# Hot Mix Asphalt (HMA) Facilities

# Overview

- Introduction
- Emissions and Effects
- Process
- Control
- Permit Requirements
- Inspection Procedures

# Introduction

## Industry Background

- **Over 125 Hot Mix Asphalt (HMA) facilities in CA**
  - ✓ **Stationary**
  - ✓ **Some transportable**
- **HMA is combination of**
  - ✓ **Hot aggregate,**
  - ✓ **Hot liquid asphalt binder**
  - ✓ **Filler**

- **Recycled Hot Mix (RHM) is HMA with**
  - ✓ **Crumb rubber (rubberized asphalt concrete)**
  - ✓ **Reclaimed asphalt**

# Introduction

## Industry Background

- Two basic processes
  - ✓ Batch
  - ✓ Continuous mix
- Batch change recipe based on customers order
- Continuous mix one recipe at a time stored for up to 7 days in insulated silo

# Introduction

**<u>Permit Process Requirements</u>**

- District issues an
- "Authority to Construct"
- Inspection conducted
  - ✓ Usually includes a source test
- All conditions met "Permit to Operate" is issued

# Emissions and Effects

HMA facilities emit pollutants such as PM, CO, NOx, SOx, VOCs and other toxic substances

NOx and VOCs are Ozone ($O_3$) precursors each reacts with sunlight to form $O_3$

# Emissions/Effects

| Typical HMA Pollutants | Emissions (tons/yr) |
|---|---|
| PM (total for all size categories) | 1500 |
| PM10 | 700 |
| PM2.5 | 400 |
| CO | 800 |
| NOx | 450 |
| Total Organic Compounds | 200 |
| Reactive Organic Gas | 200 |
| SOx | 100 |
| VOCs | 200 |

# Emissions/Effects

## AB 2588 Emission Inventory

- Requires HMA facilities to submit an emission inventory
- HMA emit 78 of the 730 listed "Toxic  Substances"
- Emission Estimates
  - ✓US EPA, AP-42;
  - ✓District; or
  - ✓Source Test

# Emissions/Effects

**<u>Criteria and Precursor Pollutants</u>**

- Created during production, storage, and transport of HMA
- PM from aggregate

# Emissions/Effects

<u>Criteria and Precursor Pollutants (cont.)</u>

- **PM, CO, NOx, VOCs, and SOx from fuel combustion and storage of asphalt binder and HMA**
- **Blue Smoke (VOCs) from production and loading**

# Process/Control

## Hot Mix Facilities are Regulated Under Subpart OOO

- ✓ How much aggregate is processed
- ✓ Moisture content of the processed material
- ✓ Control efficiency of the air pollution control equipment
- ✓ Opacity

# The Process

# Process

## Composition of HMA

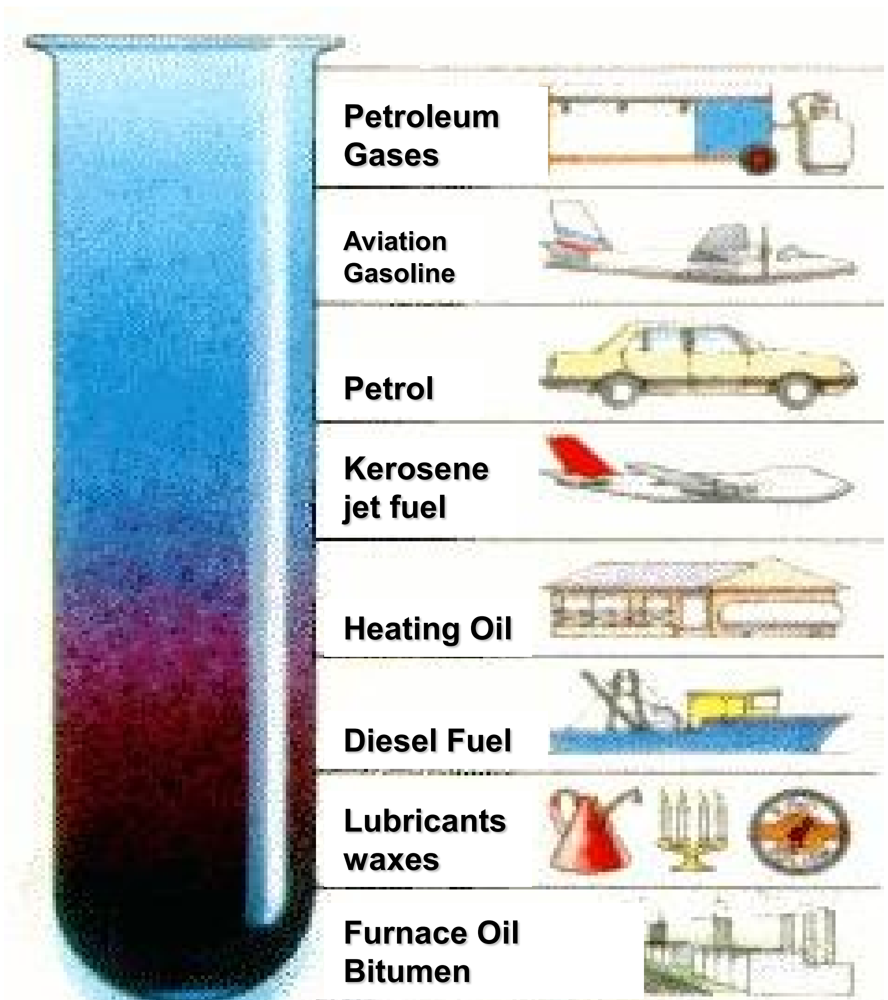
- Binder
- Filler
- Aggregate

# Process
# Binder Composition

## Binder Terms

- **Asphalt Binder**
  - ✓ Includes asphalt cement and any material added to modify properties
- **Bitumen**
  - ✓ Class of dark colored (solid, semi solid, or viscous)

# Process
# Binder Composition




**Crude Petroleum Distillation Fractions**

# Process
# Asphalt Grading

- Two grading methods
  - ✓Viscosity Grading of Binder
  - ✓Superpave Performance Grade (PG)

# Process

<u>Viscosity Grading of Binder</u>

- Viscosity test developed during the early part of the 20th century.
  - ✓ AC
    - Tests viscosity of binder to characterize viscosity as supplied (simulating condition before used)
  - ✓ AR
    - Tests viscosity of binder aged in a rolling thin-film oven (simulating HMA production)

# Process

## Viscosity Grading of Binder (cond.)

- PG (Superpave Performance Grade)
  - ✓Test developed in 1980-1990
  - ✓Based on performance of binder in relation to climate
  - ✓Temperature range is 115 to 180 F
  - ✓Address rutting, fatigue cracking, and thermal cracking

# Process

**Conventional HMA Binder**

- Solid at room temperature
- 250 and 325 F from point of origin to the final destination
- Softening binder adds VOCs by
  1. Adding softer grade asphalt
  2. Adding  lighter petroleum oils

# Process

**Typical Alternative Asphalt Binder**

- Reclaimed asphalt pavement (RAP)
- Used tires (crumb rubber)
- Proprietary polymers
- Anti-stripping agents (hydrated lime)
- Recycled baghouse dust

Figure 2.16: RAP in Aggregate-Sized Chunks

# Process

**Polymer Modified Binders**

- proprietary blends added to bitumen
- Formula varies depending on desired result of end product

# Process

## Filler

- Dust added to asphalt binder and aggregate to improve adhesion

# Process

## RECIPE FOR HOT MIX ASPHALT

# Process

**Hydrated Lime**

- Caltrans requires a lime-slurry-marination (LSM) where climate promotes stripping
- Requires that mixture be stockpiled for 24 hours before use "marinated"

# Process

## Hydrated Lime

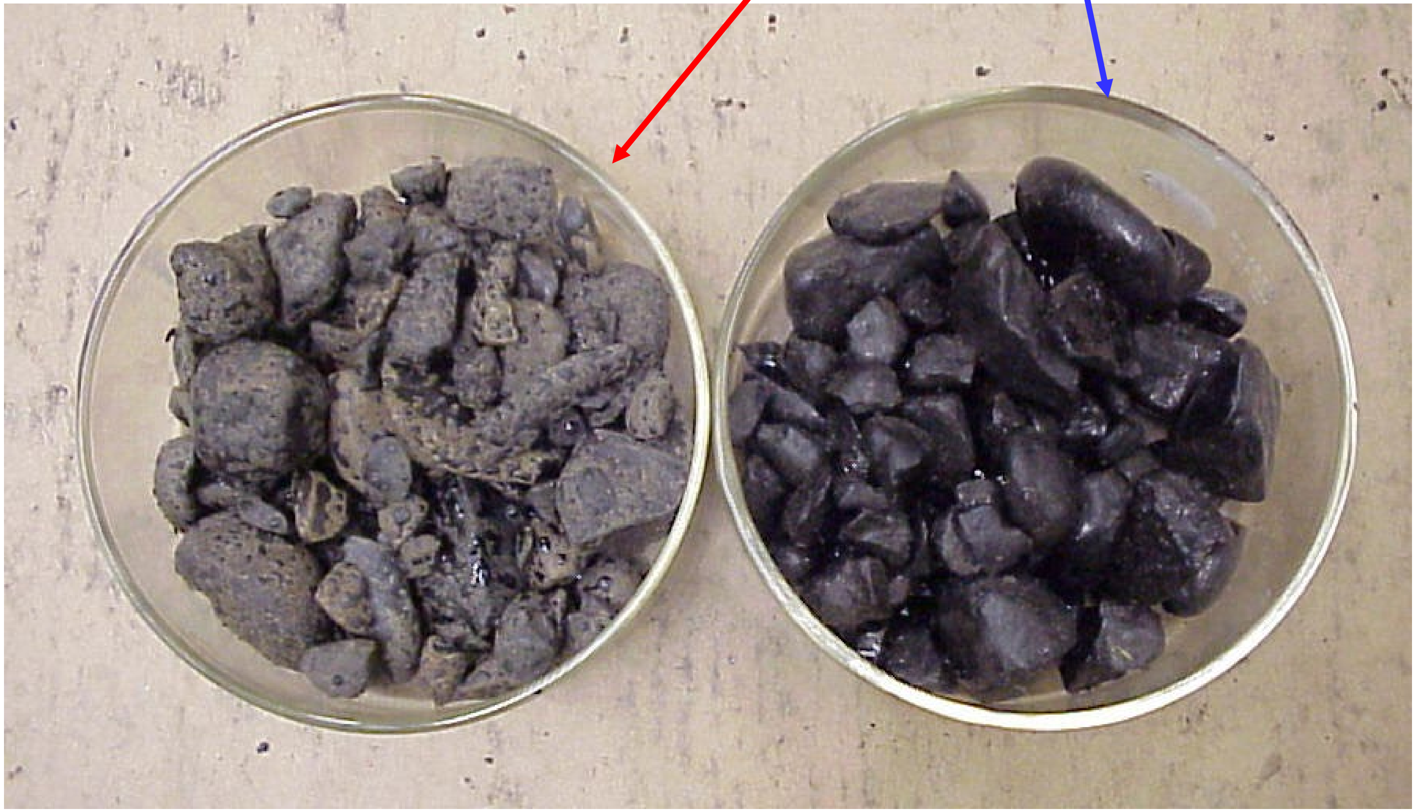
- Anti-stripping agent:

1. Added dry with binder
2. Added dry to wet or dry aggregate and "marinated" for several days
3. Added as lime slurry for immediate use or "marinated"

# Process

## <u>Anit-stripping Agents</u>

**Illustration of binder <u>with</u> anti-stripping agent and <u>without</u> anti-stripping**



# Process

<u>Alternative Binders</u>

- Kept at temperatures higher than conventional binder
- Two types
  1. Polymer-modified asphalt cement
  2. Crumb rubber modified

# Process

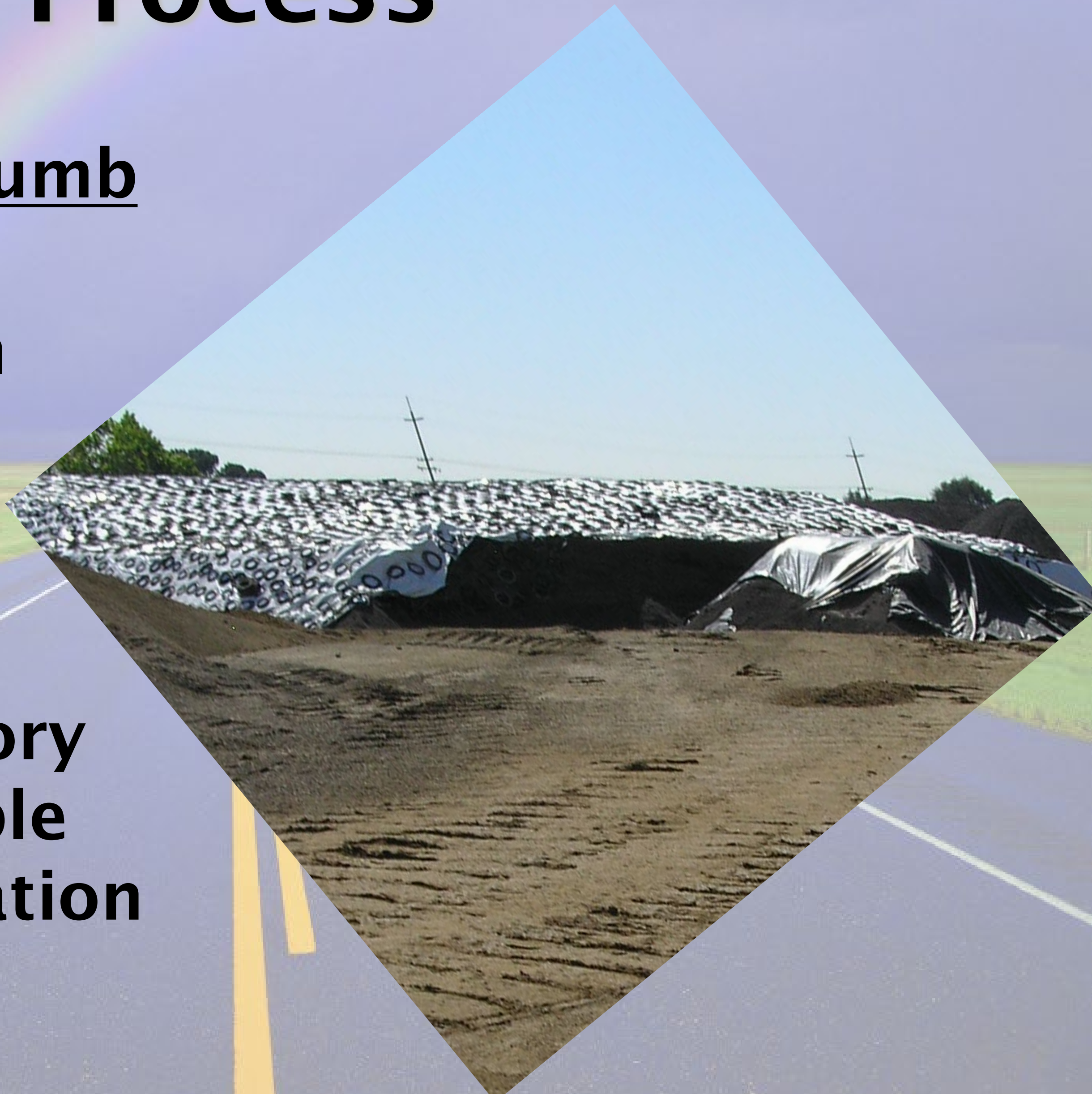
## Crumb Rubber

- Added to binder to make crumb rubber modified (CRM)
- 75% scrap tire and 25% virgin rubber
- Non-hazardous hydrocarbon polymer
- Rubber-modified asphalt concrete (RAC)

# Process

**Advantages of Crumb Rubber**

- Waste reduction
- Less water
- Quiet
- Lasts Longer
- BUT No regulatory relief from visible emission evaluation (VEE)



# Process

RECIPE FOR RAC

# Process
# Reclaimed Asphalt Pavement

- RAP is
  - ✓ Top layer of asphalt pavement removed
- Developed because of energy, economic, and environmental concerns
- RAP could be 30% of mix
- Increases asphalt lifetime
- May increase generation of Blue Smoke

# Process RAP

- Production temp of virgin aggregate is 500-800 F
- RAP is heated through conductive heat transfer
- RHM is 350 F

