)
PMT	Project Management Team
ppm	parts per million, by volume
RCJ	Royal Commission of Jubail
RCY	Royal Commission of Yanbu
RVP	Reid Vapor Pressure
SAES	Saudi Aramco Engineering Standard
SCR	Selective Catalytic Reduction
SES	Source Emission Standard

---

STP	Standard temperature & pressure (STP) conditions of 25°C (298°K) & 1 standard atmosphere (760 mm Hg) (used for air quality applications)
TSP	Total suspended particulates less than 100 microns in diameter
TVP	True Vapor Pressure
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator Coordinate System
VOC	Volatile organic compounds
µg/m <sup>3</sup>	micrograms per cubic meter

30 November, 2002      **Revision Summary**  
Major revision.



**Appendix I – Ambient Air Quality Standards**

**Table I – Presidency of Meteorology & the Environment (PME)  
 and Royal Commission Ambient Air Quality Standards**

POLLUTANT	TIME PERIOD <sup>(1)</sup>	PME LIMITS		RCJ LIMITS		RCY LIMITS	
		MAX. CONC. µg/m <sup>3</sup> (ppm) <sup>(2)</sup>	ALLOWABLE EXCEED-ANCES <sup>(3)</sup>	MAX. CONC. µg/m <sup>3</sup> (ppm) <sup>(2)</sup>	ALLOWABLE EXCEED-ANCES <sup>(3)</sup>	MAX. CONC. µg/m <sup>3</sup> (ppm) <sup>(2)</sup>	ALLOWABLE EXCEED-ANCES <sup>(3)</sup>
<b>Sulfur Dioxide (SO<sub>2</sub>)</b>	1 hour	730 (0.280)	2 per 30 days	730 (0.280)	2 per 30 days	730 (0.280)	2 per 30 days
	24 hours	365 (0.140)	1 per year	365 (0.140)	1 per year	365 (0.140)	1 per year
	Annual	80 (0.030)	0	80 (0.030)	0	80 (0.030)	0
<b>Hydrogen Sulfide (H<sub>2</sub>S)</b>	1 hour	200 (0.140)	1 per year	200 (0.140)	1 per year	200 (0.140)	2 per 30 days
	24 hours	40 (0.030)	1 per year	40 (0.030)	1 per year	40 (0.030)	1 per year
<b>Nitrogen Dioxide (NO<sub>2</sub>)</b>	1 hour	660 (0.350)	2 per 30 days	660 (0.350)	2 per 30 days	660 (0.350)	2 per 30 days
	Annual	100 (0.050)	0	100 (0.050)	0	100 (0.053)	0
<b>Ozone (O<sub>3</sub>)</b>	1 hour	295 (0.150)	2 per 30 days	240 (0.120)	1 per year	235 (0.120)	2 per 30 days
<b>Inhalable Particulate Matter (PM<sub>10</sub>)<sup>(4)</sup></b>	24 hours (PM-15µ)	340	1 per year	NS	NS	340	1 per year
	Annual (PM-15µ)	80	0	NS	NS	80	0
	24 hours (PM-10µ)	NS	NS	150	1 per year	150	1 per year
	Annual (PM-10µ)	NS	NS	50	0	50	0
<b>Carbon Monoxide (CO)</b>	1 hour	40,000 (35)	2 per 30 days	40,000 (35)	2 per 30 days	40,000 (35)	1 per year
	8 hours	10,000 (9)	2 per 30 days	10,000 (9)	2 per 30 days	10,000 (9)	1 per year
<b>Non-Methane Hydrocarbons (NMHC)</b>	3 hours <sup>(5)</sup>	NS	NS	160 (0.240) <sup>(6)</sup>	NS	160	0
<b>Ammonia (NH<sub>3</sub>)</b>	1 hour	NS	NS	1,800 (2.60)	NS	1,800(2.60)	0
<b>Lead (Pb)</b>	3 months	NS	NS	1.5	NS	1.5	NS
<b>Chlorine (Cl<sub>2</sub>)</b>	1 hour	NS	NS	300 (0.10)	NS	300 (0.10)	0
<b>Sulfates</b>	24 hours	NS	NS	25	NS	NS	NS
<b>Fluorides (F)</b>	Monthly	1.0 (0.001)	0	1.0 (0.001)	0	1.0 (0.001)	0

**Notes:**

NS = None Stated

- (1) Readings are averaged over this period. Example: period of 1 hour means values are averaged over 60 minutes.
- (2) Maximum ground-level concentration (GLC) value corrected to STP (Standard Temperature and Pressure conditions of 25°C (298°K) and 760 mm Hg.
- (3) Indicates the number of times a GLC may be in excess of the GLC limit value without registering as a violation of the standard.
- (4) Exceedances of this pollutant as a result of natural causes such as sand storms are not considered violations of the standard.
- (5) Sampling period is 6 a.m. through 9 a.m.
- (6) There is no adopted standard for NMHC; this level is a goal to aid in the control of ambient ozone concentrations.

## Attachment I

### Environmental Protection Department Environmental Engineering Division

<b>AIR QUALITY COMPLIANCE ASSESSMENT FORM</b>
---

<b>Facility</b> _____ <b>Location</b> _____ <b>Facility Contact</b> _____ <b>Facility Phone</b> _____ <b>Facility Fax</b> _____	<b>Date of Report</b> _____ <b>Reporting Org</b> <u>EPD/EED</u> <b>Reporting Contact</b> _____ <b>Reporting Phone</b> _____ <b>Reporting Fax</b> _____
---	--

Note the following air quality exceedances were recorded for your facility. Please review, determine reason(s) for these exceedances, sign and return this form via fax with your response/comments in the provided space below.

