Republic of Lebanon
Ministry of Environment

GUIDELINES FOR HOT MIX ASPHALT PLANTS

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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
</tr>
<tr>
<td>DGUP</td>
<td>Directorate General for Urban Planning</td>
</tr>
<tr>
<td>ECC</td>
<td>Environmental Compliance Certificate</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
</tr>
<tr>
<td>GEF</td>
<td>Global Environment Facility</td>
</tr>
<tr>
<td>HAP</td>
<td>Hazardous Air Pollutants</td>
</tr>
<tr>
<td>HCL</td>
<td>Hydrogen Chloride</td>
</tr>
<tr>
<td>HMA</td>
<td>Hot Mix Asphalt</td>
</tr>
<tr>
<td>IEE</td>
<td>Initial Environmental Examination</td>
</tr>
<tr>
<td>MoE</td>
<td>Ministry of Environment</td>
</tr>
<tr>
<td>MoI</td>
<td>Ministry of Industry</td>
</tr>
<tr>
<td>MoIM</td>
<td>The Ministry of Interior And Municipalities</td>
</tr>
<tr>
<td>MoIM</td>
<td>Ministry of Interior and Municipalities</td>
</tr>
<tr>
<td>MoMRA</td>
<td>Ministry of Municipal And Rural Affairs</td>
</tr>
<tr>
<td>MoPH</td>
<td>Ministry of Public Health</td>
</tr>
<tr>
<td>ND</td>
<td>No Data</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>NO</td>
<td>Nitrogen Dioxide</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>SO</td>
<td>Sulfur Dioxide</td>
</tr>
<tr>
<td>TOC</td>
<td>Total Organic Carbon</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>U.S. EPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>VOCs</td>
<td>Volatile Organic Compounds</td>
</tr>
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</table>
I. National Legislation and Institutional Framework:

1. Introduction:

Industrial establishments may cause environmental perturbations during construction and/or operation which will differ according to the practiced activities.

The decree law number 21/L dated 22/7/1932 defines rules and conditions related to classified establishments that require permits. In follow up to this decree law, Decree No. 4917 dated 24/3/1994 was issued to amend the classifications of establishments with hazardous activities or with impacts/harm on health. Decree 4917/94 categorizes classified establishments in 3 groups depending on their location, size (production capacity) and potential impacts.

In 2001, industrial establishments were classified according to Decree No. 5243 dated 5/4/2001 listing all available industrial facilities in categories numbered from one to five taking into consideration its potential environmental impacts. The conditions, criteria and rules for the permitting of the industrial establishments were set in Decree No. 8018 dated 12/6/2002.

| Category I: Generates very dangerous impacts on the environment, surroundings and public health which requires moving it away from the households to prevent its impacts. |
| Category II: Generates dangerous impacts on the environment, surroundings and public health but does not require moving it away from the households. However, it will not be given an investment permit unless mitigation measures are taken to prevent its impacts. |
| Category III: Generates limited negative impacts on the environment, surroundings and public health and must be subjected to special conditions to avoid its limited impacts. |
| Category IV: Generates minimal negative impacts on the environment, surroundings and public health and must be subjected to special conditions to avoid its minimal impacts. |
| Category V: Does not generate any negative impact on the environment, surroundings and public health. |

Table I-1: Definition of Industrial Establishments Categories (Decree No. 8018/2002)
### Hot Mix Asphalt Plants (ISIC code 2414)

<table>
<thead>
<tr>
<th>Production process</th>
<th>Classification</th>
<th>Classification Criteria</th>
<th>Setback Distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Mix Asphalt</td>
<td>Category 2</td>
<td>Generates dangerous impacts on the environment, surroundings and public health but does not require moving it away from the households. However, it will not be given an Operation permit unless mitigation measures are taken to prevent its impacts.</td>
<td>If project area is located within a classified industrial land, refer to its correspondent legislative. If the proposed plot is located within a non-classified area, the following requirements must be met:</td>
</tr>
</tbody>
</table>

- Distance ≤1000m from any archaeological and natural areas protect by a specific and/or Urban Decree.
- Distance ≤250m from main rivers (Aarka, AL Estwan, Al Bared, Abu Ali, Al Bouhsas, Al Jawz, Ibrahim, Beirut, Al Damour, Al Awali, Al Zahrani, Al Litani)
- Distance ≤150m from winter drainage system.
- Distance ≤1000m from hospitals, schools, nurseries or shelter plots limit.
- Distance ≤1000m from the residential community of five or more houses.
- Distance 1000m from coastal shoreline.
- Distance ≤200 m from international highways boundaries.
- Distance ≤100 m from international roads boundaries.

*Table I-2: Hot Mix Asphalt Plant Classification System (according to Decree No. 5243/2001) and setback distances (according to Decree No. 8018/2002)*
2. Environmental Assessment

Hot Mix Asphalt is an activity of environmental significance; these activities require an establishment permit and an operation permit.

The national principal legislation addressing pollution is the Environment Protection law 444/2002 that imposes the general environmental duty on industries undertaking an activity that affects or may affect the environment to take all reasonable and practicable measures to prevent or minimize any resulting environmental harm. However, decision 4/1 dated 6 August 2005 defines environmental conditions for construction and/or operation of hot mix asphalt plants.

However, Hot Mix Asphalt plants should prepare an Initial Environmental Examination (IEE) report for the proposed project and submit it to the Ministry of Environment (MoE), as per Decree No. 8633/2012 “Fundamentals for Environmental Impact Assessment”. In case the plant falls under a sensitive area as per annex 3 of the decree 8633/2012, the plant is subject to prepare an Environmental Impact Assessment (EIA) study.

3. Environmental Compliance Certificate

The Hot Mix Asphalt Plant should abide by the Decree No.8471/2012 on “Environmental Compliance for Establishments” and its related decisions. Applying for this certificate includes preparing an Environmental Audit with an Environmental Management Plan (EMP). Once environmental compliance is proven, after acquiring an operational permit, the facility will be awarded with an Environmental Compliance Certificate. The plant will be required to renew the Environmental Compliance Certificate (ECC) every three years based on a self-audit prepared by the industry.