# Process

## RECIPE FOR RECYCLED HOT MIX

# Process
# In the News

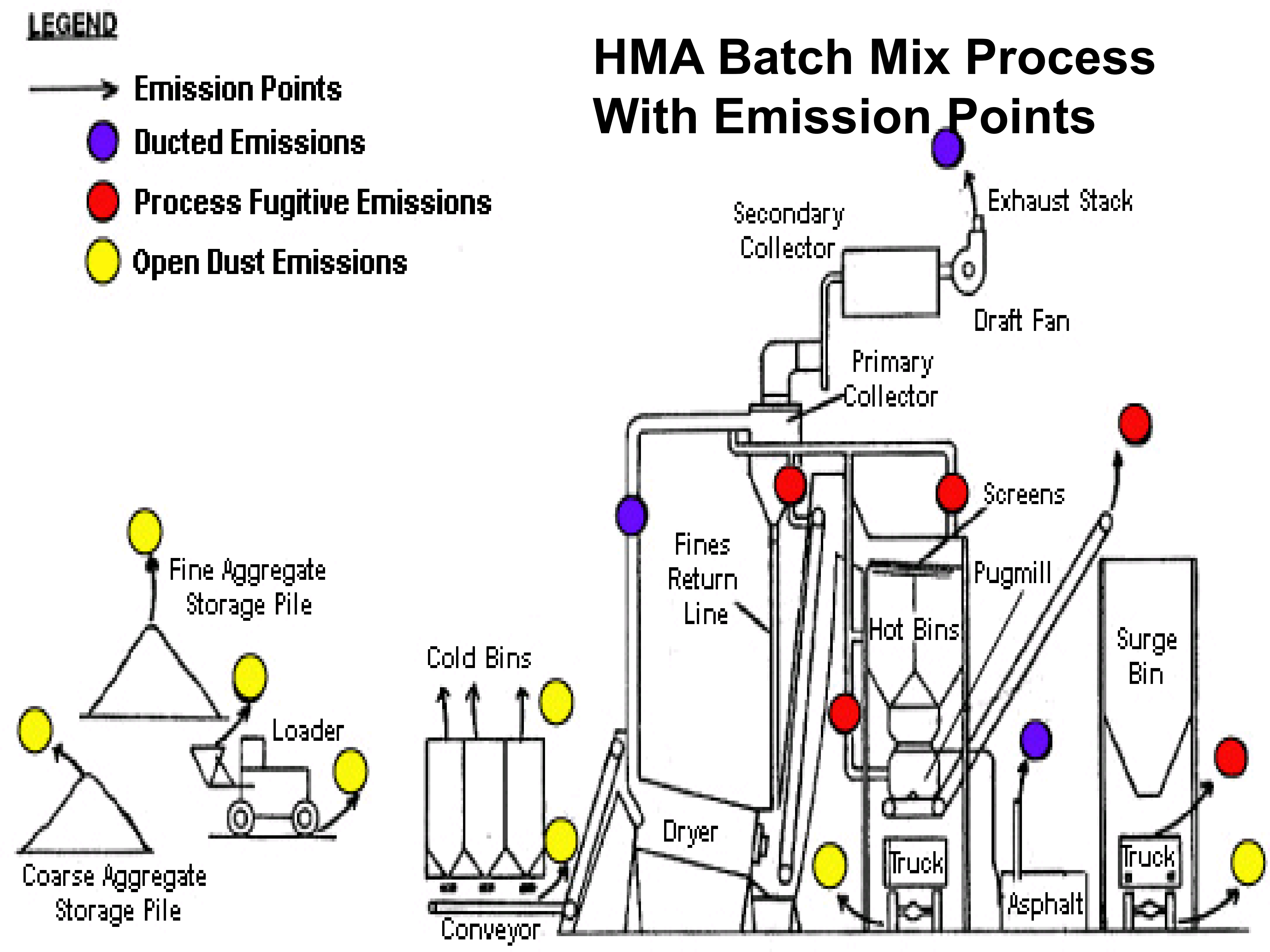
- Watch for
  - ✓ Warm mix asphalt
- Advantages
  - ✓ Lower Production temp. 220 to 275 F
  - ✓ Less energy
  - ✓ Reduced cracking
- Disadvantages
  - ✓ Further testing to ensure QA/QC
  - ✓ Rutting
  - ✓ Workability
  - ✓ Longer setting=traffic delays

# Process
# HMA Facility Types

- Batch
- Continuous Mix

# Process
# Batch Mix

# HMA Batch Mix Process With Emission Points



# Process
# Batch Facility

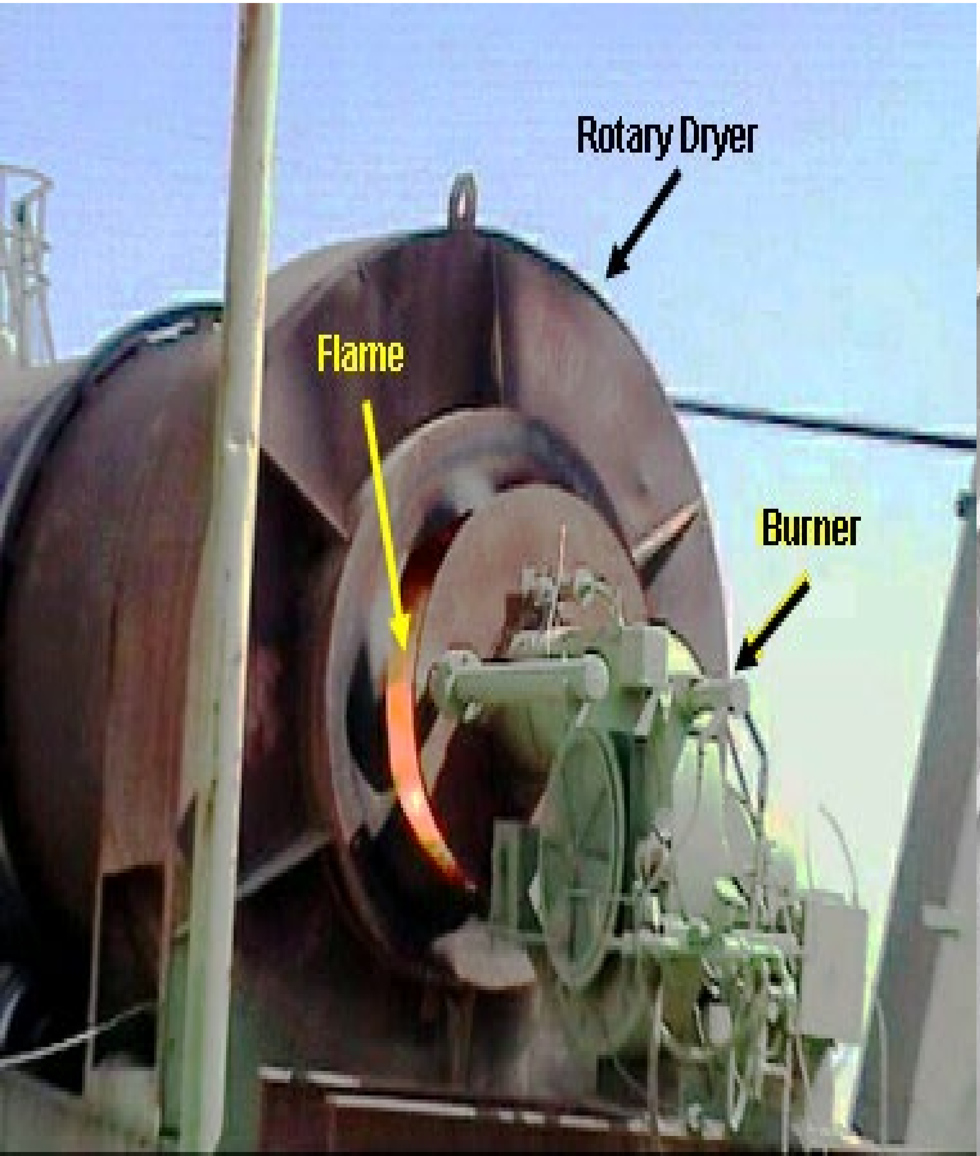
- Aggregate
  - ✓ Stored in cold bins
  - ✓ Moved by conveyor
  - ✓ Sorted and weighted
  - ✓ Dropped into dryer
  - ✓ Elevated to top of batch tower and
  - ✓ Separated