Date	Hour	Pollutant	Standard Exceeded	Standard Limit (ppm)	Reported Conc. (ppm)	% Above Standard	Wind Direction (Degrees)	Wind Speed (mps)

**Facility Response/Comments:**

---



---



---



---



---

**Facility Operations Engineering Authority Signature:**

**Gen. Supervisor  
 Environmental Engineering Div.**

---



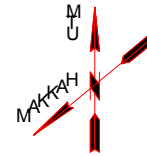
---

cc: Facility Manager,  
 Manager, EPD, E-3600, Dhahran  
 Manager, LPD, Dhahran  
 Facility Environmental Coordinator,  
 General Supervisor, EED/EPD  
 General Supervisor, ECD/EPD  
 Supervisor, AMU/EED/EPD  
 Env. File 100.30

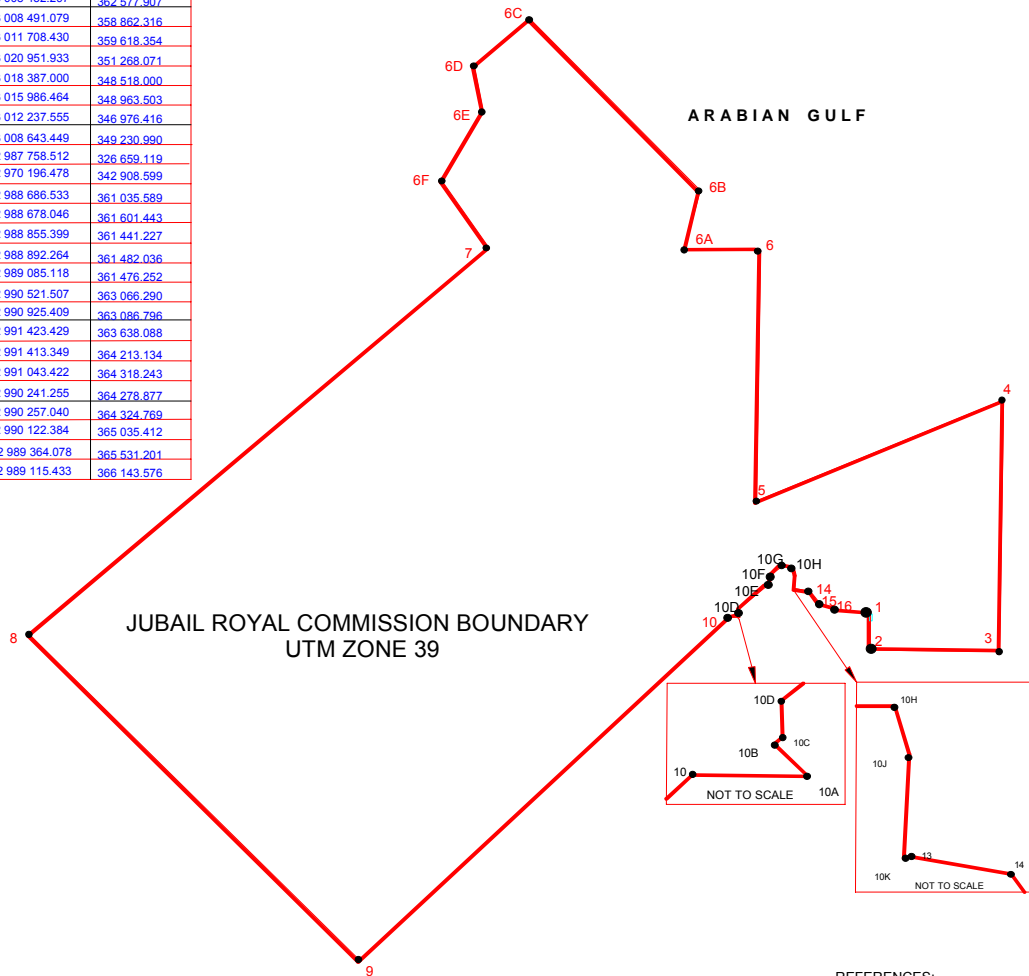
**ATTACHMENT II - ROYAL COMMISSION OF JUBAIL BOUNDARIES**

**NOTES:**

1. COORDINATE SYSTEM : UTM (ZONE 39)/INT. SPHEROID (1985 HORIZONTAL ADJUSTMENT)
2. INFORMATION SHOWN WAS COMPILED FROM DATA FURNISHED BY THE ROYAL COMMISSION, LAND & LEASE DIVISION, AND SAUDI ARAMCO SURVEYING DIVISION RECORDS. NO SURVEY OF THIS SITE HAS BEEN MADE BY SAUDI ARAMCO SURVEYING



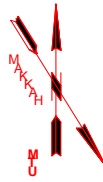
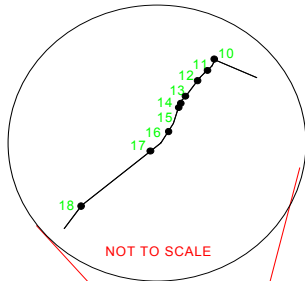
POINT #	NORTHING (m)	EASTING (m)
1	2 988 937.799	368 018.817
2	2 986 938.261	367 987.185
3	2 986 837.826	374 335.718
4	3 000 384.696	374 550.034
5	2 994 935.414	362 364.382
6	3 008 432.297	362 577.907
6A	3 008 491.079	358 862.316
6B	3 011 708.430	359 618.354
6C	3 020 951.933	351 268.071
6D	3 018 387.000	348 518.000
6E	3 015 986.464	348 963.503
6F	3 012 237.555	346 976.416
7	3 008 843.449	349 230.990
8	2 987 758.512	326 659.119
9	2 970 196.478	342 908.599
10	2 988 686.533	361 035.589
10A	2 988 678.046	361 601.443
10B	2 988 855.399	361 441.227
10C	2 988 892.264	361 482.036
10D	2 989 085.118	361 476.252
10E	2 990 521.507	363 066.290
10F	2 990 925.409	363 086.796
10G	2 991 423.429	363 638.088
10H	2 991 413.349	364 213.134
10J	2 991 043.422	364 318.243
10K	2 990 241.255	364 278.877
13	2 990 257.040	364 324.769
14	2 990 122.384	365 035.412
15	2 989 364.078	365 531.201
16	2 989 115.433	366 143.576