Tables I-3 and I-4 indicate existing laws, decrees and decisions that are related to the environmental sector and responsibilities of the concerned ministries and governmental institutions.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Date of Issue</th>
<th>Source</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law 444/2002</td>
<td>8/8/2002</td>
<td>MoE</td>
<td>Environmental Protection</td>
</tr>
<tr>
<td>Decree No. 8633/2012</td>
<td>9/8/2012</td>
<td>MoE</td>
<td>Environmental Impact Assessment Fundamentals</td>
</tr>
<tr>
<td>Decree No. 847/2012</td>
<td>19/7/2012</td>
<td>MoE</td>
<td>Environmental Compliance for Establishment</td>
</tr>
<tr>
<td>Decision No. 8/1</td>
<td>30/1/2001</td>
<td>MoE</td>
<td>Standards and limits for air pollutants and liquid wastes discharged by classified facilities and wastewater treatment plants.</td>
</tr>
<tr>
<td>Decision No. 52/1</td>
<td>29/7/1996</td>
<td>MoE</td>
<td>Standards and limits for air, water and soil pollutants</td>
</tr>
<tr>
<td>Decision No. 4/1</td>
<td>6/8/2005</td>
<td>MoE</td>
<td>Environmental conditions for Construction and/or operation of Hot Mix Asphalt plants.</td>
</tr>
<tr>
<td>Decision 539/1</td>
<td>17/11/2015</td>
<td>MoE</td>
<td>Deadlines for Industrial Establishments to apply for the</td>
</tr>
</tbody>
</table>
### Table I-3: Existing Laws, Decrees and Decisions related to the Environmental Sector

<table>
<thead>
<tr>
<th>Decision</th>
<th>Date</th>
<th>Institution</th>
<th>Compliance Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>261/1</td>
<td>12/6/2015</td>
<td>MoE</td>
<td>EIA Review Procedures</td>
</tr>
<tr>
<td>590/1</td>
<td>21/12/2015</td>
<td>MoE</td>
<td>Environmental permitting clearance</td>
</tr>
</tbody>
</table>

4. **Permitting Procedure**

The following steps should be undertaken to acquire a construction or operation permit:

1. Submit file to the industrial permitting committee of the concerned Mohafaza. This committee is formed of members from different concerned ministries (Documents required are listed in Annex 2);

2. The file will be transferred to the concerned Municipality for their review and approval;

3. When approved by the Municipality, the file will be transferred to the concerned governmental authorities (MoI, MoE, MoPH, Urban Planning). After acquiring the feedback from all concerned governmental authorities, the industrial permitting committee will recommend the final decision to the Director General of the MoI who will transfer the file to the Minister of Industry with his recommendation;

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1 Environmental studies are required as defined previously in section 2.1 (Environmental Assessment)
Figure I-1: Process for obtaining an industrial permit according to Decree No. 8018/2002 (Adapted from Policy Paper & Action Plan for Industrial Wastewater Management in Lebanon)

<table>
<thead>
<tr>
<th>Type of Application</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Construction and Operation Permit | Each industry is subject to apply for establishment and operation permit.  
  - For categories 1, 2, and 3, the industry is subject to an Establishment Permit followed by an Operational Permit |
| Construction Permit Renewal | If the construction of the industry wasn’t achieved during the previously specified time period |
| Permit Addendum | Is mandatory in the following cases:  
  - Expansion or change in the industrial process or classification of the industry  
  - Addition of another industry |

Table I-5: Permitting Applications
II. Detailed Description of the Production Process

Hot mix asphalt is used primarily as paving material and consists of a mixture of aggregate and liquid asphalt cement, which are heated and mixed in measured quantities. Hot mix asphalt facilities can be broadly classified as either drum mix plants or batch mix plants, according to the process by which the raw materials are mixed. In a batch mix plant, the aggregate is dried first, then transferred to a mixer where it is mixed with the liquid asphalt. In a drum mix plant, a rotary dryer serves to dry the aggregate and mix it with the liquid asphalt cement. After mixing, the HMA generally is transferred to a storage bin or silo, where it is stored temporarily. From the silo, the HMA is emptied into haul trucks, which transport the material to the job site.

Hot mix asphalt plants can be classified by their mixing operation as one of the following: (1) batch mix plants, (2) continuous mix (mix outside dryer drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. (EPA-454/R-00-019, December 2000). However, hot mix asphalt facilities can be broadly categorized as either Batch Mix Plants or Drum Mix Plants, depending on the mixing process of the raw materials.
Figure II-1: Process flowchart for Batch Mix Plants
Figure II-2: Process flowchart for Drum Mix Plants
Figure II-3 Typical layout plant for HMA plants
A. **Batch Mixing Plants:**

1) **Reception and Storage of Raw Materials**

This stage includes the acquisition of raw materials needed for the production process. The raw materials include: fuel and aggregates. The reception and storage of bitumen differs from other raw materials. Bitumen is usually stored in designated tanks, whereas other raw materials are stored in open piles or in bunkers onsite.

Bitumen and diesel are delivered to asphalt manufacturing plants by tankers. These materials are transferred via hoses and pipes. On the other hand, aggregates are transferred to the facility via trucks, and stored in piles.

2) **Drying of Aggregates**

The raw aggregates are divided and separated into different sizes and introduced into the cold feed unit. Then raw materials are transferred into a rotary dryer which is generally fuel-fired. The flights located inside the drum help the raw aggregate mixture to bounce up into the hot air stream and fall back down, to dry more efficiently, while the drum is rotating. During this process, the exhaust gas and the water vapor are driven out to the atmosphere through a exhaust stack after passing through a dust separator or a bag filter; this is where the dust and fines will settle at the bottom. The dust and fines are either collected in silos or fed in the mixing process (EAPA, 2007).
3) **Screening, Grading and Weighing**

The hot aggregate is then transferred onto a bucket elevator, and then onto a set of vibrating screens which divide it to different sizes, which will be stored in bins according to their respective sizes. After deciding on a processing method, the hot aggregates are timely dropped into the weigh hopper, then into the pug mill (EAPA, 2007).