# Process
# Cold Bins
# Aggregate Stockpiles

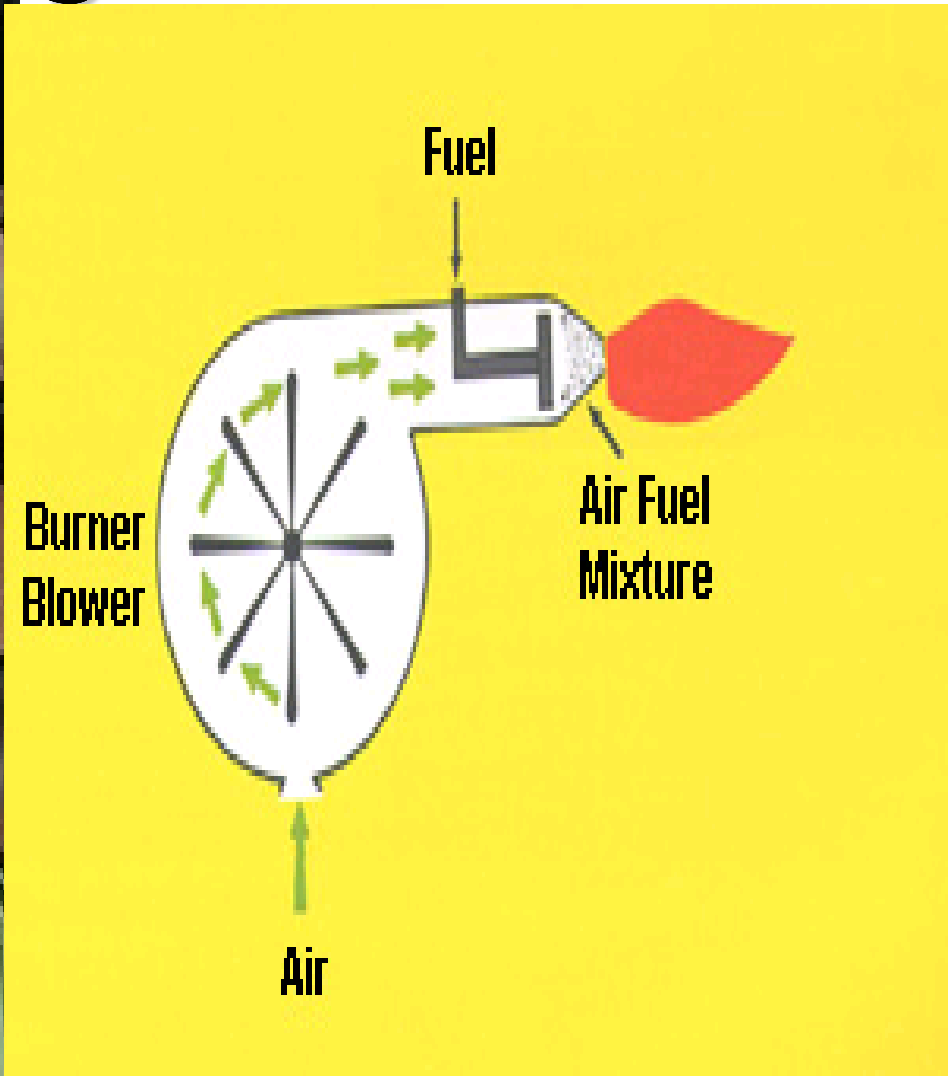
# Process
# Cold Bins and Conveyors

# Batch Process
# Aggregate Dryer

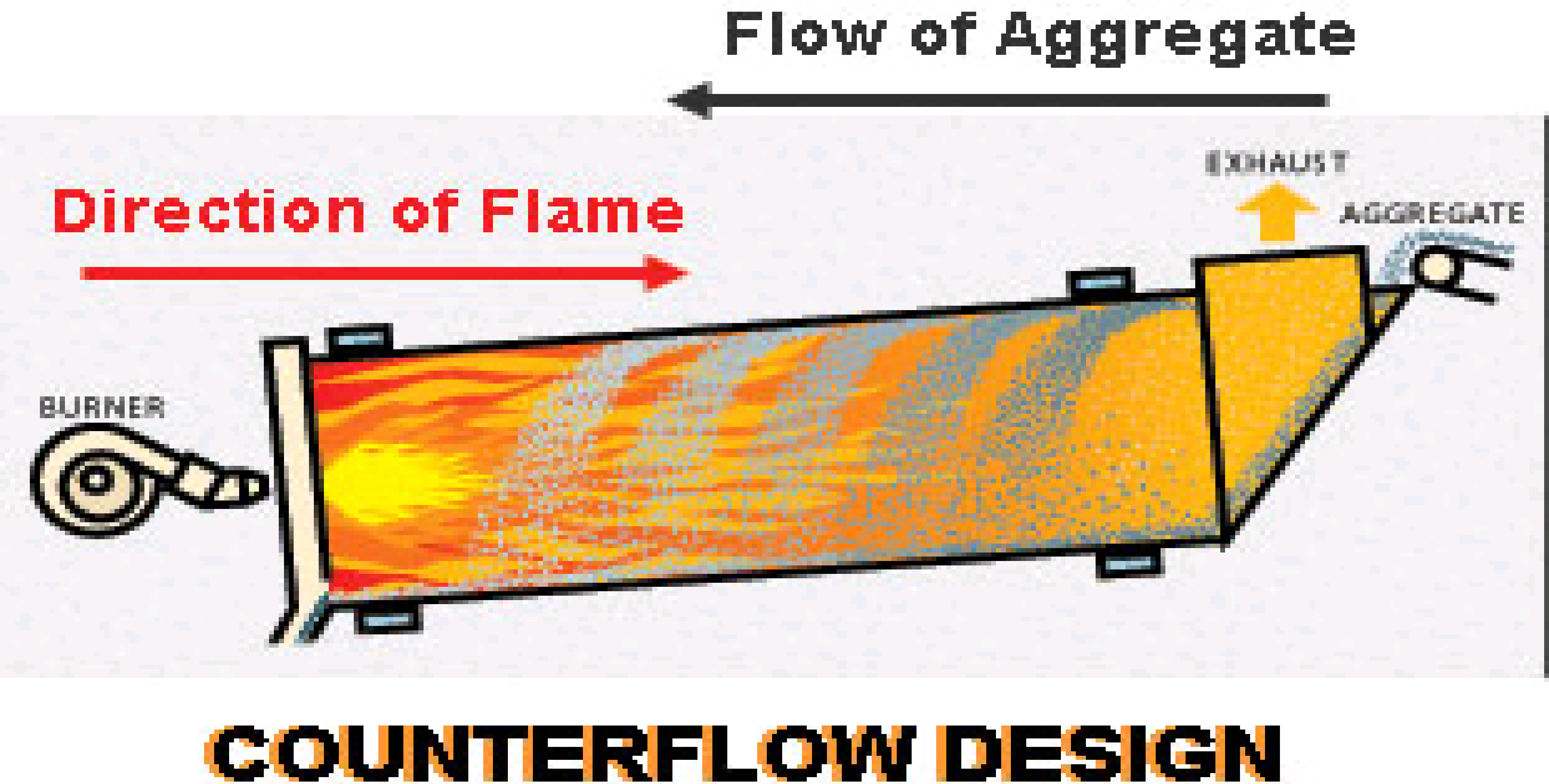
# Batch Process
# Rotary Dryer




# Process
# Combustion and Basic Burner Design

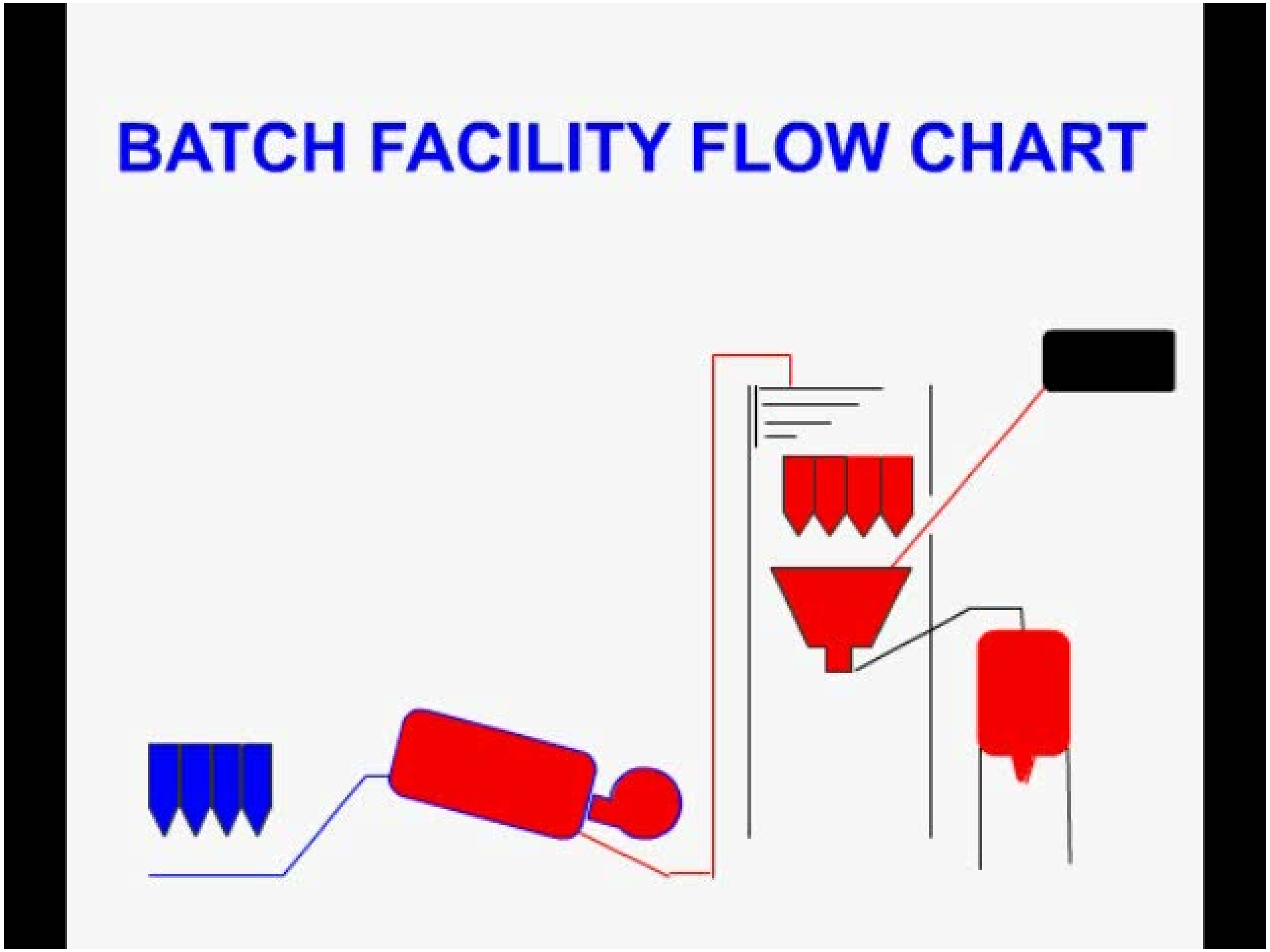
# Batch Process
# Rotary Dryer Counterflow Design



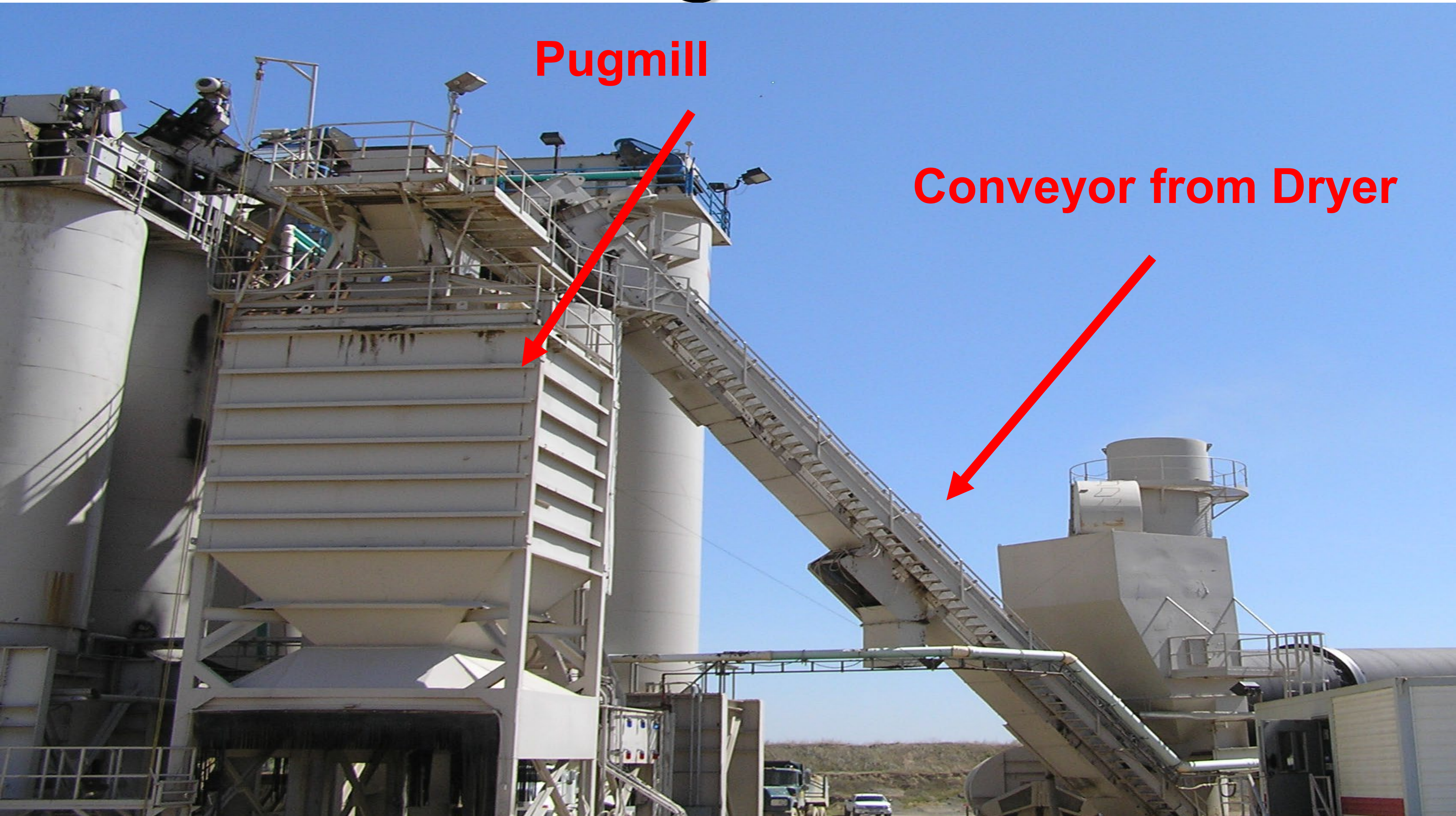
# Batch Process
## (continued)

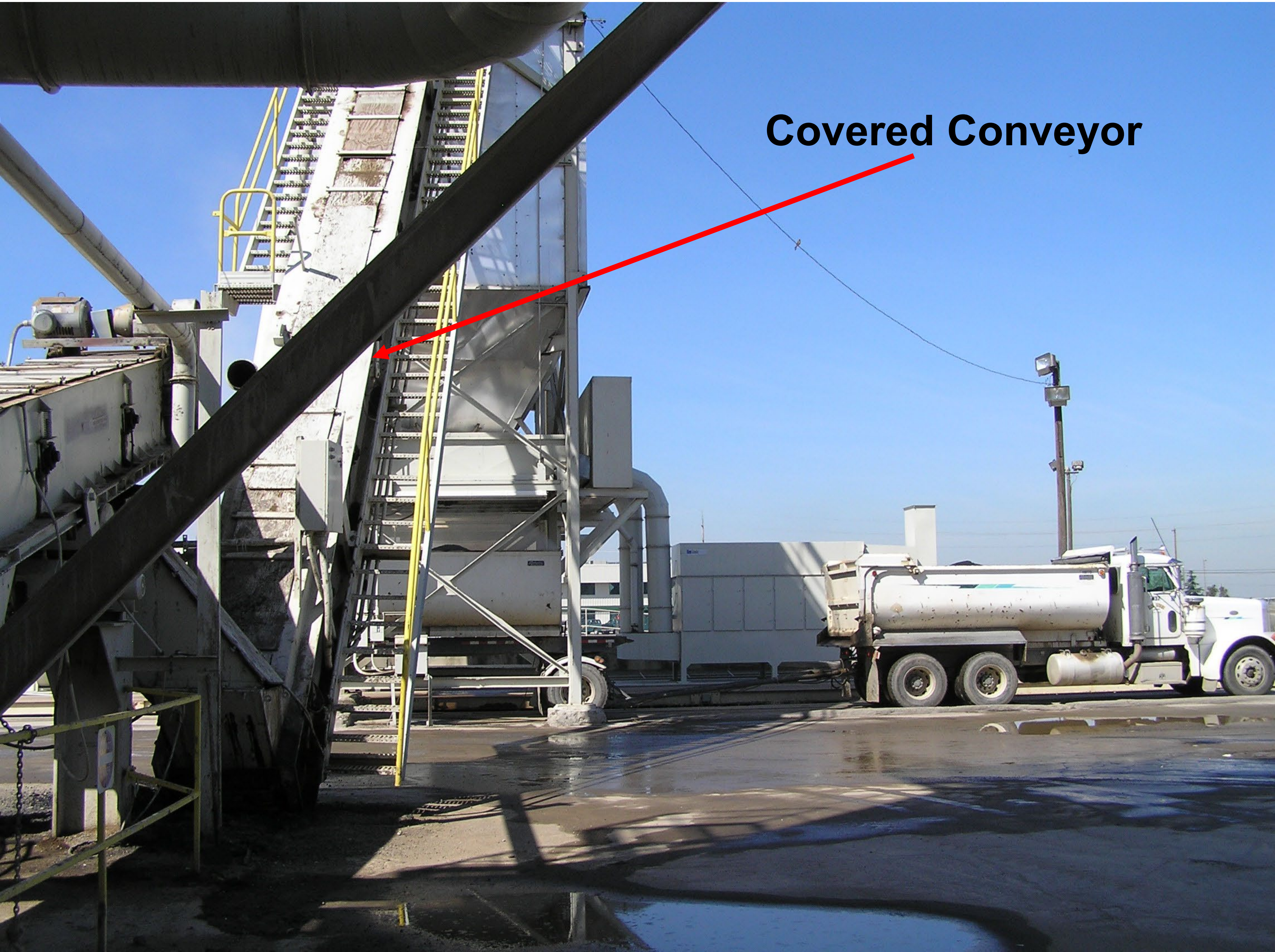
- Hot aggregate dropped from elevator to vibrating screens, sorted by size
- Weighed, and dropped into pugmill for mixing with
- Hot liquid asphalt binder and filler until coated
- Dropped into truck for delivery

# Process



# Batch Process
# Hot Aggregate Conveyor to Pugmill




Covered Conveyor

# Batch Process
# View of Pugmills


D.H. WINN


3
2
HOT PLANT
CB
CHANNEL 20
1
DRIVERS
DO NOT WEAR
OILY GLOVES
WHEN
CLIMBING LADDERS
TURNING VALVES
STARTING PUMPS

# Batch Mix Process without Pugmill

- Newer design
- All ingredients are mixed together in the drum and sent to silos
- Better controls

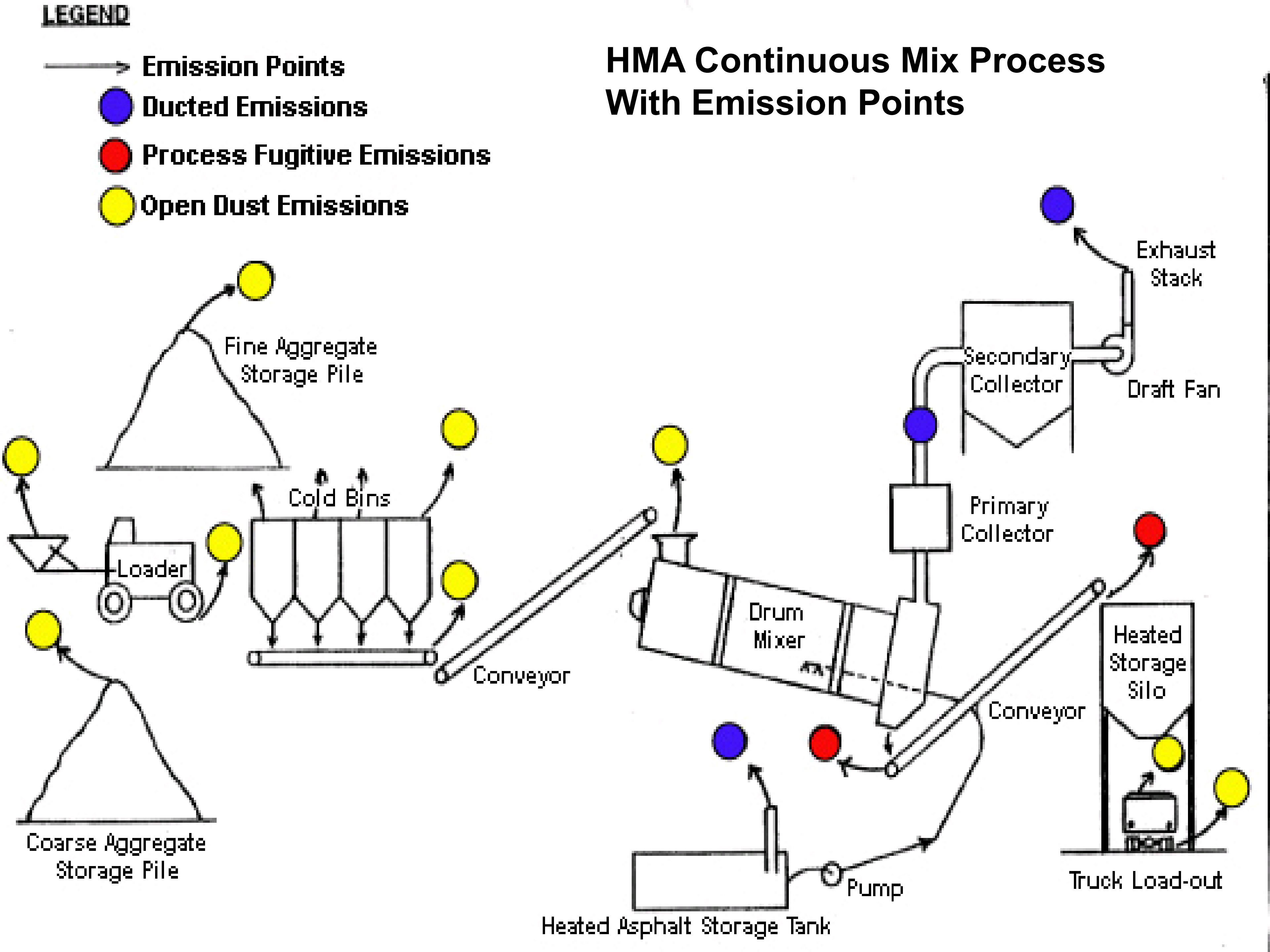
# Batch Process Rotary Dryer/Mixer Combined