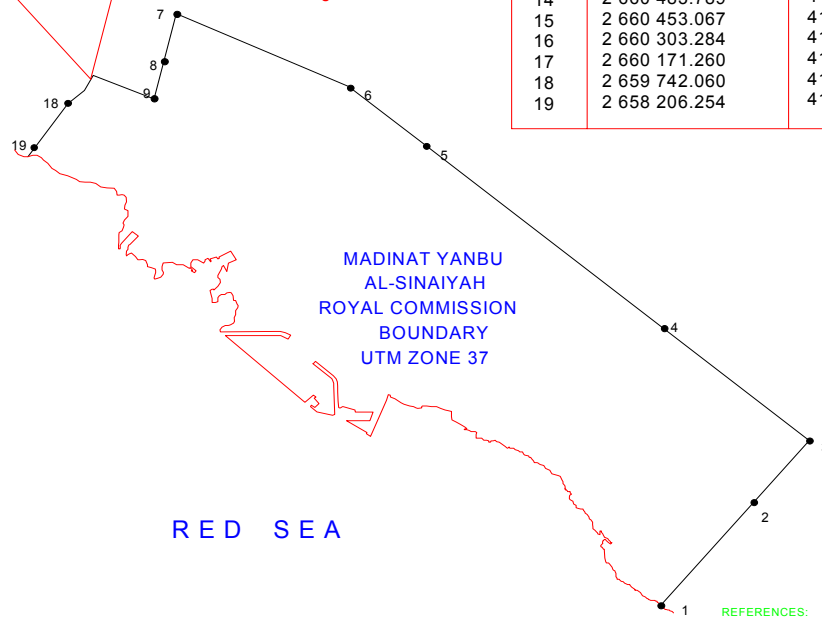
REFERENCES:  
 JOB No. R290-8012 SUR  
 DWG. No. SAES-A-103

**ATTACHMENT III - ROYAL COMMISSION OF YANBU BOUNDARIES**

- NOTES:  
 1. COORDINATE SYSTEM : UTM (ZONE 37) SAUDI ARABIA NATIONAL GRID.  
 2. INFORMATION SHOWN WAS COMPILED FROM DATA FURNISHED BY THE ROYAL COMMISSION. NO SURVEY OF THIS SITE HAS BEEN MADE BY SAUDI ARAMCO SURVEYING SERVICES DIVISION.  
 3. SCALE = 1 : 200,000



POINT No.	NORTHING (m)	EASTING (m)
1	2 642 546.475	431 426.087
2	2 645 880.576	434 192.737
3	2 648 177.312	436 098.579
4	2 651 939.921	431 564.245
5	2 658 258.936	423 948.316
6	2 660 300.666	421 496.690
7	2 662 821.938	416 022.384
8	2 660 905.966	415 602.850
9	2 659 878.058	415 320.853
10	2 660 741.371	413 442.393
11	2 660 697.182	413 422.084
12	2 660 649.878	413 379.735
13	2 660 614 227	413 347.200
14	2 660 483.789	413 248.554
15	2 660 453.067	413 229.323
16	2 660 303.284	413 177.535
17	2 660 171.260	413 101.903
18	2 659 742.060	412 598.905
19	2 658 206.254	411 528.518



REFERENCES:  
 DWG. No. RCB-SU-A1-002A

**Appendix II – Source Emission Standards**

**Table I – Presidency of Meteorology & the Environment (PME) and Royal Commission Source Emission Standards (SES)**

Source Category	Pollutant or Source	PME Limits & Requirements	Royal Commission Jubail Limits & Requirements	Royal Commission Yanbu Limits & Requirements
All facilities and emission sources (Includes stacks, vents, stockpiles, & other point sources)	Visible Emissions <sup>(1)</sup>	20% opacity <sup>(2)</sup>	20% opacity <sup>(2A)</sup>	20% opacity <sup>(2B)</sup>
	Particulates	NS	max. 10% opacity above background (stockpiles); 20% for all others <sup>(2A)</sup>	NS
	VOC's & HAP's	See Footnotes <sup>(4)</sup> and <sup>(5)</sup>	No emissions allowed for asbestos; see Footnote <sup>(6)</sup> for others	See Footnote <sup>(5)</sup>
Fuel Gas Combustion	Sulfur Dioxide (SO <sub>2</sub> )	Hydrogen Sulfide (H <sub>2</sub> S) content not to exceed 150 ppm (230 mg/dscm) <sup>(8)</sup>	<230 mg/dscm H <sub>2</sub> S in fuel gas or equivalent SO <sub>2</sub> removal system	230 mg/dscm <sup>(8)</sup>
Combustion Facilities consisting of fossil fuel-fired steam generating units or furnaces with an input heat capacity rating > 250 MMBtu/hr or >73 MW	Particulate Matter (PM)	43 ng/J (0.1 lb/MMBtu)	43 ng/J (0.1 lb/MMBtu)	43 ng/J (0.1 lb/MMBtu)
	Sulfur Dioxide (SO <sub>2</sub> )	1000 ng/J (2.3 lb/MMBtu)	340 ng/J (0.8 lb/MMBtu)	340 ng/J (0.8 lb/MMBtu)
	Nitrogen Oxides (oil fired)	130 ng/J (0.3 lb/MMBtu)	130 ng/J (0.3 lb/MMBtu)	130 ng/J (0.3 lb/MMBtu)
	Nitrogen Oxides (gas fired)	86 ng/J (0.2 lb / MMBtu)	86 ng/J (0.2 lb/MMBtu)	86 ng/J (0.2 lb/MMBtu)
	Opacity	20% <sup>(2)</sup>	20% <sup>(2A)</sup>	20% except 6 minutes per hour ≤ 27% <sup>(2B)</sup>
Combustion Facilities consisting of industrial steam generating units or furnaces with an input heat capacity rating >100 MM Btu/hr or >29 MW	Particulate Matter (PM)	43 ng/J (0.1 lb/MMBtu)	43 ng/J (0.1 lb/MMBtu)	43 ng/J (0.1 lb/MMBtu)
	Sulfur Dioxide (SO <sub>2</sub> )	1000 ng/J (2.3 lb/MMBtu)	215 ng/J (0.5 lb/MMBtu) 340 ng/J (0.8 lb/MMBtu) <sup>(3)</sup>	215 ng/J (0.5 lb/MMBtu)
	Nitrogen Oxides (oil fired)	130 ng/J (0.3 lb/MMBtu)	130 ng/J (0.3 lb/MMBtu)	130 ng/J (0.3 lb/MMBtu)
	Nitrogen Oxides (gas fired)	86 ng/J (0.2 lb / MMBtu)	86 ng/J (0.2 lb/MMBtu)	86 ng/J (0.2 lb/MMBtu)
	Opacity	20% <sup>(2)</sup>	20% <sup>(2A)</sup>	20% except 6 minutes per hour ≤ 27% <sup>(2B)</sup>