![Diagram of Screening, Grading and Weighing]

- **Aggregates**
- **Fuel**
- Fugitive particulate matter emissions (PM2.5- PM10)
- Noise pollution from screening and conveying

4) **Mixing**

In the mixing tower or pug mill, an appropriate amount of bitumen is injected from a hot storage tank into the pug mill, as well as the filler. The hot aggregate, filler and bitumen are mixed for a specific time depending on the desired end product specifications (EAPA, 2007).

![Diagram of Mixing]

- **Aggregate**
- **Bitumen**
- **Filler**
- **Fuel**
- Fugitive particulate matter emissions (PM2.5- PM10)
during the loading of aggregates into the mixer
- Hydrocarbon-based emissions and odours from heating and mixing of bitumen
- Soil and water pollution in case of accidental spills
- Noise and odors originating from mixing and heating of bitumen

5) **Loading and Hauling**

The end product is either filled directly into trucks to be hauled to the work site or stored in hot tanks.

![Diagram of Loading and Hauling]

- **Hot Mix asphalt**
- Fugitive particulate matter emissions (PM2.5- PM10) from trucks movement
- Hydrocarbon-based emissions/odours from asphalt
- Exhaust emissions from trucks
- Soil and water pollution in case of accidental spills
- Noise pollution from the hauling process

B. **Drum Mix Plant:**

1) **Reception and Storage of Raw Materials**

This stage includes the acquisition of raw materials needed for the production process. The raw materials include: Bitumen, fuel, aggregates. This production stage is the same for both batch mix and drum mix plants. The raw aggregate mixture is stored in piles; this process
aims to reduce its moisture content down to 3-5% by weight, therefore reducing the cost of energy consumption (USEPA, 2000). On the other hand, the bitumen is usually stored in designated heated tanks.

Bitumen and diesel are delivered to asphalt manufacturing plants by tankers. These materials are transferred via hoses and pipes.

2) Weighing, Drying and Mixing

During this process, both the heat-drying and mixing of the raw material take place in the same drum. The raw materials; filler, bitumen and aggregates, are proportionally added into the drum mixer. The aggregates are transferred from the storage silos into the rotating drum by conveyor belt. The aggregates are heated and dried by hot burner gases in the drum mixer. The liquid bitumen and filler are added about midway of the drum, where they will mix with the aggregates. The drum mixer is equipped with flights which will ensure efficient mixing of the materials (EAPA, 2007).

The exhaust gas and water vapor are collected in a bag house where the settled dust will be re-circulated in the drum mixer while the cleaned air will be discharged into the atmosphere (EAPA, 2007).
3) **Loading and Hauling**

The end product (hot mix asphalt) is then discharged into either trucks or hot storage silos via conveyor belt.

![Diagram showing Loading and Hauling process]

- Hot asphalt → Loading and Hauling →
  - Fugitive particulate matter emissions (PM2.5–PM10) from trucks movement
  - Hydrocarbon-based emissions/odours from asphalt
  - Exhaust emissions from trucks
  - Soil and water pollution in case of accidental spills
  - Noise pollution from the hauling process

### III. Potential Impacts of the Production Process

Hot Mix Asphalt Plants can result in significant environmental impacts, if not properly managed or maintained. The environmental operational impacts are set out in the following sections.

#### 1. Impacts on Air Quality:

The primary sources of emissions in HMA plants are the conveyors, dryers, hot bins, and mixers, which emit particulate matter (PM) and a variety of gaseous pollutants. Other emission sources include storage tanks/silos (temporarily holding the HMA), truck load-out operations, liquid asphalt storage tanks, burners (used to heat the asphalt storage tanks). Emissions also result from vehicular traffic on paved and unpaved roads, aggregate storage and handling operations, and vehicle exhaust (EPA, 2000). Thus, the major air emissions include:

- Particulate Matter emissions from HMA plants can be divided into: ducted production emissions, pre-production fugitive dust emissions, and other production-related fugitive emissions (EPA, 2000).

The main sources of PM emissions from the following operation activities include:

- Delivery of raw materials: unloading of aggregates from delivery trucks onto storage piles, movement of delivery trucks, etc.
- Storage of raw materials: wind erosion of aggregate storage piles, movement of raw materials to maintain the shape of storage piles… etc.
- Hauling of aggregates into the bucket elevators and during the screening process
- Unloading of aggregates into the drier
- Stack emissions from the dryer

Fugitive dust may range from 0.1 μm to more than 300 μm in aerodynamic diameter. On average, 5 percent of cold aggregate feed is less than 74 μm (minus 200 mesh) (EPA, 2000).
• Organic gaseous emissions (Total Organic Carbons (TOC) and Volatile Organic Carbons VOC) and odours emitted from the heated bitumen tanks, especially during the loading and heating of bitumen in tanks, as well as mixing. The type and grade of bitumen and the heating temperature influence the rate and composition of the gaseous emission.

• Inorganic gaseous emissions which include:
  - Carbon Monoxide which most of it occur in the combustion process inside the dryer drum. In some cases, the small combustion space causes the incomplete combustion of the fuel where it is affected by the straight contact of mineral material with the burner flame. The CO emitted at HMA plants strongly depend on the fines contained in the mineral material, and the moisture content inside the drum (EAPA, 2007).
  - Carbon Dioxide emission which depends on the quality of the fuel consumed and the amount of energy consumed during the drying process for each of the aggregates
  - Sulfur Dioxides which are mainly emitted from the combustion process inside the dryer; the amount of SO\(_2\) emitted depends on the quality of the fuel (how much sulfur it contains) (EAPA, 2007).
  - Nitrogen Oxides: The nitrous oxides are mainly emitted in the dryer drum by the burner, the amount of NO\(_x\) emitted relies on the quality of the fuel being burned (the amount of nitrogen it contains), the type of the burner and its temperature and the amount of air in excess (EAPA, 2007).
  - Volatile Organic Carbon (VOCs) where incomplete combustion may occur, causing the emission of VOCs particularly toluene, xylene and benzene; this is caused by inadequate mixing of fuel and air, inadequate temperature and quenching of the burner flame (NPI, 1999).

Quantification of emissions can be done using specific emission factors and predictive equations, listed in Error! Reference source not found.