# View of Batch Operated Double Drum Mixer Down for Maintenance

# Inside View of Double Drum Mixer

# Continuous Mix Process

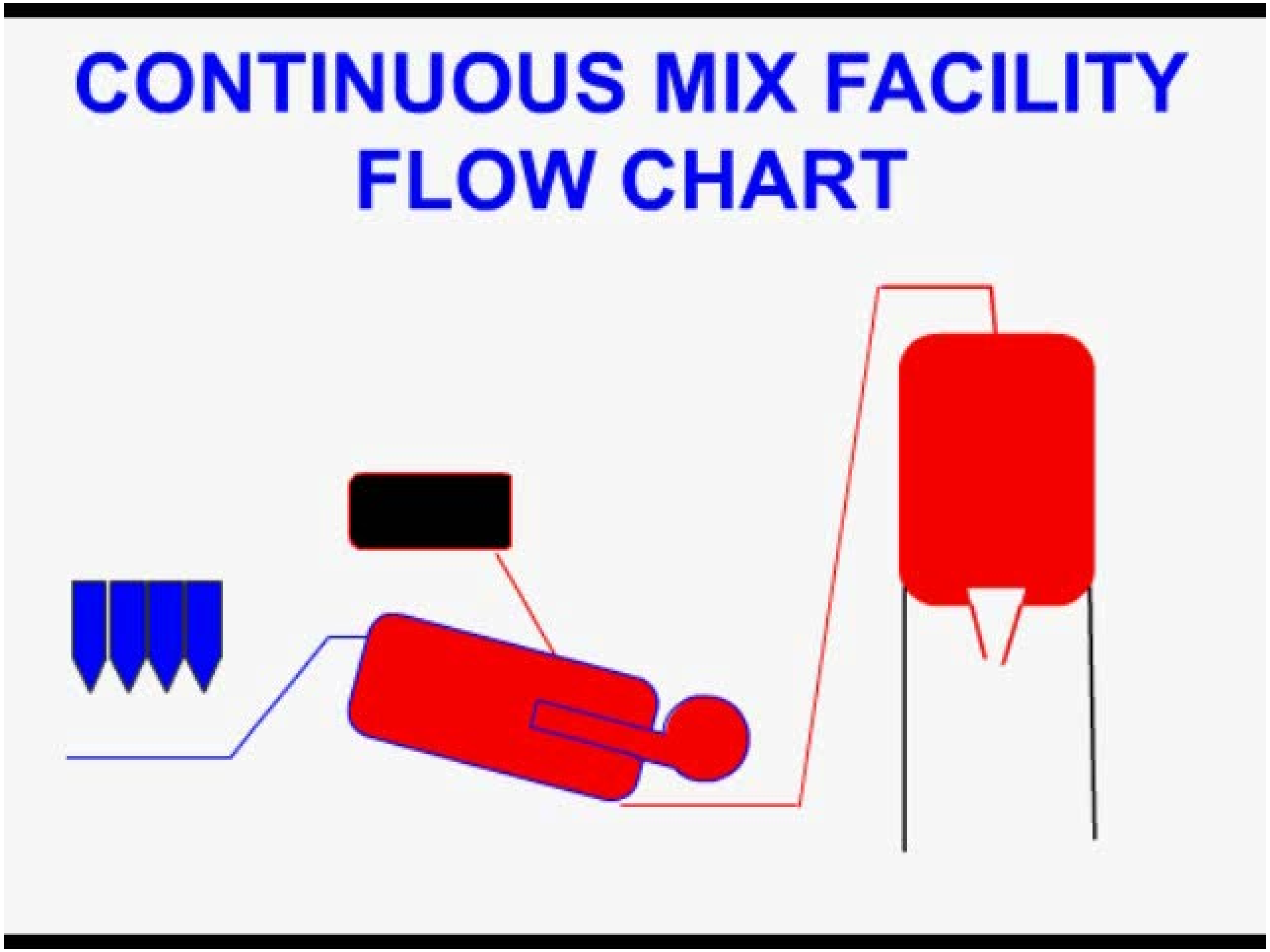
# HMA Continuous Mix Process With Emission Points



# Process
# Continuous Mix Facility Characteristics

1. HMA is continuously produced
2. No batch towers to segregate hot aggregate
3. Insulated heated storage silos are used  instead of surge bins to store HMA
4. Production is horizontal verses vertical

# Process

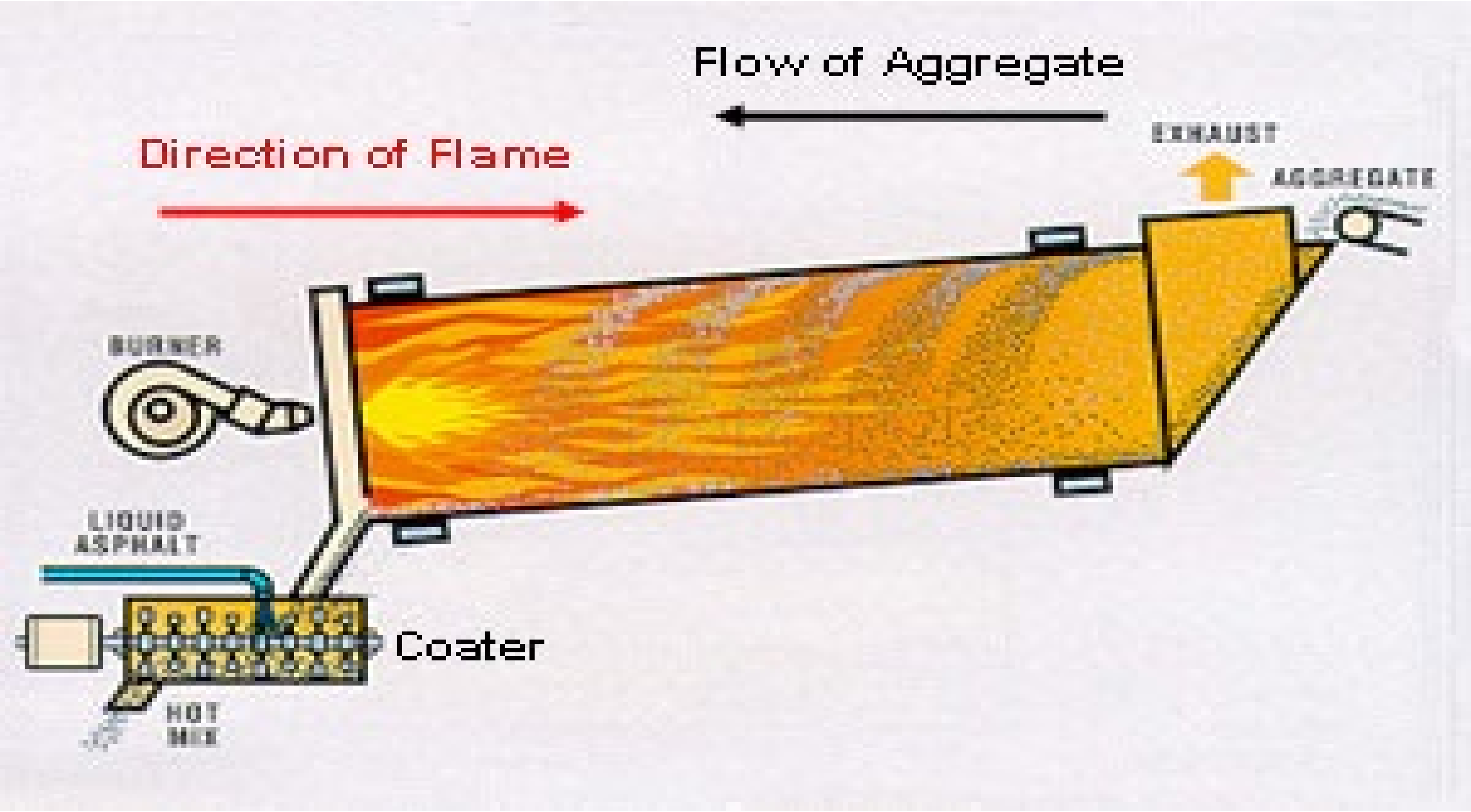


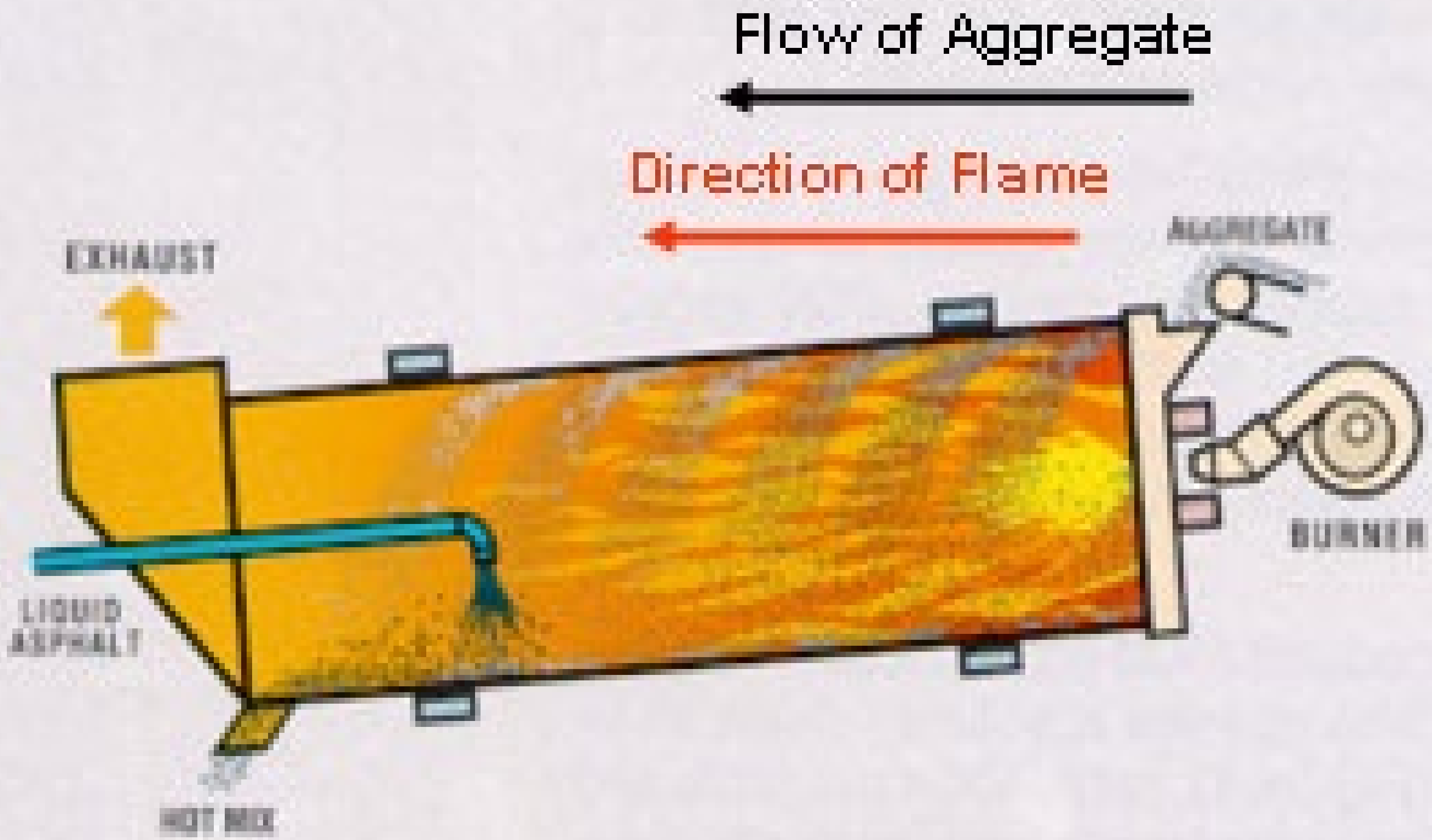
# Process
# HMA Drum Design

# Process
# Drum Design

- 4 general designs
  - ✓ Counter Flow Dryer Coater
  - ✓ Parallel Flow Drum Mixer
  - ✓ Double Barrel Drum Mixer
  - ✓ Triple-Drum™ Mixer
- Drum mixers two zones:
  - ✓ primary for aggregate drying and heating
  - ✓ secondary for mixing heated aggregate with binder and filler

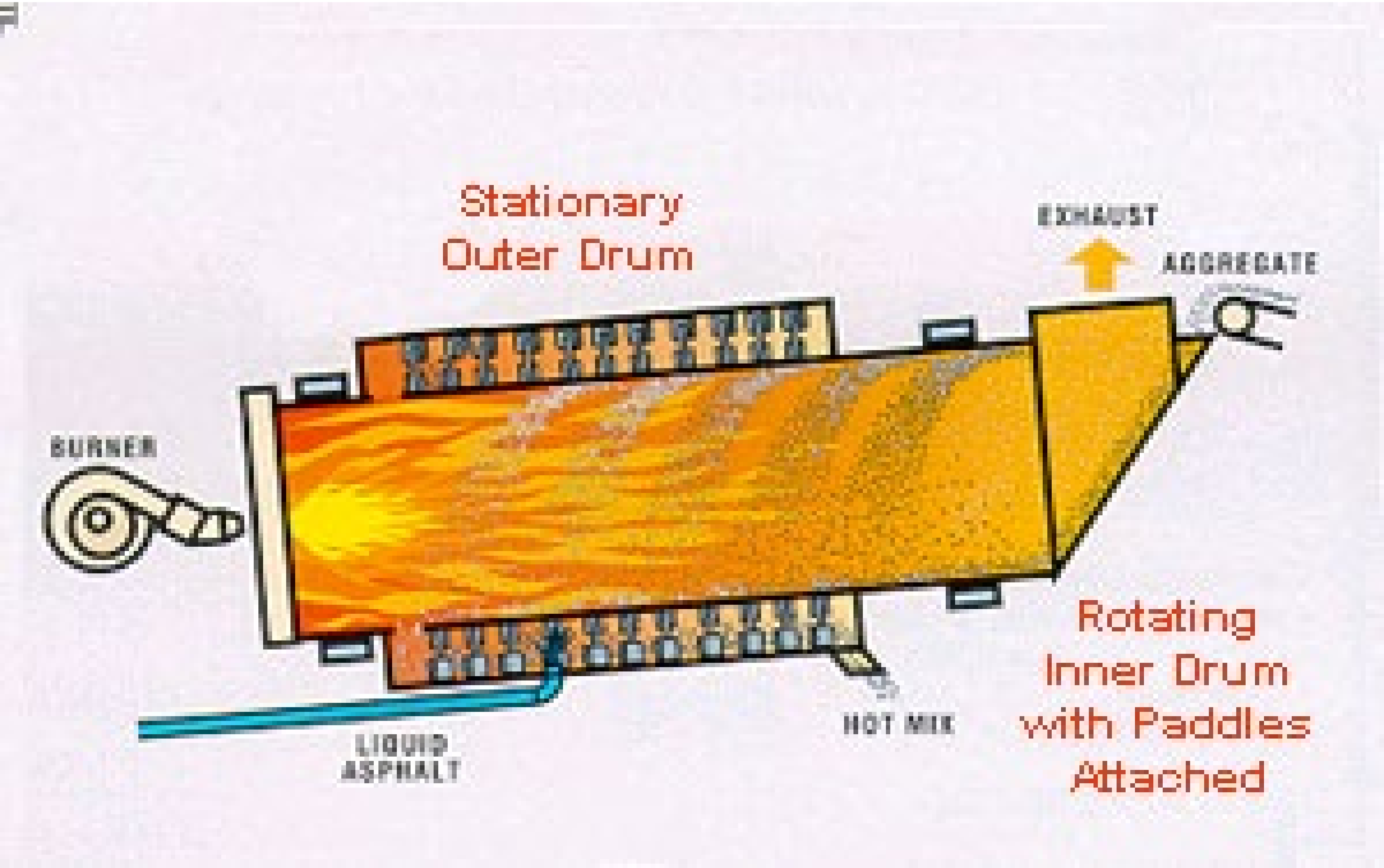
# Counter Flow Dryer and Coater

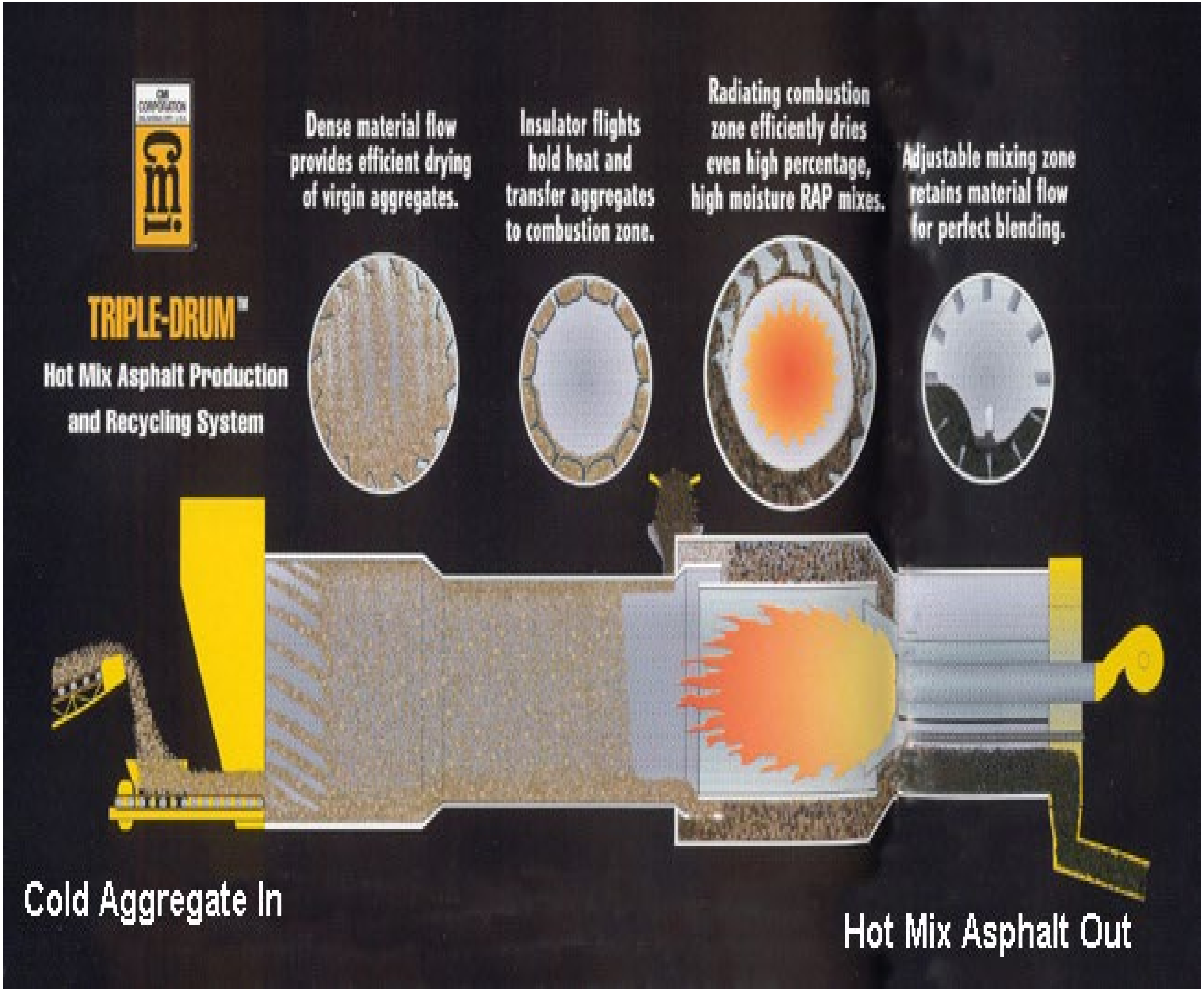





**PARALLEL FLOW DESIGN**

# Double Barrel Drum Mixer





TRIPLE-DRUM™
Hot Mix Asphalt Production and Recycling System
Dense material flow provides efficient drying of virgin aggregates.
Insulator flights hold heat and transfer aggregates to combustion zone.
Radiating combustion zone efficiently dries even high percentage, high moisture RAP mixes.
Adjustable mixing zone retains material flow for perfect blending.
Cold Aggregate In
Hot Mix Asphalt Out