Table I – Source Emission Standards (Continued)				
Source Category	Pollutant or Source	PME Limits & Requirements	Royal Commission Jubail Limits & Requirements	Royal Commission Yanbu Limits & Requirements
Combustion Facilities consisting of industrial steam generating units or furnaces with an input heat capacity rating between 10 MM Btu/hr (2.9 MW) and 100 MM Btu/hr (29 MW)	Sulfur Dioxide (SO <sub>2</sub> )	NS	215 ng/J (0.5 lb/MMBtu)	NS
Stationary Combustion Gas Turbines (CGTs)	Nitrogen Oxides (NO <sub>x</sub> )	NS  <b>NOTE:</b>  <b>Saudi Aramco Standard</b>  Source Emission Standard for CGT's is 50 ppm or less at site rated conditions (base load at site temperature rating) <sup>(7C)</sup>	NO <sub>x</sub> = 0.0150 (14.4/Y) + F <sup>(7A)</sup>  NO <sub>x</sub> = 0.0075 (14.4/Y) + F <sup>(7B)</sup>  % volume calc. at 15% O <sub>2</sub> on a dry basis; Y=manufacturer's rated heat rate at manufacturer rated peak load (kj / w-hr) or actual measured heat rate based on lower heating value of fuel measured at peak load. Value of Y shall not exceed 14.4 kj / w-hr; F = NO <sub>x</sub> emission allowance for fuel – bound nitrogen as defined in Footnote <sup>(7)</sup> .	NO <sub>x</sub> = 0.0150 (14.4/Y) + F  % volume calculated at 15% O <sub>2</sub> on a dry basis; Y = manufacturer's heat rate at manufacturer's rated peak load (kj / w-hr) or actual measured heat rate based on lower heating value of fuel measured at peak load. Value of Y shall not exceed 14.4 kj / w-hr; F = NO <sub>x</sub> emission allowance for fuel-bound nitrogen as defined in Footnote <sup>(7)</sup> .
	Sulfur Dioxide (SO <sub>2</sub> )	Any emission control will be based on AAQS compliance	0.015% by volume at 15% O <sub>2</sub> on a dry basis	0.015% by volume at 15% O <sub>2</sub> on a dry basis
	Hydrogen Sulfide (H <sub>2</sub> S)	Hydrogen Sulfide (H <sub>2</sub> S) content not to exceed 150 ppm (230 mg/dscm) <sup>(8)</sup>	Max. 0.8% sulfur by weight	Max. 0.8% sulfur by weight

Table I – Source Emission Standards (Continued)				
Source Category	Pollutant or Source	PME Limits & Requirements	Royal Commission Jubail Limits & Requirements	Royal Commission Yanbu Limits & Requirements
Petroleum Liquids Storage Tanks	CRUDE OIL (Small Tanks) <sup>(9)</sup>	Seal & inspection / reporting program <sup>(10)</sup>	Floating roof with seal inspection / reporting program <sup>(11)</sup>	Floating roof with inspection / reporting program <sup>(11)</sup>
	Crude Oil Storage Tanks	For all tanks with TVP of 78 mm Hg (1.5 psia) - 570 mm Hg (11 psia): a) Floating roof with double boot seal or, b) Equivalent system  For all tanks with TVP > 570 mm Hg (11 psia): a) Vapor recovery or, b) Equivalent system <sup>(15)</sup>	For tanks ≥ 19, 815 gallons (75 m <sup>3</sup> ) for crude oil with TVP of 5.2 - 76.6 kPa:  a) fixed roof with internal floating roof or, b) external floating roof or, c) closed vent system with control device  For tanks ≥ 19,815 gallons (75 m <sup>3</sup> ) for crude oil with TVP ≥ 76.6 kPa: Closed vent system with control device	For tanks > 420,000 gallons <sup>(12)</sup> for crude oil or tanks > 40,000 gallons <sup>(13)</sup> for crude oil or refined products with TVP of 78 mm Hg (1.5 psia) – 570 mm Hg (11.1 psia): a) External floating roof with double seals or, b) Fixed roof with internal floating roof or, c) Vapor recovery system that collects VOC's to reduce emissions by at least 95% by weight or, d) Equivalent to a, b, or c
	Refined Product Storage Tanks	For all tanks with TVP of 78 mm Hg (1.5 psia) - 570 mm Hg (11 psia): a) Floating roof with double boot seal or, b) Equivalent system  For all tanks with TVP > 570 mm Hg (11 psia): a) Vapor recovery or, b) Equivalent system <sup>(15)</sup>	For tanks ≥ 19, 815 gallons (75 m <sup>3</sup> ) with TVP of 5.2 - 76.6 kPa: a) Fixed roof with internal Floating roof or, b) External floating roof or, c) Closed vent system with control device  For tanks ≥ 19,815 gallons (75 m <sup>3</sup> ) with TVP ≥ 76.6 kPa: Closed vent system with control device	For tanks > 420,000 gallons <sup>(12)</sup> for crude oil or tanks > 40,000 gallons <sup>(13)</sup> for crude oil or refined products with TVP > 570 mm Hg: Vapor recovery system or equivalent to reduce VOC emissions by ≥ 95% by weight  For tanks > 40,000 gallons <sup>(14)</sup> for refined products with TVP 39 mm Hg (0.75 psia) – 570 mm Hg or tanks between 20,000 & 40,000 gallons for refined products with TVP > 207 mm Hg (4 psia) and < 570 mm Hg: a) External floating roof with double seals or, b) Fixed roof with internal floating roof  For tanks of 20,000 gallons <sup>(14)</sup> for refined products with TVP > 570 mm Hg: Vapor recovery system or equivalent <sup>(15)</sup> to reduce VOC emissions by ≥95% by weight