2. Impacts on Water and Soil Quality:

Wastewater generated during the reception and storage of raw materials in the asphalt batching plant mainly consists of:

• Contaminated storm water runoff
• Dust suppression wastewater
• Leakages or accidental spills during filling of bitumen tank and loading of raw materials into the mixers
• Accidental spills or leakages of oil storage tanks
• Improper discharge of asphalt failed batches or residues

The main environmental concerns related to the generated wastewater from asphalt batching plants are the levels of: alkalinity, Total Suspended Solids (TSS) and oil and grease.

The wastewater is expected to have an elevated pH (between 11 and 12) due to the presence calcareous materials such as limestone. Similarly, the wastewater might also have high levels of dissolved limestone solids derived from the aggregate stockpiles.
Oil and grease is also a potential pollution source generated from the trucks and other equipment which requires oil in their operation and maintenance.

If mishandled, the generated wastewater would negatively affect the physical, biological and chemical characteristics of both the local water and soil quality, resulting in inevitable implications on both the environment and the public health.

3. Impact on Acoustic Environment:

Noise emissions are considered as an environmental impact due to its irritant potential to the local community and the operators of the batching plant. Major noise sources at the asphalt batching plants include:

- Trucks, front-end loaders and other heavy machinery
- Unloading of aggregates onto stockpiles
- Dryer drum
- Conveyors/ bucket elevator
- Screens
- Hydraulic pumps
- Aggregates delivery to hoppers/bunkers
- Mixer
- Alarms/ warning devices

If noise pollution is not well managed, it is most likely to affect the health of the personnel on-site and the plant’s surroundings.

4. Occupational Health and Safety

The main occupational hazards in this production stage include:

- Exposure of emissions emitted during the delivery, storage and handling of raw materials, mainly dust emissions and bitumen fumes
- Risk of inhaling the crystalline form of Silica, which is mainly found in aggregates
- Noise hazards emitted from trucks and heavy machinery
- Slipping hazards
- Poor ergonomics upon mechanical activities (i.e. Lifting, loading, unloading of raw material, etc.)
- Risk of exposure to wet asphalt, which cause skin irritation and chemical burns.
- Noise hazards emitted from mechanical equipment, trucks and heavy machinery
- Tripping hazards (i.e. during repairs and maintenance works)
- Noise hazards emitted from trucks and heavy machinery
- Traffic related accidents
IV. Detailed description of Pollution Prevention and Pollution Abatement Methods

Applying best environmental management practices in asphalt batching industries is essential to maximize the efficiency of raw materials and resources, reduce water consumption, minimize wastewater generation, reduce air pollution, decrease solid waste generation rates and protect the amenity of the site. The required environmental management practices to protect the major environmental components are presented in the following sections.

1. Air Quality:

The appropriate facility design and management practices can prevent the release of air pollutants. The measures, which should be taken to prevent the degradation of air quality, include:

- The entire plant premises should be paved with hard, impervious materials, including the drive ways from and into the plant.
- The entire plant floor should remain dust-free.
- Natural or artificial wind barriers are to be placed to help control the emission of dust into the surroundings of the facility (i.e. trees, fences and landforms in accordance with prevailing wind direction).
- The trucks hauling aggregates and other raw materials should be covered during transport.
- Sand and aggregates should be delivered to the site in a dampened state to prevent fugitive dust emissions. These raw materials should be water sprayed, if it has dried out during the transport process.
- The loading bay of raw materials should be roofed and enclosed in at least 3 sides.
- The stockpiles storage areas should be fitted with dust suppression water sprayers to dampen the stockpiles.
- The facility is required to cover raw materials stockpiles with rubber sheets, plastic sheets or any water impermeable covers.
- It is recommended to install silos for the storage of filler raw materials.
- Leakages or spillages should be prevented during unloading of raw materials and dispensing of bitumen in tanks. In cases of spill incidents or leakages, the spill should be immediately cleaned and contained (refer to the contingency plan in the section V).
- Conveyors and storage hoppers should be enclosed and roofed to protect the raw materials from weather conditions.
- Conveyor belts shall be equipped with belt cleaners to ensure that the raw materials remaining on the belt are well-contained and won’t emit particulate matter emissions.
- The transport points of conveyors and hopper discharge area should be enclosed. Rubber curtain seals can be used for transfer point outlets.
- Raw materials discharged into hoppers should be damped.
- All trucks leaving the facility’s premises should be clean and free of dust.
- Air quality control equipment should be installed on, driers and mixers.
- Air quality control equipment should be well maintained on a regular basis.
- Low sulfur fuel is recommended to be used for the burners, generators and machinery.
- Air to fuel ratio should be regularly monitored in burners to prevent incomplete combustion.
• Over-heating of bitumen in storage tanks should be prevented
• The unnecessary opening of the bitumen storage tank should be prevented to reduce odor emissions
• It is advisable to enclose the processing steps (conveyor belts, dyer and mixer and other dust generating areas)
• Overheating of asphalt should be prevented (the emission of fumes doubles at every 10°C increase in temperature (EAPA, 2007))

Characteristics of Fabric Bag Filter:

The typical air quality control equipment in asphalt batching plants are bag filters (Equivalent or better performance dust abatement alternatives are accepted). Fabric bag filters should be installed on the mixers and dryers. Fabric filters should have the following requirements:

• The bags’ materials should be chosen to withstand the continuous exposure to PM emissions (i.e. polyester, polypropylene, etc.).
• The collector bags should be carefully sized according to the equipment’s specific dimensions to prevent clogging (refer to manufacturer’s recommendations or requirements).
• A filter should be protected from weather conditions and external factors (i.e. rain, humidity, wind, etc.).
• The filters should be equipped, at least, dryers and mixers.
• The bag filters should be cleaned automatically.
• The high pressure air used in the bag filters should be oil-free and with low moisture content.
• The bag filter should be capable of withstanding the maximum differential pressure which may be faced. It is recommended to set an alarm to monitor the differential pressure indicators.
• It is advisable to install primary dust removal equipment prior the filter such as cyclones or separators (Figure IV-2) (EAPA, 2007).
Figure IV-1: Typical Fabric Bag Filter (envirofloeng.com)