# Triple-Drum

# Process Asphalt Binder Storage

# Underground Asphalt Storage Tanks

# Emission Controls

# Control Aggregate


- Wind-blown dust
- Fugitive dust
- Common Control methods

# Process
# Cold Bin Dust Collection System



DANGER
Keep hands clear of moving machinery

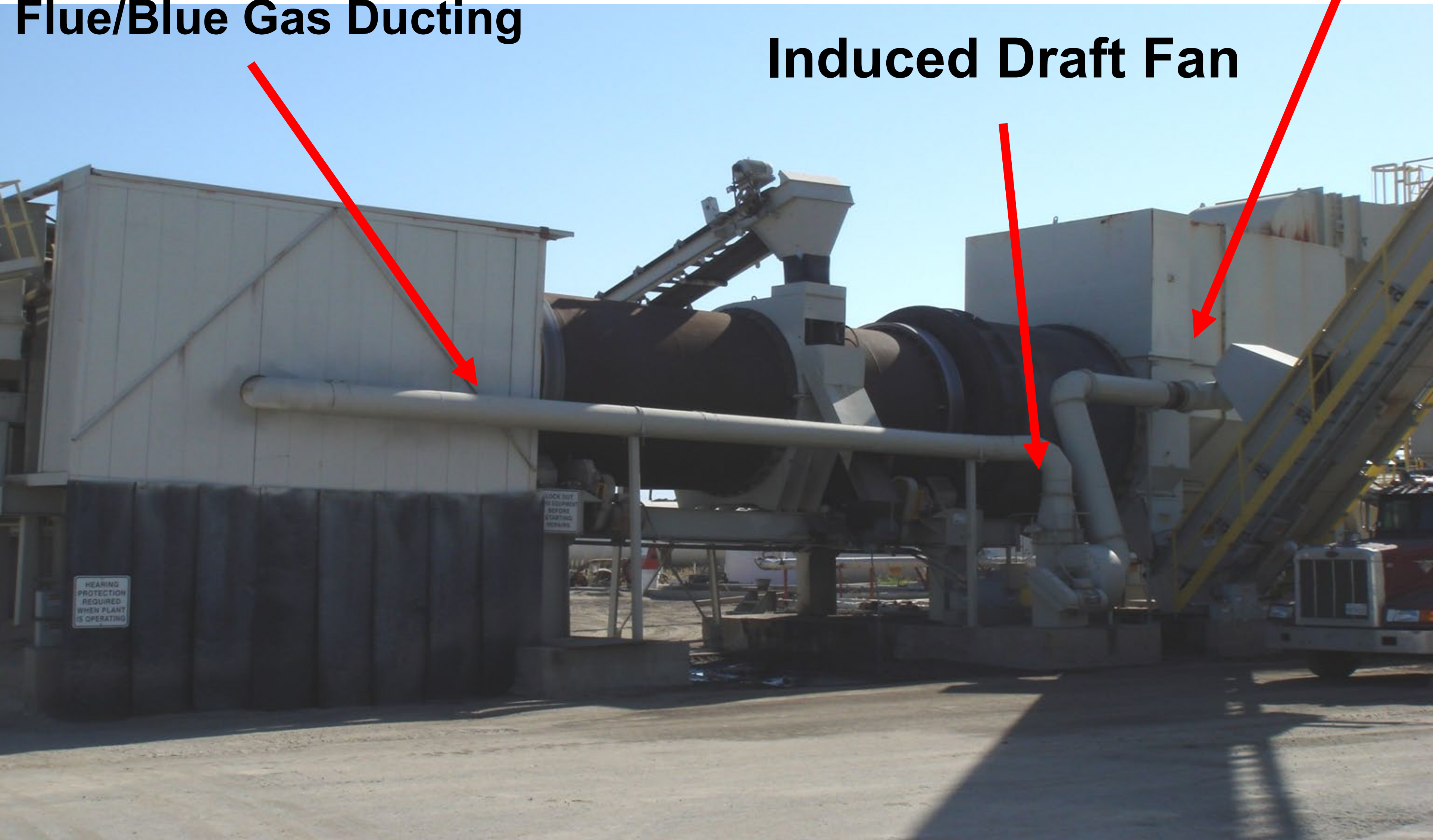

Keep hands clear of moving machinery
CAUTION
Louisville


Dust Suppression?

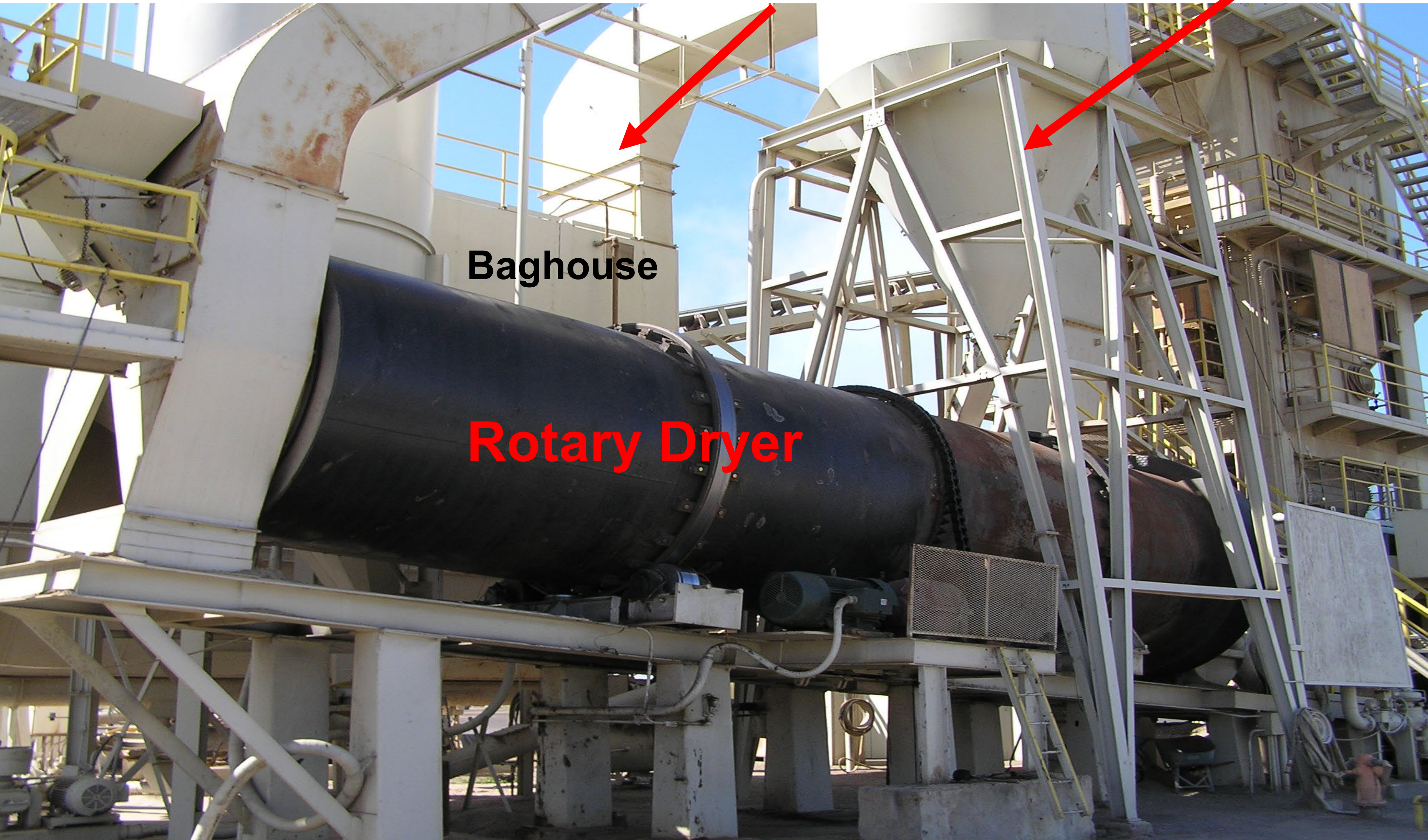
# Emission Control
# Hot Aggregate Handling

# Emission Control
# Hot Aggregate Handling

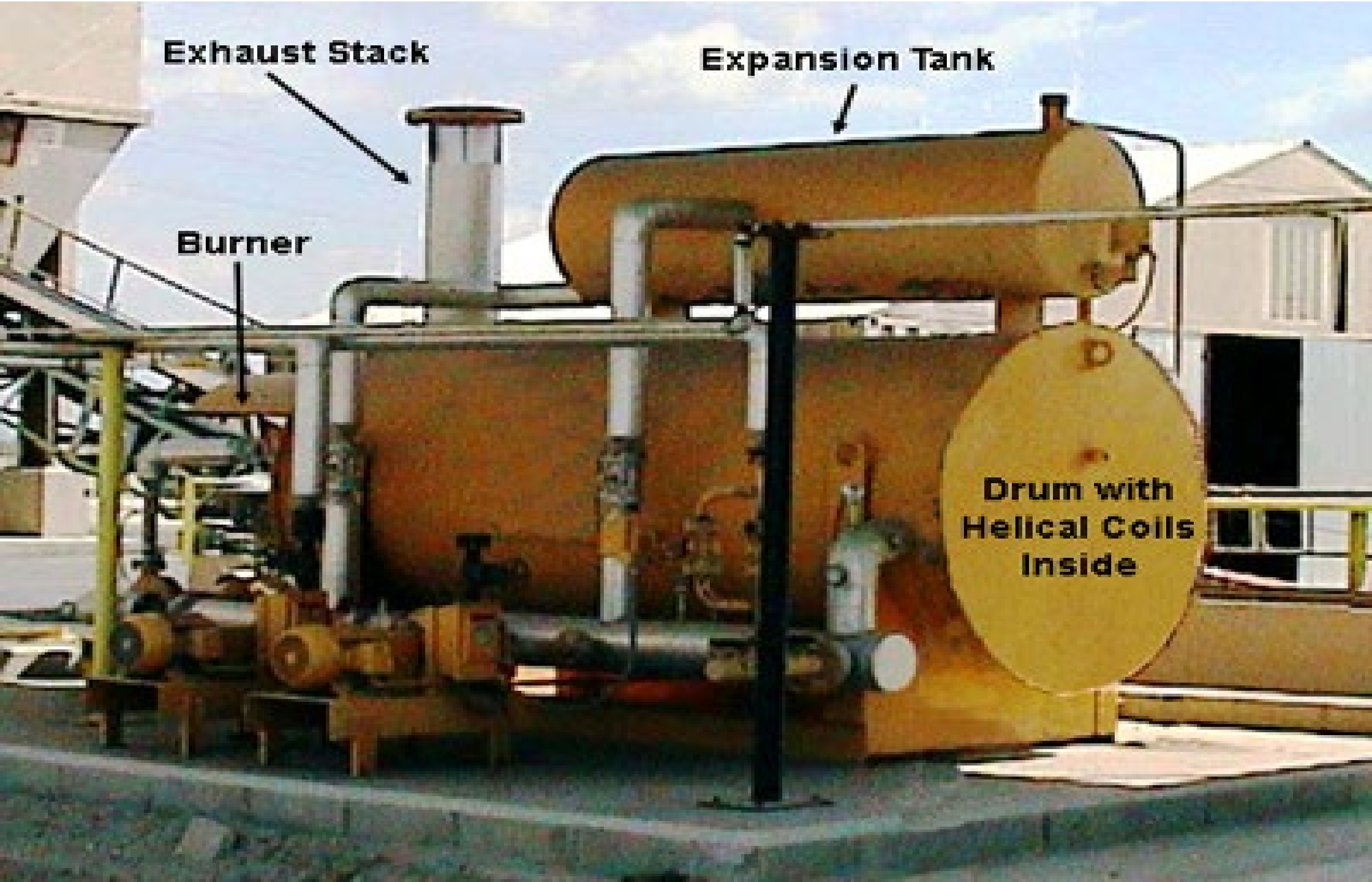
# Emission Control Flue Gas Recirculation