Table I – Source Emission Standards (Continued)				
Source Category	Pollutant or Source	PME Limits & Requirements	Royal Commission Jubail Limits & Requirements	Royal Commission Yanbu Limits & Requirements
PETROLEUM REFINERIES:  Fluid Catalytic Cracking Unit Regenerator (FCCU)  Sulfur Recovery Plants (SRU) <sup>(19)</sup>	Carbon Monoxide (CO)	500 ppm <sup>(16)</sup>	500 ppm	500 ppm <sup>(16)</sup>
	Sulfur Dioxide (SO <sub>2</sub> )	NS	50 ppm with add-on control device or 9.8 kg/mt of coke burn-off without add-on control <sup>(17)</sup>	50 ppm with add-on control device or 9.8 kg/mt of coke burn-off without add-on control <sup>(17)</sup>
	Opacity	20% <sup>(2)</sup>	30%	30%
	Particulate Matter (PM)	1.0 kg/mt coke burn-off <sup>(18)</sup>	1.0 kg/mt coke burn-off <sup>(18)</sup>	1.0 kg/mt coke burn-off <sup>(18)</sup>
	Hydrogen Sulfide (H <sub>2</sub> S)	NS	≤10 ppm calculated as SO <sub>2</sub> at 0% O <sub>2</sub> on a dry basis <sup>(20)</sup>	≤10 ppm calculated as SO <sub>2</sub> <sup>(20)</sup>
	Sulfur Dioxide (SO <sub>2</sub> )	NS	250 ppm at 0% O <sub>2</sub> on dry basis <sup>(21)</sup>	250 ppm at 0% O <sub>2</sub> on dry basis <sup>(21)</sup>
	Total Sulfur (S)	at least 95% total sulfur recovery <sup>(22)</sup>	300 ppm <sup>(20)</sup>	300 ppm <sup>(20)</sup>
Oil Water, Oil Storage, Slop Separator Tanks	VOC's	NS	NS	Shall be equipped with a fixed roof tank to reduce VOC emissions
Fugitive Emissions	VOC's	Maintenance / Inspection & Monitoring <sup>(5)</sup>	See Footnote <sup>(6)</sup>	Max. 10,000 ppm at surface of valves, pumps, and compressors; max. 500 ppm at surface of pressure relief valves
Acid Gas Flares	Visible Emissions	20% opacity <sup>(2)</sup>	20% opacity <sup>(2A)</sup>	20% opacity <sup>(2B)</sup>
Process Flares	Visible Emissions	20% opacity <sup>(2)</sup>	No more than 5 minutes of visible emission within any 2-hour period	20% opacity <sup>(2B)</sup>
Steam – Assisted Flares <sup>(23)</sup>	VOC's	NS	Ht ≥ 11.2 MMJ/scm; Vmax < 122 m/s if Ht > 37.3 MMJ / scm; Log10 (Vmax) ≤ (Ht + 28.8)/31.7 if Ht < 37.3 MMJ/scm	NS
Air-Assisted Flares <sup>(23)</sup>	VOC's	NS	Ht ≥ 11.2 MMJ/scm; Vmax ≤ 8.706 + 0.7084 (Ht)	NS
Non-Assisted Flares <sup>(23)</sup>	VOC's	NS	Ht ≥ 7.45 MMJ/scm; Vmax < 122 m/s if Ht > 37.3 MMJ/scm; Log10 (Vmax) ≤ (Ht + 28.8)/31.7 if Ht < 37.3 MMJ/scm	NS



Table I – Source Emission Standards (Continued)				
Source Category	Pollutant or Source	PME Limits & Requirements	Royal Commission Jubail Limits & Requirements	Royal Commission Yanbu Limits & Requirements
Hazardous and Medical Incineration	Particulates	See Footnote <sup>(4)</sup>	34 mg / dscm cor. to 7% O <sub>2</sub>	NS
	Hydrogen Chloride	See Footnote <sup>(4)</sup>	100 mg / dscm or at least 99% DRE if emission > 1.8 kg/hr	NS
	SO <sub>2</sub>	See Footnote <sup>(4)</sup>	500 mg / dscm	NS
	CO	See Footnote <sup>(4)</sup>	100 mg / dscm	NS
	PCB	See Footnote <sup>(4)</sup>	1 mg / kg PCB feed, max. 1-hour ave. conc. (99.9999% DRE)	NS
	Total Dioxins & Furans	See Footnote <sup>(4)</sup>	30 ng / dscm	NS
	Organics	See Footnote <sup>(4)</sup>	99.99% DRE of each	NS
	Visible Emissions	See Footnote <sup>(4)</sup>	10% opacity except 6-minute period per hour	NS
	Hydrogen Fluoride	See Footnote <sup>(4)</sup>	5 mg / dscm	NS
	Metals	See Footnote <sup>(4)</sup>	See Footnote <sup>(24)</sup>	NS
	Secondary Chamber Temperature	NS	1100 degrees Celsius	NS
	Secondary Chamber Time	NS	2 seconds minimum	NS
Sewage Treatment Plant – Sludge Incineration	Particulates	NS	0.65 grams / kg dry sludge	0.65 grams / kg dry sludge
	Opacity	NS	20%	20%
Bulk Gasoline Terminals	Total Organic Compounds (TOC's) (excl. methane & ethane)	See Footnote <sup>(4)</sup>	NS	80 mg/liter of gasoline loaded
Boilers & industrial furnaces burning hazardous materials	Organics	See Footnote <sup>(4)</sup>	99.99% Destruction removal efficiency (DRE); 99.9999% DRE for chlorinated organics	NS
	CO	See Footnote <sup>(4)</sup>	Not to exceed 100 ppmv on an hourly rolling average basis, corrected to 7% O <sub>2</sub> , dry gas basis	NS
	Metals	See Footnote <sup>(4)</sup>	See Footnote <sup>(24)</sup>	NS
	Particulate	See Footnote <sup>(4)</sup>	180 mg/dscm after correction to 7% O <sub>2</sub> stack gas concentration	NS