Figure IV-2: Cyclone scheme
Characteristics of Bitumen Storage Tank:

- Bitumen storage tank, including the associated piping, should have primary and secondary containment to protect the soil and ground water quality in case of accidental spills or leakages. The secondary containment can be of concrete or steel.
- Primary containment should be with sufficient thickness equivalent to not less than (6 mm) to provide protection. Secondary containment consists of concrete and will not be an integral part of the primary. It must a sufficient thickness, density and corrosion resistant to protect the primary containment (Portland cement type II or V depending on alkaline percentage of soil and heat built-up).
- Owing to its high viscosity, bitumen must be heated (up to 150°C) to make them sufficient fluid for bulk distribution and application. Therefore, it should be stored at the lowest temperature possible which is consistent with the efficient energy use.
- Horizontal tanks are usually used for storage of liquid bitumen and equipped with heating coils to maintain viscosity. The liquid bitumen in the tank is indirectly heated by the hot thermal oil flowing through the coils.
- The tank must have a level indicator to prevent overflowing of the tank during the refilling operations. In addition, it must has two openings to be used in refilling the tank with bitumen raw material.
- Area where all the operations are taking place (truck filling, tank evacuation, storage...etc.) should be paved by a concrete base to prevent any penetration of accidental spillages into the soil or any ground water aquifers.

![Bitumen storage tank cross-section](image)

Figure IV-3: Bitumen storage tank cross-section

2. Water and Soil Quality:

The main purpose of the environmental management of water quality is to ensure that the generated wastewater does not directly reach sewerage network(s), surface waters, ground water or land, prior appropriate treatment. The two major approaches to manage wastewater in asphalt batching plants are through: wastewater minimization, and wastewater recycling/reuse.

- The entire plant should be paved with hard, impervious materials such as asphalt or concrete.
All generated wastewater should be collected and retained on-site, including stormwater.
Domestic wastewater should be directed to the local sewerage network. In case a sewerage network is absent, a well-controlled septic tank should be used to store the domestic wastewater, prior its evacuation by the responsible personnel.
Used oils from the generators shall be safely stored in closed containers and handled to specialized contractors for recycling.
The areas contaminated with dust should be minimized to decrease the amounts of contaminated stormwater runoff.
Certain areas should be bunded with small bunds or canals to ensure that the wastewater is captured, mainly including: raw materials storage piles, generator room(s) and bitumen storage tanks.

3. Solid Waste

Solid wastes are inevitably generated during or after the operation of the batching plant. However, a number of management practices and operation modalities can be implemented to minimize generation and ensure the proper handling and disposal. These practices include:
- Adopting a waste minimization approach to all operational activities on-site (i.e. loading, unloading, mixing, washing, etc.), including administrative activities.
- Carefully matching the design mix with the received batching order (i.e. amount, characteristics, number of batches, delivery, etc.).
- Use of all fresh waste asphalt in on-site paving activities, whenever feasible.
- Waste asphalt should be reused wherever possible (i.e. off-site construction, rehabilitation works, etc.) or recycled by licensed facilities (i.e. into gravel, aggregates, etc.) or sent to designated licensed landfills.
- All domestic solid wastes should be sorted at source and handled by designated solid waste management facilities.
- All recyclables generated on-site should be recycled by designated companies (i.e. paper, plastics, cans, aluminum, etc.).

4. Acoustic Environment

Noise pollution can be mitigated to prevent environmental and social implications, as such:
- Ensure that the facility’s noise emissions doesn’t exceed the Environmental Limit Values provided in MoE Decision 52/1 dated 12/9/1996.
- Locate noisy equipment away from sources of conflict or behind noise absorbers/receptors.
- All pressure-operated equipment should be fit with silencers or enclosed (i.e. compressors, pumps, etc.).
- Avoid unnecessary movement of trucks
- The hoppers should be lined with sound absorbing materials such as rubber or wood
- Efficient muffling devices should be installed on engines or noisy equipment
- Replace audible alarms with visual alarms, whenever possible.
- Limit, whenever possible, late night working shifts.
- Maintenance operations should be conducted in enclosed areas or sheds.
The national maximum allowable noise level as per MoE Decision No. 52/1/1996 are presented in the table below.

<table>
<thead>
<tr>
<th>Region Type</th>
<th>Limit for noise level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day time (7 am - 6 pm)</td>
</tr>
<tr>
<td>Industrial areas</td>
<td>60-70</td>
</tr>
</tbody>
</table>

*Table IV-1 Permissible Ambient Noise Levels in Different Regions*

The maximum national standard of 90 dB for occupational noise exposure limits should not exceed an average duration of 8 hours working days. If the limits are higher than the acceptable limits, then the exposure duration should be reduced as mentioned in the Table below.

<table>
<thead>
<tr>
<th>Sound Pressure Level dB(A)</th>
<th>Exposure Duration (hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>105</td>
<td>1</td>
</tr>
<tr>
<td>110</td>
<td>0.5</td>
</tr>
<tr>
<td>115</td>
<td>0.25</td>
</tr>
</tbody>
</table>

*Table IV-2: Noise exposure limits*

5. Occupational Health and Safety

A series of occupational behaviors are required at all times during plant operation to ensure that all foreseeable risks and hazards are prevented, minimized and mitigated. Such actions and behaviors include:

- Wear required Personal Protective Equipment (PPE) when handling raw material (i.e. alkali-resistant gloves, long sleeved and full length pants coveralls, waterproof boots and eye protection).
- In case of eye contamination with raw materials dust, rinse eyes with water and consult a physician.
- Meticulously follow advised lockout/tagout procedures when servicing equipment or machinery.
- Avoid working beneath frontload lifters, conveyor belts and stacker/de-stacker machinery.
- Minimize the mechanical lifting of material and bulky material, relying mainly on forklifts or frontload lifters.
- Keep floors clear to avoid slipping and tripping hazards.
- Provide appropriate lightening in closed or dark work places to avoid slipping or tripping hazards.
- Avoid working in awkward postures and in confined areas.
- Make sure back-up alarms on all vehicles are functioning.
- Avoid overloading equipment or machinery.
- Avoid workers exposure to bitumen or asphalt. In case of exposure, he should directly wash thoroughly and apply the first aid medical procedures for burns.
- Beware of hot surfaces on equipment and truck components.
- Use hearing protection during noisy operations, such as cement and aggregates loading/unloading

V. Contingency Plan

1. Spill Response Plan:

The proper spill risk assessment begins with identifying potential spills, preventing the potential occurrences, containing the areas of potential risks, detecting any leakages or spills and finally properly removing the spill.