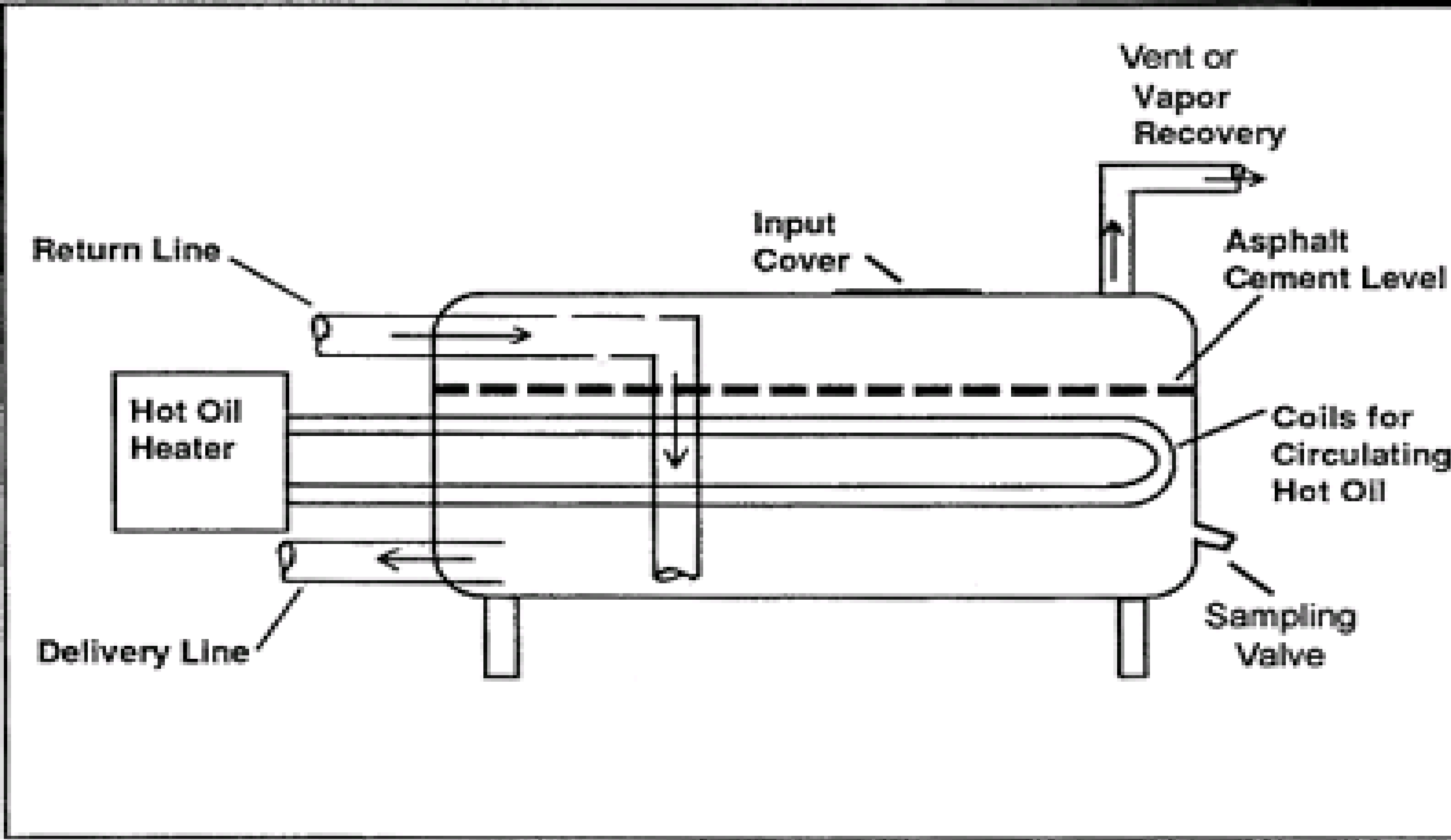
# Emission Control



# Small Binder Storage Tank



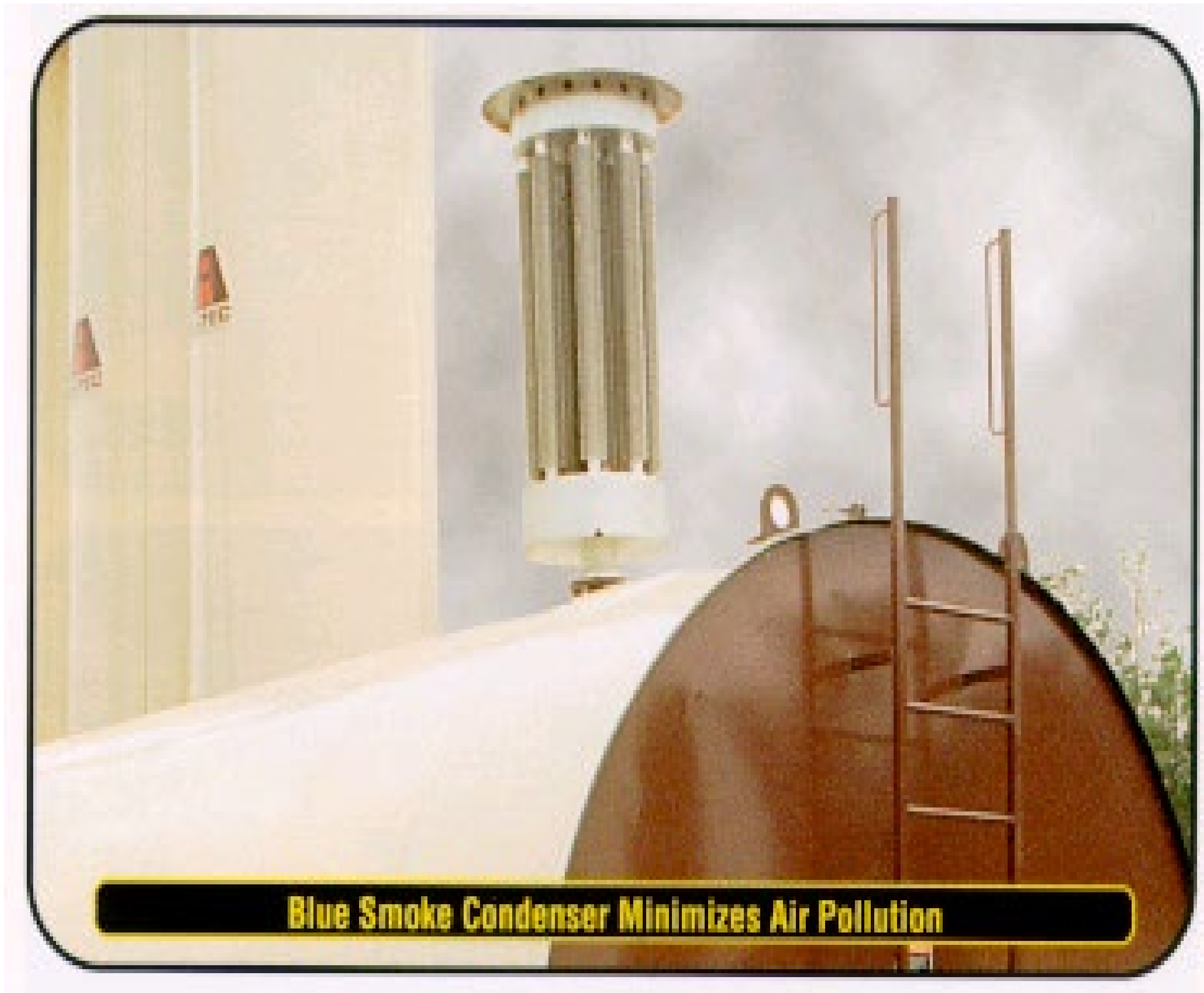
# Hot Oil Heater Coils



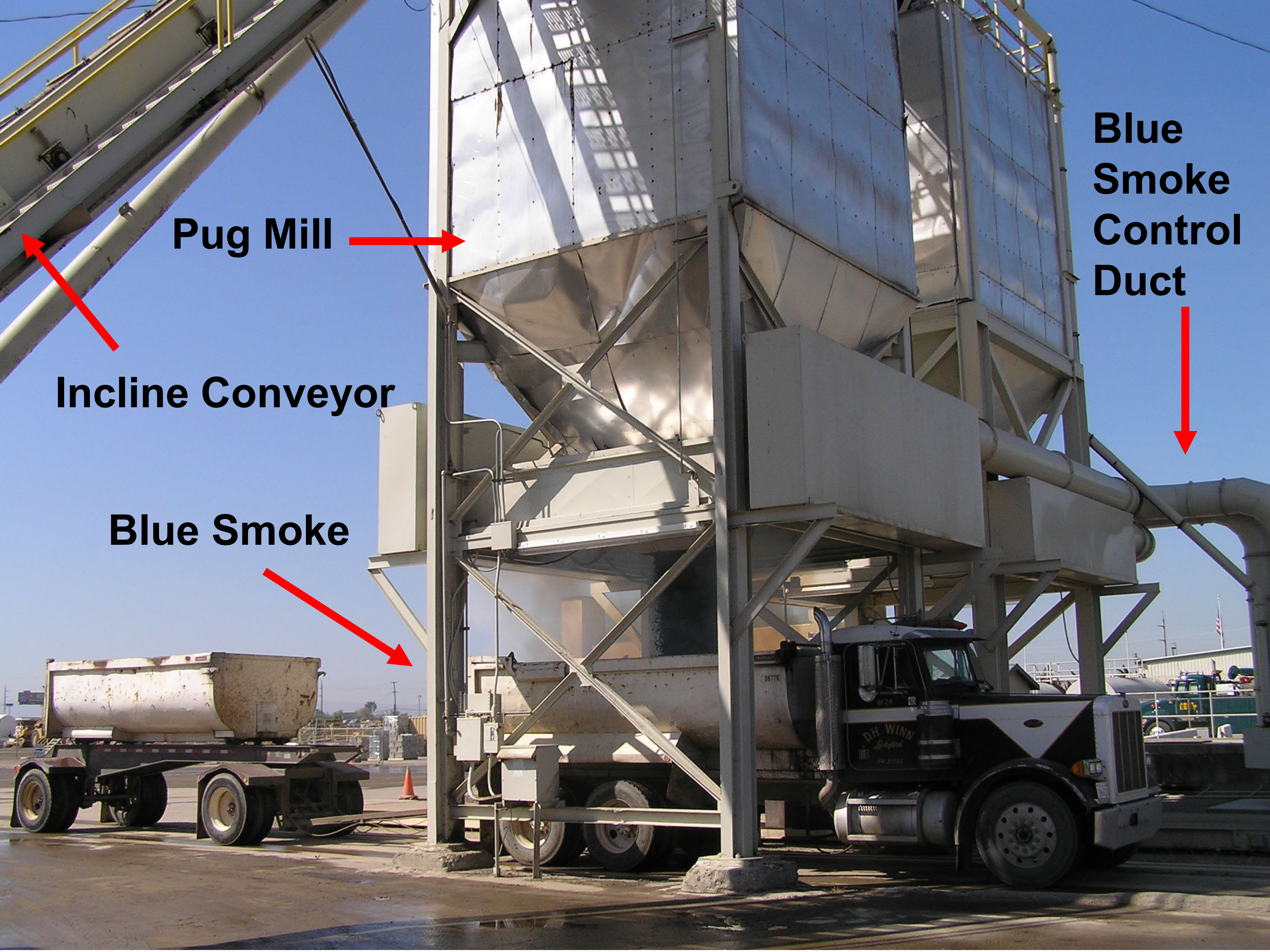
# Process Underground Storage Tanks


Uncontrolled RAC
Binder Storage Tank

# Controlled Binder Storage Tank Vent Condenser



# Dust Silo


Pug Mill
Incline Conveyor
Blue Smoke
Blue Smoke Control Duct
DH WINN

# Control
# Draft Air

# Control
# Draft Air

- Draft air passes through ducting due to pressure differential
- Draft air affects

1. Combustion efficiency
2. How a system develops leaks
3. Control effectiveness

# Control
# Types of Draft Air

- 4 Type

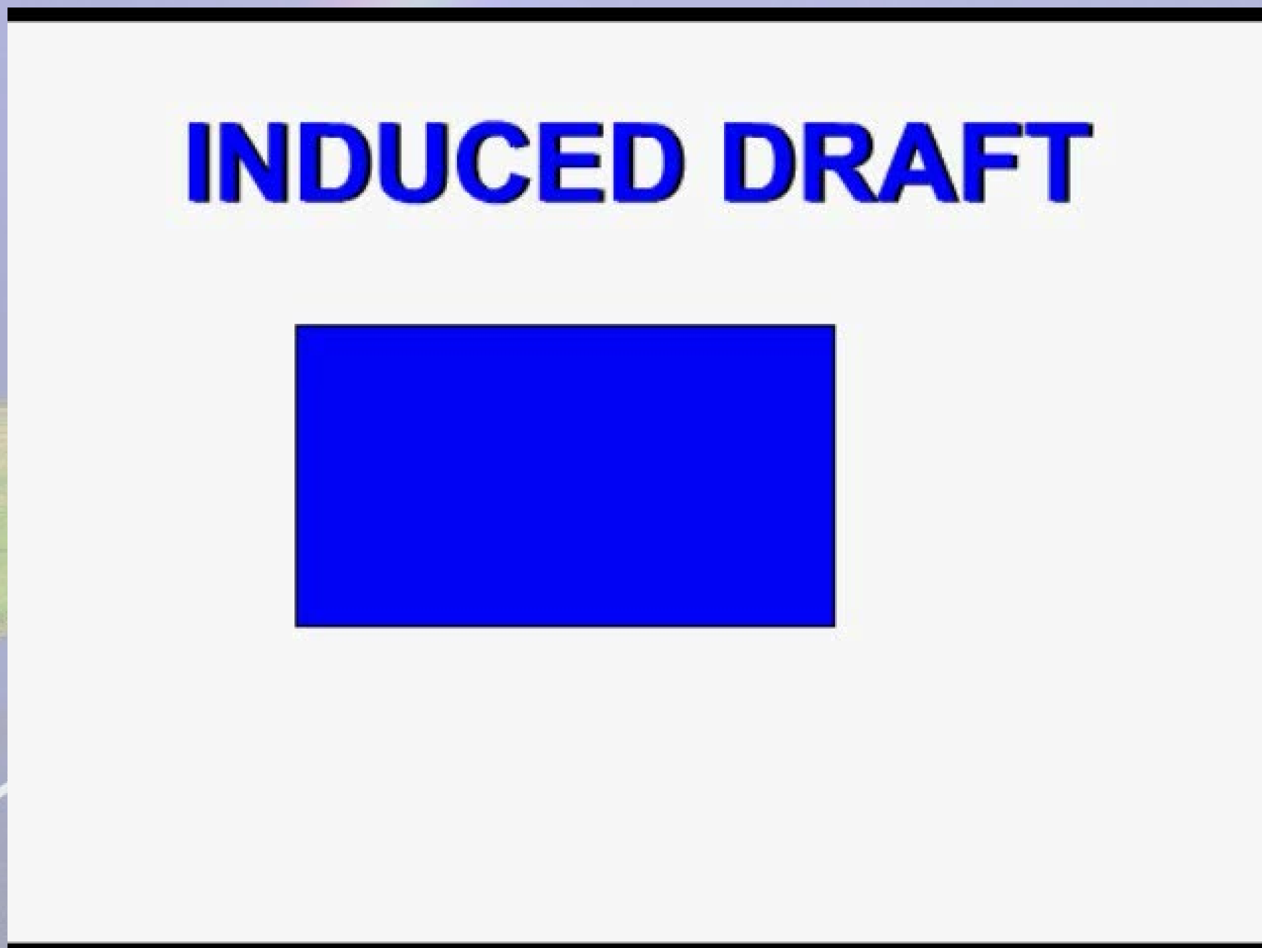
1. Forced Draft Air
   - ✓ Air that is pushed resulting in positive pressure
2. Induced Draft
   - ✓ Air is pulled by a fan resulting in negative pressure

# Control
# Draft Air Cont.

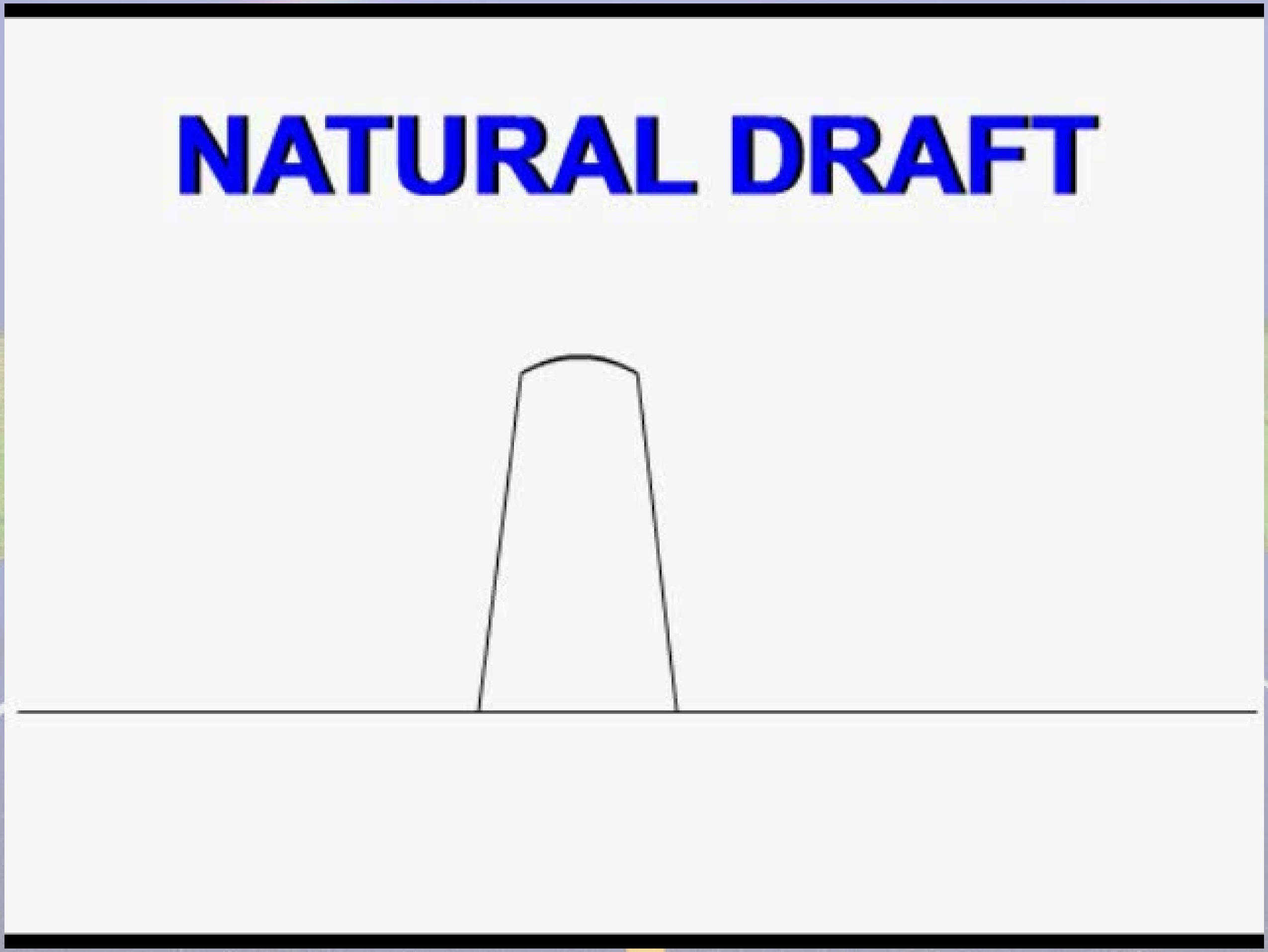
3. Natural Draft Air
   - ✓ Difference in temp between flue gases and the ambient air.
4. Balanced Draft
   - ✓ Forced draft fan pushes combustion air into combustion chamber.