**Notes:**

- (1) Applies to all industrial activities, including flaring. Water vapor not included.
- (2) Visible emissions from all industrial sources including flaring shall be controlled to a maximum of 20% opacity excluding water vapor, with an allowance of 3 minutes during any continuous 60-minute period.
- (2A) Visible emissions directed toward flaring activities in Jubail shall be controlled to a maximum of 20% opacity excluding water vapor, with an allowance of 6 minutes during any continuous 60-minute period.
- (2B) Visible emissions directed toward flaring activities in Yanbu shall be controlled to a maximum of 20% opacity excluding water vapor, with an allowance of 6 minutes not to exceed 27% opacity during any continuous 60-minute period.
- (3) In Jubail, any industrial steam generating unit or furnace rated with an input heat capacity > 100 MM Btu/hr (29 MW) and > 30% of heat input derived from fuel oil.
- (4) Each facility (new or existing) shall be operated and maintained to avoid release of any toxic substance (regulated or not) in quantities sufficient to be harmful to the public.
- (5) Fugitive emissions shall be minimized by each facility through utilization of good maintenance and inspection procedures as well as by monitoring of potential emission sources using techniques and procedures defined by the EPD.
- (6) All affected flanges, valves, pumps, compressors, & pressure relief valves in VOC or organic HAP service shall be individually identified by specific number, service, and location. An updated master list of all affected components shall be kept on site at all times.
- (7) Value of F determined as follows:

<i>Fuel Bound Nitrogen (N) (% by weight)</i>	<i>F [NO<sub>x</sub> Emission Allowance (% by weight)]</i>
N ≤ 0.015	0
0.015 ≤ N < 0.1	0.04 (N)
0.1 < N ≤ 0.25	0.004+0.0067 (N- 0.1)
N > 0.25	0.005

- (7A) Equation applies to CGT's with > 100 MM Btu/hr (29 MW) located in the RCJ area
  - (7B) Equation applies to CGT's with ≤ 100 MM Btu/hr (29 MW) located in the RCJ area
  - (7C) The fuel range is to be specified in the Gas Turbine sheet provided to the manufacturer. Also, refer to [SAES-K-502](#), [SAES-K-501](#), and [36-SAMSS-001](#). Contact EPD/EED for further clarifications.
  - (8) To remove H<sub>2</sub>S, amine scrubbing or other gas cleaning technology as approved by the regulatory agency shall be used.
  - (9) Small tank is defined as <40,000 gallons for the RCY; <19, 815 gallons for the RCJ; and <1000 bbls (42,000 gallons) for PME.
  - (10) Floating roof tanks are acceptable to PME for the storage of crude oil provided an EPD-approved Seal Inspection and Reporting program is implemented to control VOC emissions.
  - (11) Floating roof tanks are acceptable to the RCY and RCJ for crude oil if the tank is < 40,000 gallons for RCY, and < 19, 815 gallons for RCJ, provided a consistent seal inspection and reporting program is implemented to control VOC emissions.
  - (12) Prior to custody transfer and construction commenced after 1978; exact requirements for Yanbu storage tank configurations depend on construction date. Refer to the "Environmental Protection Manual," Directorate General for Yanbu Project, Royal Commission for Jubail and Yanbu, January 1991 for specific detail.
-

- (13) Construction commenced after 1978 and before 1984. Refer to the "Environmental Protection Manual," Directorate General for Yanbu Project, Royal Commission for Jubail and Yanbu, January 1991 for specific detail.
- (14) Construction commenced after 1984; exact requirements for Yanbu storage tank configurations depend on construction date. Refer to the "Environmental Protection Manual," Directorate General for Yanbu Project, Royal Commission for Jubail and Yanbu, January 1991 for specific detail.
- (15) Equivalent not defined by regulation; shall be reviewed and approved by EPD.
- (16) Shall use CO boiler or high temperature regeneration to control emissions
- (17) SO<sub>2</sub> limit of 50 ppm is a seven-day rolling average; 9.8 kg/mt refers to gas phase SO<sub>2</sub> emissions.
- (18) 1.0 kg/metric tonne refers to non-sulfate particulates; scrubber is appropriate control technology to limit particulates
- (19) Two or three-stage Claus process shall be used.
- (20) H<sub>2</sub>S limited to 10 ppm and total reduced sulfur compounds limited to 300 ppm if no tail gas treatment (only reduction control used without incineration).
- (21) SO<sub>2</sub> limited to 250 ppm if tail gas treatment used (oxidation/reduction control used followed by incineration).
- (22) A minimum of 95% recovery of inlet sulfur averaged over a year.
- (23) Maximum exit velocity of a flare ( $V_{max}$ ) is calc. by dividing the maximum volumetric flow rate at STP by the cross-sectional area of the flare tip.  $H_t$  is the Net Heating Value of the gas being combusted.
- (24) Refer to RCJ environmental regulations for specific metals and limits.