The improper storage and management of fluids are the major cause of spills. The spilled materials lead to soil, ground and surface water, wetlands pollution. Furthermore, air quality, as well as occupational health is affected. In order to prevent spills, the following must be undertaken:

- Materials must be stored in closed containers in order to prevent the any spills and evaporation
- The content level of the bitumen container must be checked before filling
- The containers must be checked for leakages, the containers that are in good condition can only be used
- Solvents must be filled in containers that are compatible to the specific solvent
- Spilled materials must be kept from entering water drains through the use of drain covers( such as plastic seals)
- Workers must be trained in safe material handling as well as equipment use

Response Actions/ Cleanup Methods

- Employees must be trained on the quick and efficient response to different kind of spills as well as the use of spill cleaning equipment
- Once a spill occurs, all workers in the spill area should be alerted
- All ignition sources should be terminated
- Spill cleaning (such as containers, spill pads, seals…)equipment must always be present and maintained
- Dike the spilled liquid as quickly as possible to prevent spreading
- Personnel cleaning the spill should be equipped with proper PPEs such as eye and skin protection, as well as gloves.
- Spill cleaning equipment include as pads, booms and absorbents such as oil dry, absorbent blankets, etc. as well as containers to hold spilled waste.
- Spill cleaning include:
  - Placing the absorbent material (i.e. sand, clay, hydrated lime) directly on the spill. The absorbent material should be inert and non-combustible.
- The absorbent materials are then directly placed in a sealed container and disposed of properly (i.e. can be fed to the burners)
- Fire extinguishers must be present in close proximity
- The spill cleanup materials should be cleaned with plastic tools and placed in plastic or glass containers with a sealable lid. It is recommended to double-bag the cleaned materials.
- Water must not be used to dilute the spills or wash the spill into drainage pipes
- Any spill of Hazardous materials must be directly reported to the adequate official authority
- Implement a recording system for all spills

2. Fire Emergency Response Plan:

- Provide all areas with sufficient fire detectors (heat and smoke) and adequate firefighting equipment (sprinklers, hoses, distinguishers, etc.).
- Develop an emergency response plan which includes the floor map and the evacuation directions, exits, stairs and location of extinguishers (this should be written in languages understood by all workers).
- Ensure that contact details of the local firefighting services are available to the relevant staff and operators.
- Every escape route should be distinctively and conspicuously marked by emergency exit signs of adequate size and languages.
- Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the project.
- All fire safety equipment and fixtures shall be regularly serviced and maintained. The owner or shall annually certify that each of the fire safety measures specified in this statement has been assessed by a properly qualified person.
- Conduct annual firefighting and leak checks training drills for the operating staff.
- Prohibit smoking as well as flammable materials build-up within the facility’s premises.

Response Actions:

- **Activate** the nearest fire alarm (i.e. pull-stations) in case alarms have not yet been automatically activated
- **Confine** the facility by closing all windows and doors and access points within reach
- **Evacuate** the premises immediately using stairways or designated fire escapes only
- **Call** the local fire department and provide them with prompt and accurate details (i.e. accident, location, extent, etc.)
<table>
<thead>
<tr>
<th><strong>Type of Impact</strong></th>
<th><strong>Source</strong></th>
<th><strong>Mitigation Measures</strong></th>
<th><strong>Monitoring</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on Air Quality</td>
<td>Movement of trucks and heavy machinery</td>
<td>The plant premises should be paved with hard, impervious materials.</td>
<td>• Ensure that all stockpiles of raw materials are covered</td>
</tr>
<tr>
<td></td>
<td>Unloading of raw materials</td>
<td>The entire plant floor should remain dust-free.</td>
<td>• All ground and handling surfaces should remain dust-free</td>
</tr>
<tr>
<td></td>
<td>Storage stockpiles</td>
<td>Natural or artificial wind barriers are to be placed landforms in accordance with prevailing wind direction (i.e. trees, and fences).</td>
<td>• Confirm that all trucks and vehicles are covered and all raw materials delivery covers</td>
</tr>
<tr>
<td></td>
<td>Transferring of bitumen into storage tanks</td>
<td>Trucks hauling sand, aggregate or other raw materials should be covered during transport.</td>
<td>• All installed alarms and warning systems of bitumen storage tanks, driers and mixers are operable</td>
</tr>
<tr>
<td></td>
<td>Stack emissions from dryers</td>
<td>The loading bay of raw materials should be roofed and enclosed in at least 3 sides</td>
<td>• Ensure that back-up generator is working at maximal efficiency through undergoing CO, SOx, NOx, and other parameters monitoring</td>
</tr>
<tr>
<td></td>
<td>Leakages or spillages of raw materials</td>
<td>Stockpiles storage areas should be fitted with dust suppression water sprayers to dampen the stockpiles.</td>
<td>• Monitor exhaust emissions from bitumen storage tanks, driers and mixers. The parameters should be monitored:</td>
</tr>
<tr>
<td></td>
<td>Exhaust emissions from trucks, front end loaders or any other fuel-based machinery</td>
<td>Raw materials should be covered with rubber sheets, plastic sheets or any water impermeable covers.</td>
<td>- Levels of dust buildup on the raw materials storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leakages or spillages should be prevented during unloading of raw materials and dispensing in silos</td>
<td>- Reverse air flow velocity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sand and aggregates should be delivered to the site in a dampened state to prevent fugitive dust.</td>
<td>- Potential tears, ruptures or leaks in dust and EX designs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conveyors and storage hoppers should be enclosed and roofed to protect the raw materials from wind.</td>
<td>- Potential damaged seals or mechanical damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The conveyor belts shall be equipped with belt cleaners to ensure that the raw materials remaining on the belt are well-contained.</td>
<td>- Lifetime duration and expiration of any protective equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The transport points of conveyors and hopper discharge area should be enclosed. Rubber curtain seals can be used for transfer point outlets.</td>
<td>- Operating hours and different equipment scenarios</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Raw materials discharged into hoppers should be damped.</td>
<td>• Monitor VOC emissions from the bitumen storage tanks, driers and mixers.</td>
</tr>
<tr>
<td>Type of Impact</td>
<td>Source</td>
<td>Mitigation Measures</td>
<td>Monitor</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Impact on Water and Soil Quality | Contaminated storm water runoff, Wash water generated from washing of the premises, Dust suppression wastewater | - Air quality control equipment should be monitored on a regular basis  
- Low sulfur fuel should be used for the burners, generators and machinery  
- Air to fuel ratio should be regularly monitored in burners to prevent incomplete combustion  
- Over-heating of bitumen in storage tanks should be prevented  
- The unnecessary opening of the bitumen storage tank should be prevented to reduce odour emissions  
- Monitor the operations of bag filters (inlet and outlet temperature, pressure drop, proper operation of valves, absence of ruptured bags, cleaning cycles, discharge procedure...) | - Visual inspections to ensure the absence of any leakage and the absence of any leakage  
- Ensure no spills are present at the storage tanks, overheating or leakages...  
- Monitor fuel storage tanks to prevent spills |
| Impact on Acoustic             | Trucks, front-end loaders                                               | - The entire plant should be paved with hard, impervious materials such as asphalt or concrete  
- All generated wastewater should be collected and retained on-site, including storm water  
- The generated domestic wastewater should be discharged in a safe manner, namely it should be directed to the local sewerage network or, case a sewerage network is absent, a well-controlled septic tank should be used to store the domestic wastewater, prior its evacuation by the responsible personnel.  
- Used oils from the generators shall be stored in specific well-maintained mounted containers and handled to specialized contractors for recycling  
- All maintenance materials should be stored in their respective areas in a closed hangar with a concrete base to prevent any spillages from reaching the proximal soils  
- Certain areas should be bunded with small bunds or canals to ensure that the wastewater is captured, mainly including: raw materials storage piles, generator room(s) and bitumen storage tanks. | - Monitor generator rooms or spills or leakages of oils, lubricants, chemicals...  
- Monitor area of bitumen storage tanks |