# Control

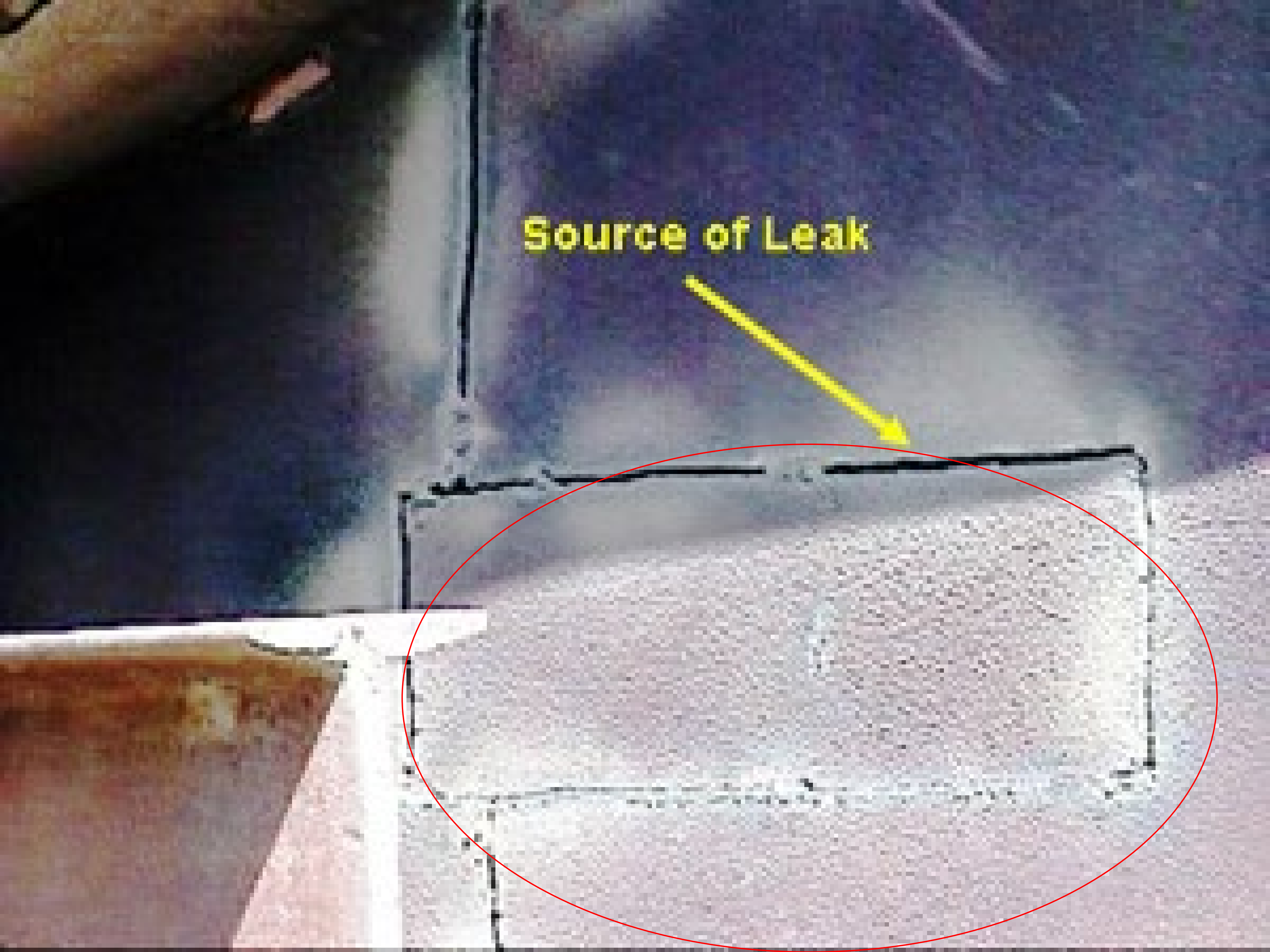
# Control



# Control



# Leak in a Rotary Dryer

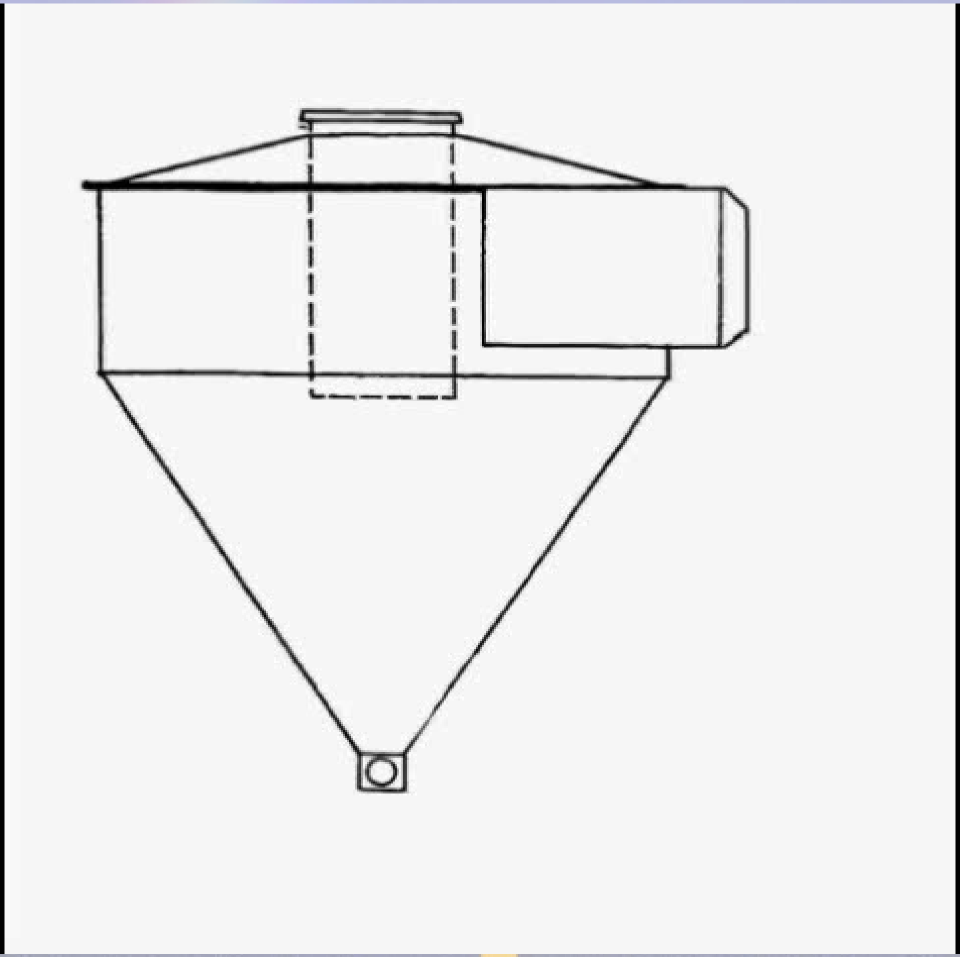

Source of Leak

# Control
# Drum/Dryer Emission

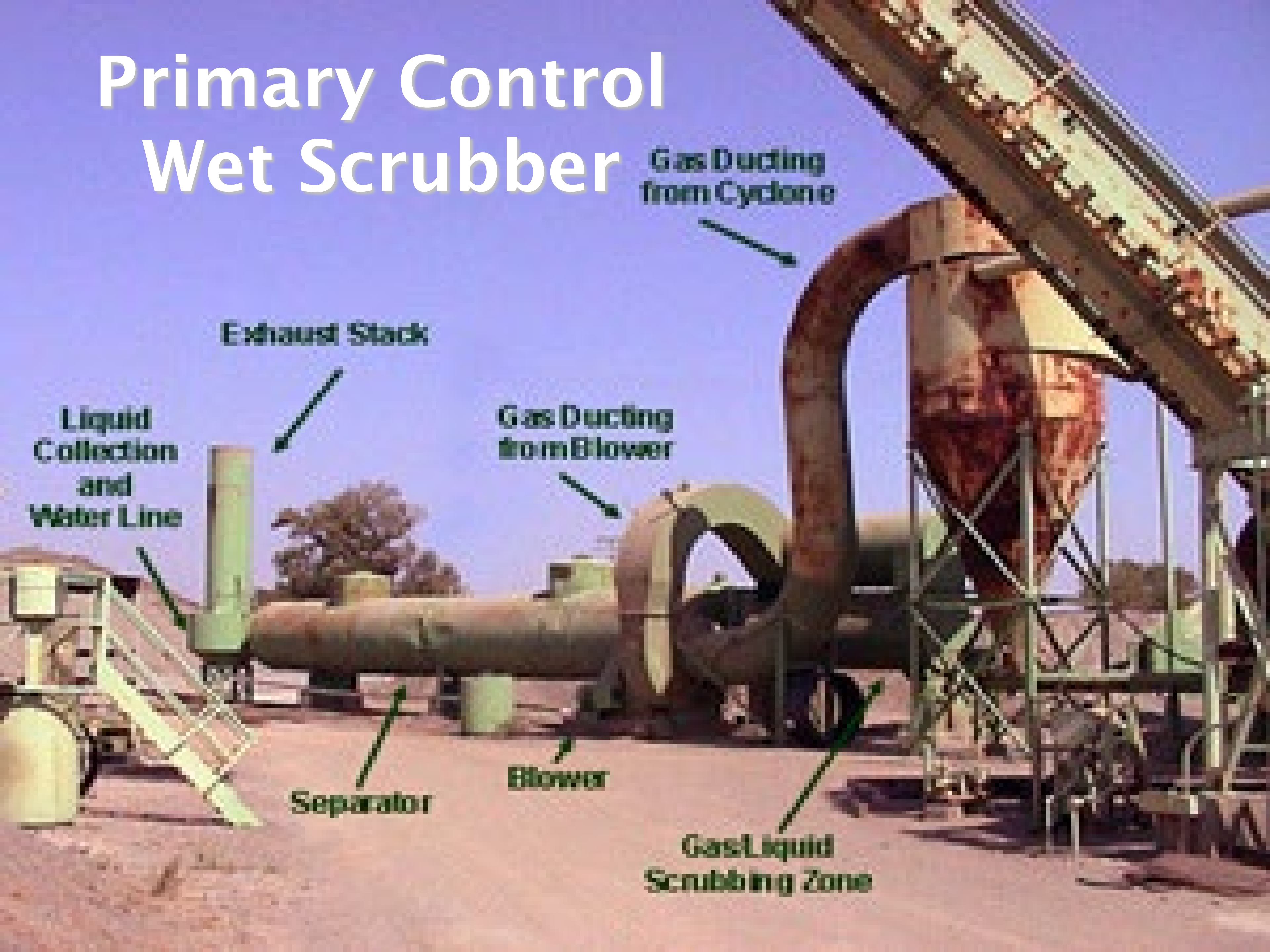
- **Drum/Dryer produce large amounts of PM**
- **Two control devices**
  - ✓ **Primary for large particles and**
  - ✓ **Secondary for small particles**
- **Combined efficiency is 99% or greater**
- **Ask for manufacturer or facility guarantee**

# Primary Controls
# Cyclone

# Primary Control Cyclone



# Primary Control Wet Scrubber



# Wet Scrubber?

# Process/Control
# Wet Scrubber

- Used to control stack emissions
  - ✓ Must meet the emission requirements specified in Subpart OOO
  - ✓ Continuous emissions pressure monitor
    - $\pm$ 250 pascals $\pm$ 1inch water gauge pressure
  - ✓ Continuous measurement of scrubbing liquid flow rate to scrubber

# Control Techniques
# Wet Scrubber

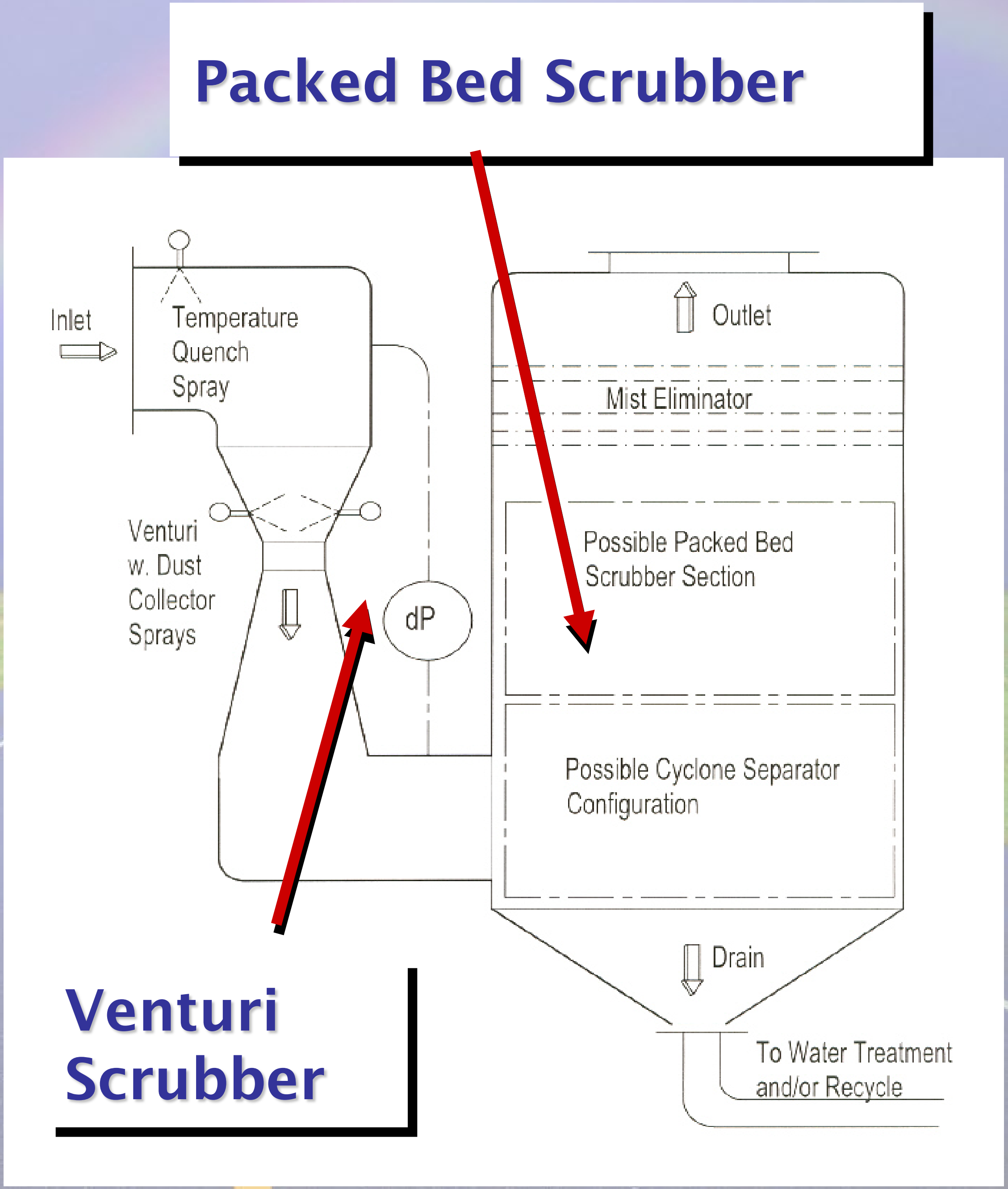
- General description
  - ✓Particles get trapped in liquids
    - Inertial impaction and diffusion
  - ✓Liquids must contact particles and dirty liquids must be removed from exhaust gas

# Particulate Scrubbers

- Initial quench – use clean water
- Water drops and particles must contact (impact)
  - ✓Requires water flow and mixing energy
- Dirty water collection
- Water treatment & recirculation