NS – None Stated

### **Appendix III – Stack Testing Methods**

The following is a list of approved stack testing methods based on U.S. EPA recommended methods as per the U.S. Code of Federal Regulations (CFR), 40 CFR, Part 60, Appendix A - Standards of Performance for Petroleum Refineries. Other methods not listed may also be acceptable; however, approval must be obtained from EPD prior to commencement of the test(s).

1. U.S. EPA Method 1 - Sample and Velocity Traverses for Stationary Sources
2. U.S. EPA Method 1A - Sample and Velocity Traverses for Stationary Sources – Small Ducts
3. U.S. EPA Method 2 - Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
4. U.S. EPA Method 2A - Determination of Stack Gas Velocity and Volumetric Flow Rate (Volume Meters)
5. U.S. EPA Method 2B - Determination of Stack Gas Velocity and Volumetric Flow Rate (Exhaust Volume Flow Rate)
6. U.S. EPA Method 2C - Determination of Stack Gas Velocity and Volumetric Flow Rate (Standard Pitot)
7. U.S. EPA Method 2D - Determination of Stack Gas Velocity and Volumetric Flow Rate (Rate Meters)
8. U.S. EPA Method 3 - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
9. U.S. EPA Method 3A - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight – Instrumental Procedure
10. U.S. EPA Method 3C - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight – Orsat Procedure
11. U.S. EPA Method 4 - Determination of Moisture Content in Stack Gases
12. U.S. EPA Method 5 - Determination of Particulate Emissions from Stationary Sources
13. U.S. EPA Method 5F - Determination of Particulate (PM) Emissions from Stationary Sources – Fluidized Catalytic Cracking Unit (FCCU)
14. U.S. EPA Method 6 - Determination of Sulfur Dioxide Emissions from Stationary Sources
15. U.S. EPA Method 6A - Determination of Sulfur Dioxide, Moisture, and Carbon Dioxide Emissions from Fossil Fuel Combustion Sources

16. U.S. EPA Method 6C - Determination of Sulfur Dioxide Emissions from Stationary Sources – Instrumental Procedure
  17. U.S. EPA Method 7 - Determination of Nitrogen Oxide Emissions from Stationary Sources
  18. U.S. EPA Method 7E - Determination of Nitrogen Oxide Emissions from Stationary Sources – Instrumental Procedure
  19. U.S. EPA Method 8 - Determination of Sulfuric Acid Mist and Sulfur Dioxide Emissions from Stationary Sources
  20. U.S. EPA Method 9 - Visual Determination of the Opacity of Emissions from Stationary Sources
  21. U.S. EPA Method 10 - Determination of Carbon Monoxide Emissions from Stationary Sources – NDIR Procedure
  22. U.S. EPA Method 10A - Determination of Carbon Monoxide Emissions from Stationary Sources – CO for Certifying CEM
  23. U.S. EPA Method 10B - Determination of Carbon Monoxide Emissions from Stationary Sources
  24. U.S. EPA Method 11 - Determination of Hydrogen Sulfide Content of Fuel Gas Streams in Petroleum Refineries
  25. U.S. EPA Method 12 - Determination of Inorganic Lead Emissions from Stationary Sources
  26. U.S. EPA Method 13 - Determination of Total Fluoride Emissions from Stationary Sources
  27. U.S. EPA Method 15 - Determination of Hydrogen Sulfide, Carbonyl Sulfide, and Carbon Disulfide Emissions from Stationary Sources
  28. U.S. EPA Method 15A - Determination of Total Reduced Sulfur (TRS) from Stationary Sources
  29. U.S. EPA Method 16 - Semi-Continuous Determination of Sulfur Emissions from Stationary Sources
  30. U.S. EPA Method 16A - Determination of Total Reduced Sulfur Emissions from Stationary Sources (Impinger Technique)
  31. U.S. EPA Method 16B - Determination of Total Reduced Sulfur Emissions from stationary Sources (GC Analysis Technique)
  32. U.S. EPA Method 17 - Determination of Particulate Emissions from Stationary Sources (In-Stack Filtration Method)
-

33. U.S. EPA Method 18 - Measurement of Gaseous Organic Compound (VOC) Emissions by Gas Chromatography
34. U.S. EPA Method 19 – SO<sub>2</sub> Removal & PM, SO<sub>2</sub>, NO<sub>x</sub> Rates from Electric Utility Steam Generators
35. U.S. EPA Method 20 - Determination of Nitrogen Oxides, Sulfur Dioxide, and Oxygen Emissions from Stationary Gas Turbines (CGT's)
36. U.S. EPA Method 21 - Determination of Volatile Organic Compounds Leaks
37. U.S. EPA Method 22 - Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares
38. U.S. EPA Method 25 - Determination of Total Gaseous Non-methane Organic Emissions as Carbon
39. U.S. EPA Method 27 – Vapor Tightness of Gasoline Tank – Pressure Vacuum
40. U.S. EPA Method 29 – Metals Emissions from Stationary Sources
41. U.S. EPA Method 201A – PM<sub>10</sub> (in-Stack, CRS)