**Mitigation Measures:**
- Monitor fuel storage tanks to prevent spills
- Monitor area of bitumen storage tanks
- Calibration of the adopted noise levels
<table>
<thead>
<tr>
<th>Type of Impact</th>
<th>Source</th>
<th>Mitigation Measures</th>
<th>Monitoration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>and other heavy machinery, unloading of aggregates onto stockpiles, dryer drum, conveyors/bucket elevator, screens, hydraulic pumps, aggregates delivery to hoppers/bunkers, mixer, alarms/warning devices</td>
<td>absorbers/receptors. Provide adequate buffer zone of a minimum of 100 meters between the facility and any identified sensitive receptor(s). All pressure-operated equipment should be fit with silencers or enclosed (i.e. compressors, pumps, etc.). The hoppers should be lined with sound absorbing materials such as rubber or wood. All roads should be paved with concrete or asphalt. Efficient muffling devices should be installed on engines or noisy equipment. Replace audible alarms with visual alarms, whenever possible. Limit, whenever possible, late night working shifts. Maintenance operations should be conducted in enclosed areas or sheds. Calibration of the adopted noise meters must be undertaken on a quarterly basis and certified by the manufacturer every two years in order to ensure the meters’ accuracy of measurements.</td>
<td>Monitoring of noise levels should be undertaken for at least one background noise.</td>
</tr>
<tr>
<td>Impact on Occupational Health and Safety</td>
<td>physical hazards (tripping, electrocution), chemical hazards (exposure)</td>
<td>Wear required Personal Protective Equipment (PPE) when handling raw material or bitumen (i.e. alkali-resistant gloves, long sleeved and full-length pants coveralls, waterproof boots and eye protection).</td>
<td>Monitor the use of PPEs by the workers. Monitor the presence of safety devices, equipment needed for hazardous materials.</td>
</tr>
</tbody>
</table>

Khalil Zein
<table>
<thead>
<tr>
<th>Type of Impact</th>
<th>Source</th>
<th>Mitigation Measures</th>
<th>Monitor</th>
</tr>
</thead>
</table>
| to bitumen, dust emissions…etc.)                 | Ergonomic hazards                           | • Eat and drink only in dust-free areas to avoid ingestion of dust (i.e. cement dust in particular).  
• In case of eye contamination with cement dust, rinse eyes with water and consult a physician.  
• Wash contaminated skin areas with cold, running water as soon as possible.  
• Meticulously follow advised lockout procedures when servicing equipment or machinery.  
• Avoid working beneath frontload lifters, conveyor belts and stacker/de-stacker machinery.  
• Minimize the mechanical lifting of material and bulky material, relying mainly on forklifts or frontload lifters.  
• Keep floors clear to avoid slipping and tripping hazards.  
• Provide appropriate lighting in closed or dark work places to avoid slipping or tripping hazards.  
• Avoid working in awkward postures and in confined areas.  
• Make sure back-up alarms on all vehicles are functioning.  
• Avoid overloading equipment or machinery.  
• Cautiously work with the load out chute on mixers to avoid injuries to hands and fingers.  
• Beware of hot surfaces on equipment and truck components.  
• Use hearing protection during noisy operations, such as aggregates loading/unloading activities  
• Injuries/illnesses and major occupational accidents must be recorded and identified at upon occurrence, including: cuts, respiratory illnesses, dermal diseases, gastro-intestinal infections, eye infections, burns, mortality, accidents leading to handicaps. |
|                                                  |                                             | • Ensure that the fire extinguisher is in easily accessible location                                                                                                                                                                                                                                                                                  |         |

Table V-1: EMP
Annex 1
Emissions Assessment for Asphalt Batching Plants

The emissions associated with Hot Mix Asphalt production include **Particulate Matter** emissions: PM-10 (PM less than 10 micrometers in aerodynamic diameter) and PM-2.5 as well as **gaseous emissions** which include the criteria pollutants sulfur dioxide (SO2), nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOC), along with volatile HAP metals and organic compounds (USEPA, 2000).