### Appendix IV – Stack Testing Figures

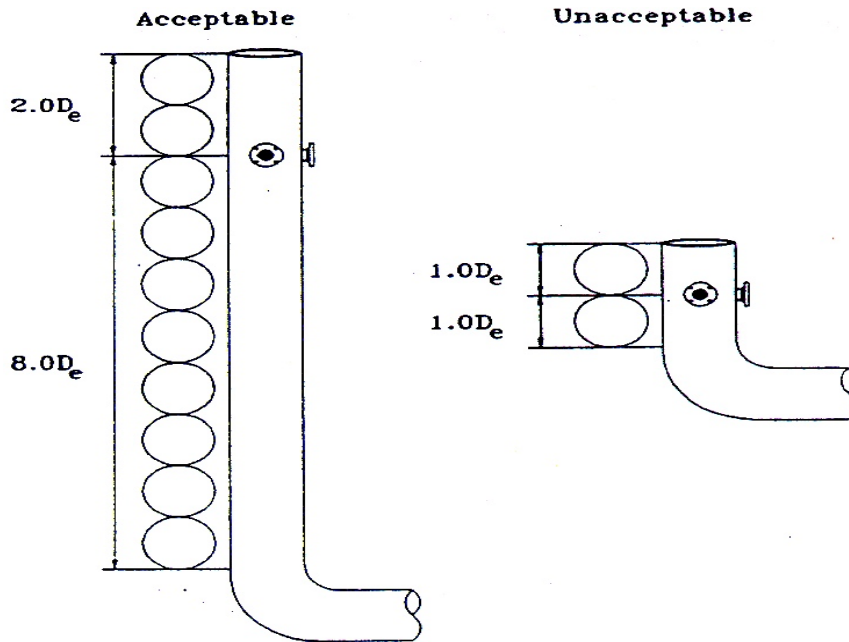


Figure 1 - Visualizing Proper Location of Stack Sampling Ports for Flow Disturbances

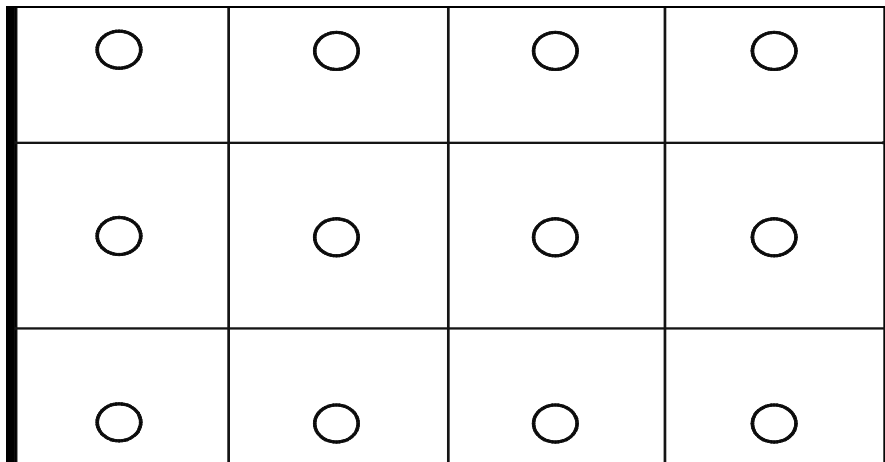
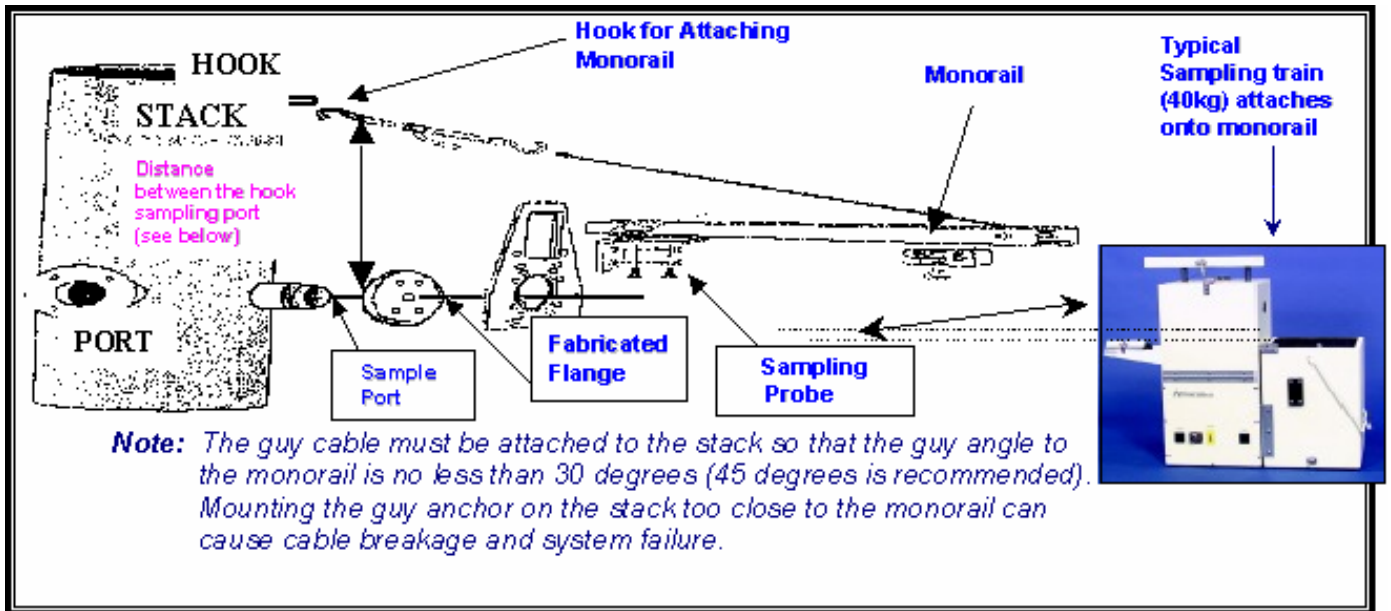


Figure 2 - Example Showing Rectangular Stack Cross Section Divided into 12 Equal Areas, with a Traverse Point at the Centroid of Each Area



**Figure 3 - Distance Required between the Port and Hook**

If required at 30 Degrees, then distance between Hook & Port is 6 ft (1.82m)  
If required at 35 Degrees, then distance between Hook & Port is 6.9 ft (2.07m)  
If required at 40 Degree, then distance between Hook & Port is 7.7 ft (2.31m)  
If required at 45 Degrees, then distance between Hook & Port is 12ft (3.60m)

**1 foot = ~ 0.3 meter**