Emission factors are generally used to estimate the expected emissions rates. Emission factors relate the quantity (weight) of pollutants emitted to a unit of activity of the source. These factors can be used to estimate emissions from one or more facilities by multiplying the emission factor by the total production rate.

U.S. Environmental Protection Agency (USEPA) calculated the emission factors from a typical batch mix and drum mix asphalt batching plants (presented in tables 1 and 2).

Emission factors can be used to estimate emissions by multiplying the emission factor by the plant’s production rate. For example, the emission factor for CO emissions from a No.2 fuel oil-fired batch mix dryer is 0.4 pounds per ton (lb/ton). If the dryer produces 200,000 tons per year (ton/yr), the estimated CO emissions during that period would be: 200,000 ton/yr × 0.4 lb/ton = 80,000 lb/yr or 40 tons/yr.
**Emission Factors:**

**Batch Mix Hot Asphalt Plants:**

<table>
<thead>
<tr>
<th>Process</th>
<th>Total PM a(lb/ton)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PM</td>
<td>PM-10</td>
<td></td>
</tr>
<tr>
<td>Dryer, hot screens, mixer(uncontrolled)b</td>
<td>32</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Venturi or wet scrubber</td>
<td>0.14</td>
<td>ND c</td>
<td></td>
</tr>
<tr>
<td>Fabric Filter</td>
<td>0.042</td>
<td>0.027</td>
<td></td>
</tr>
</tbody>
</table>

a Emission factor units are lb per ton of HMA produced. To convert to kg/Mg, multiply by 0.5; Total PM is the sum of filterable PM, condensable inorganic PM, and condensable organic PM  
b The type of fuel used for the dryer does not affect PM emissions  
c ND= no data

<table>
<thead>
<tr>
<th>Process</th>
<th>Emission Factors(lb/ton)a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO c</td>
</tr>
<tr>
<td>Fuel oil-fired dryer (No.2 fuel e oil), hot screen, and mixer</td>
<td>0.40</td>
</tr>
<tr>
<td>Coal-fired dryer, hot screens and mixer</td>
<td>ND b</td>
</tr>
</tbody>
</table>

a Emission factor units are lb per ton of HMA produced. To convert to kg/Mg, multiply by 0.5  
b ND= no data  
c CO emission factors represent normal plant operations without scrutiny of burner design, operation and maintenance  
d The CO2 emission factors represent an average of EPA data available, regardless of dryer fuel  
e No. 2 fuel oil is also called heating oil, which has low viscosity and an API of 34
<table>
<thead>
<tr>
<th>Process</th>
<th>Emission factors(lb/ton)(^a)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOC(^b)</td>
<td>CH(_4)</td>
<td>VOC (^c)</td>
</tr>
<tr>
<td>Fuel oil-fired dryer (No.2 fuel oil), hot screen, and mixer</td>
<td>0.015</td>
<td>0.0074</td>
<td>0.0082</td>
</tr>
<tr>
<td>Fuel oil-fired dryer (No.6 fuel oil(^d)), hot screen, and mixer</td>
<td>0.043</td>
<td>0.0074</td>
<td>0.0082</td>
</tr>
</tbody>
</table>

\(^a\) Emission factor units are lb per ton of HMA produced. To convert to kg/Mg, multiply by 0.5
\(^b\) TOC equals total hydrocarbons as propane, as measured with an EPA Method 25A or equivalent sampling train plus formaldehyde.
\(^c\) The VOC emission factors are equal to the TOC factors minus the methane emission factors; differences in values reported are due to rounding.
\(^d\) No. 2 fuel oil is also called heating oil, which has low viscosity and an API of 34. No. 6 fuel oil is known as residual oil with high viscosity and API of around 81.
<table>
<thead>
<tr>
<th>Process</th>
<th>Total PM a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PM</td>
</tr>
<tr>
<td>Dryer b</td>
<td>28</td>
</tr>
<tr>
<td>Venturi or wet scrubber</td>
<td>0.045</td>
</tr>
<tr>
<td>Fabric Filter</td>
<td>0.033</td>
</tr>
</tbody>
</table>

a Total PM is the sum of filterable PM, condensable inorganic PM, and condensable organic PM
b The type of fuel used for the dryer does not affect PM emissions
c ND= no data

<table>
<thead>
<tr>
<th>Process</th>
<th>Emission factors(lb/ton) a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CO c</td>
</tr>
<tr>
<td>Fuel oil-fired dryer (No.2 fuel oil b), hot screen, and mixer</td>
<td>0.13</td>
</tr>
<tr>
<td>Coal-fired dryer, hot screens and mixer</td>
<td>ND b</td>
</tr>
</tbody>
</table>

a Emission factor units are lb per ton of HMA produced. To convert to kg/Mg, multiply by 0.5
b ND= no data
c CO emission factors represent normal plant operations without scrutiny of burner design, operation and maintenance
d The CO2 emission factors represent an average of EPA data available, regardless of dryer fuel
e No. 2 fuel oil is also called heating oil, which has low viscosity and an API of 34.

<table>
<thead>
<tr>
<th>Process</th>
<th>Emission factors(lb/ton) a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOC b</td>
</tr>
<tr>
<td>Fuel oil-fired dryer (No.2 fuel oil d), hot screen, and mixer</td>
<td>0.044</td>
</tr>
</tbody>
</table>

a Emission factor units are lb per ton of HMA produced. To convert to kg/Mg, multiply by 0.5
b TOC equals total hydrocarbons as propane, as measured with an EPA Method 25A or equivalent sampling train plus formaldehyde.
c The VOC emission factors are equal to the TOC factors minus the methane emission factors; differences in values reported are due to rounding.
d No. 2 fuel oil is also called heating oil, which has low viscosity and an API of 34.
References


http://www.hse.gov.uk/msd/wbv.htm


http://dnr.mo.gov/pubs/pub545.pdf