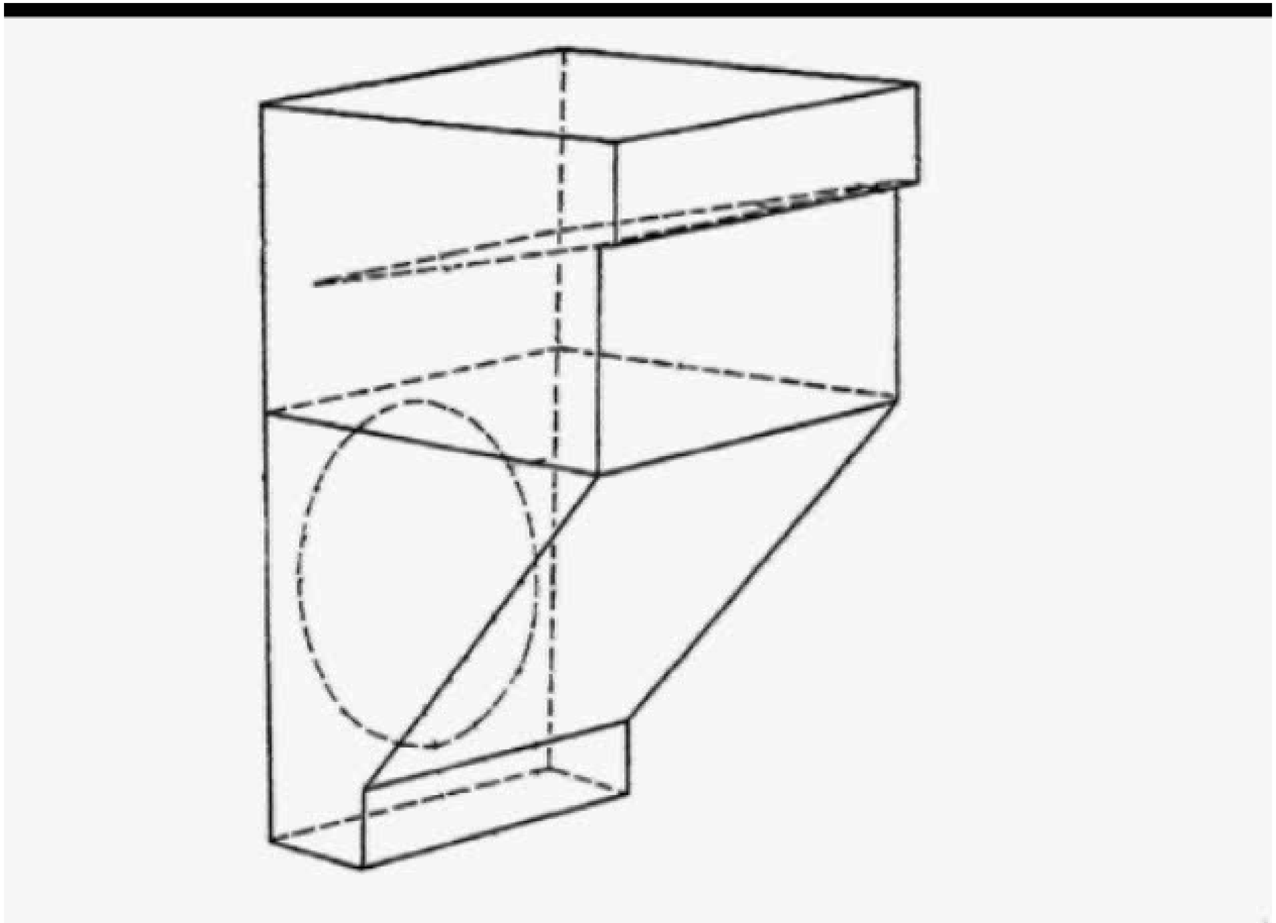
# Wet Scrubber Operation

- Particles collected by impaction
- Gasses collected by diffusion & absorption

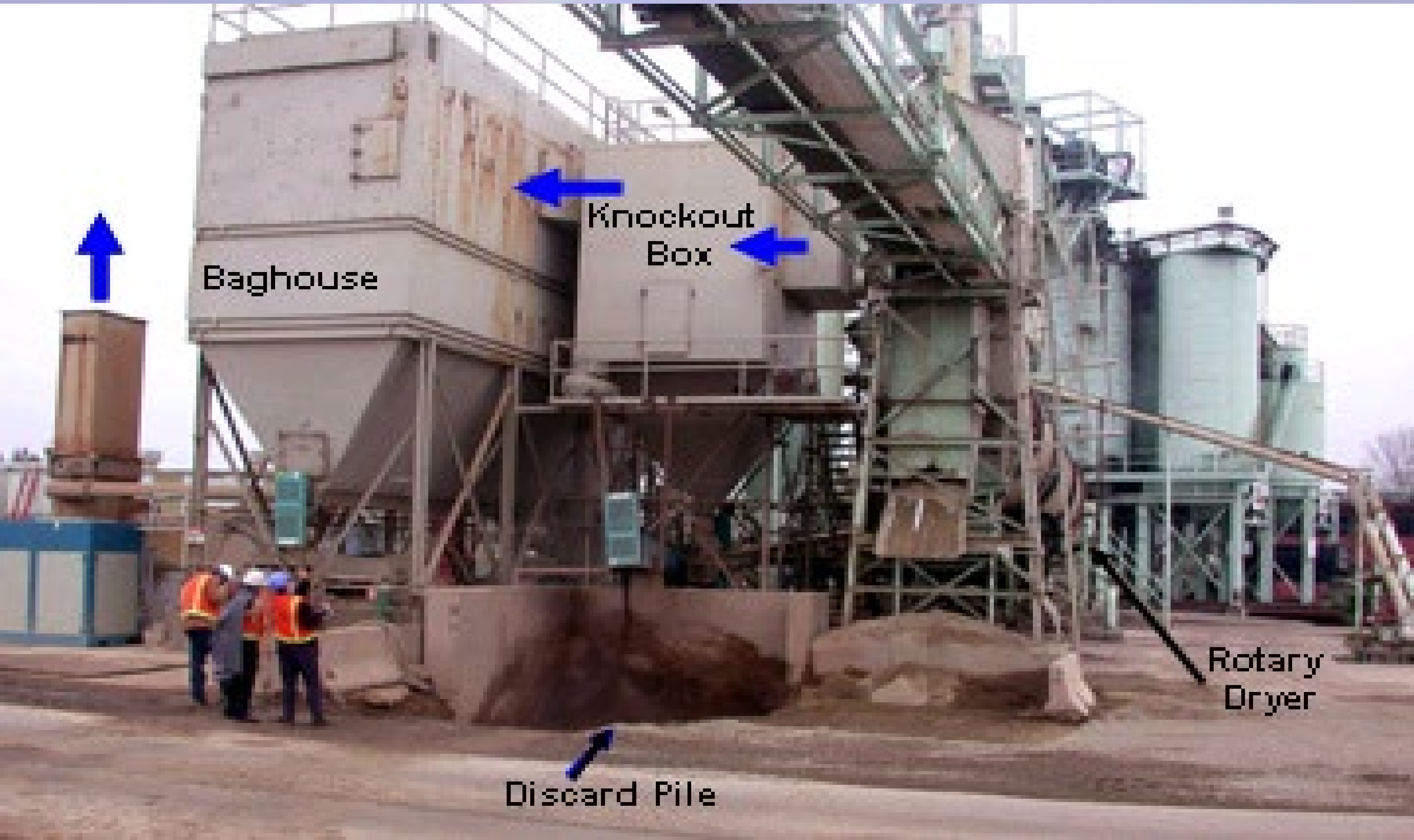



Scrubber
Liquor

# Primary Control Knock Out Box



# Primary Controls Knock-out Box

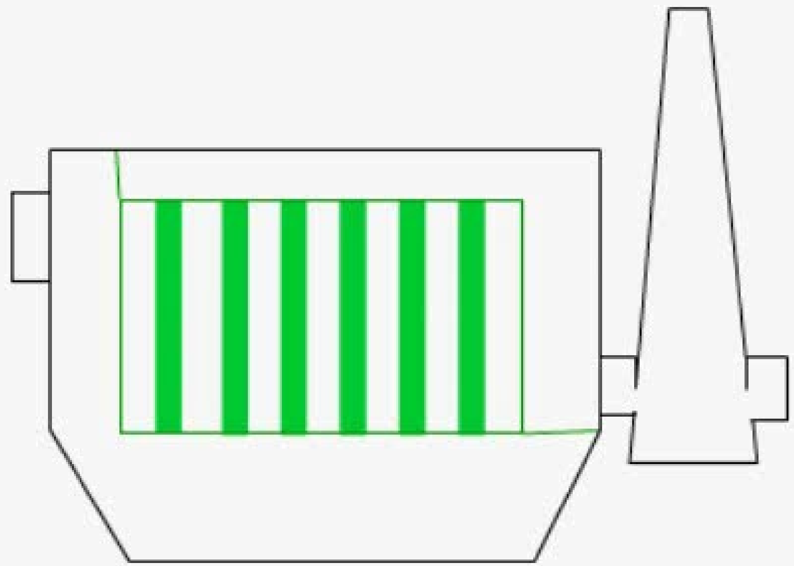


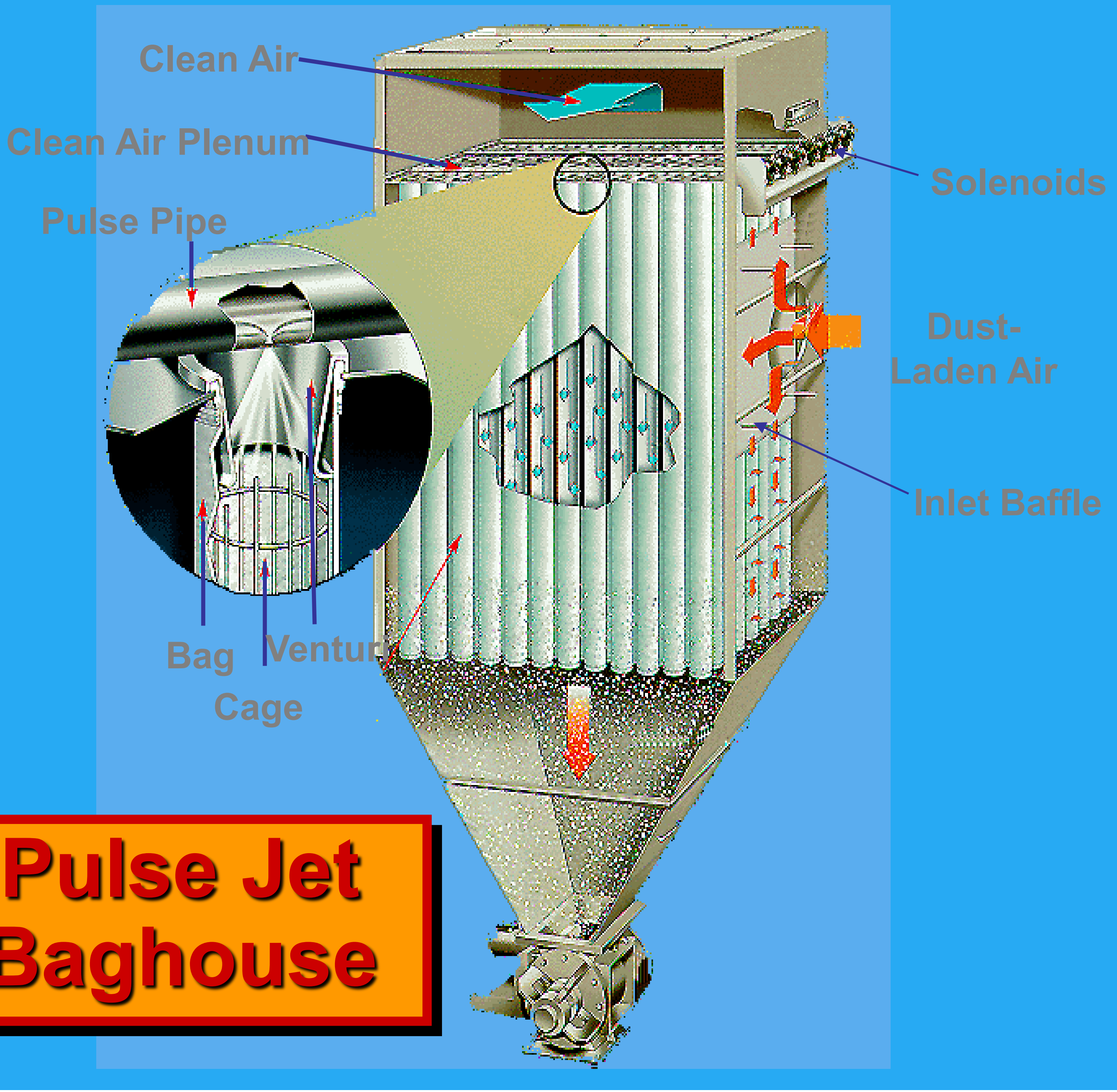

Secondary
Control
Baghouse

# Secondary Control Baghouses

- General description
  - Particles trapped on filter media, then removed
  - Either interior or exterior filtration systems
  - Up to 99.9% efficiency
  - Fabric filters are big vacuum cleaners with a cleaning mechanism

# Secondary Control Baghouse





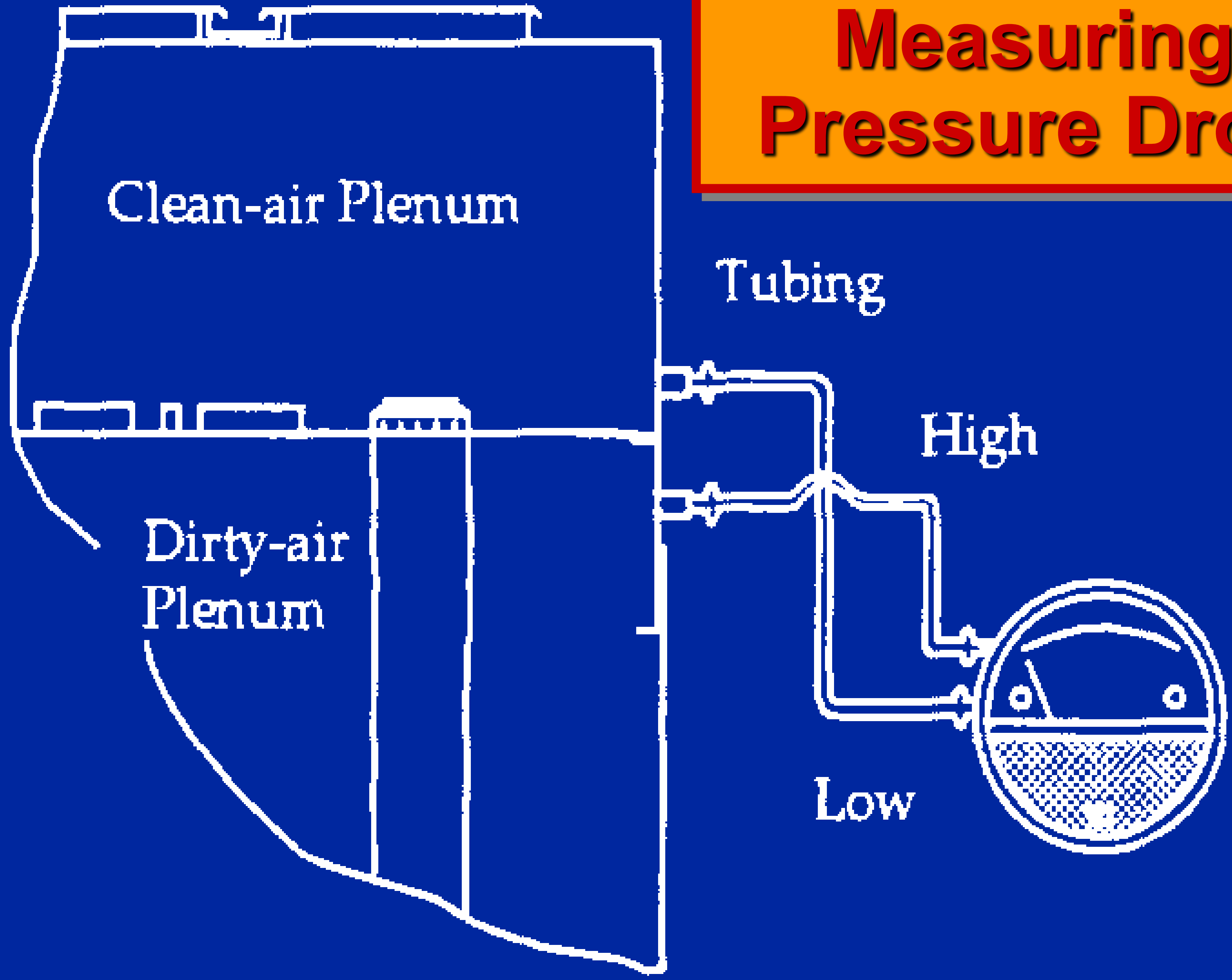

# Pulse Jet Baghouse

# Secondary Control
# Pulse Jet Baghouse

# Secondary Control Inside a Pulse Jet Baghouse

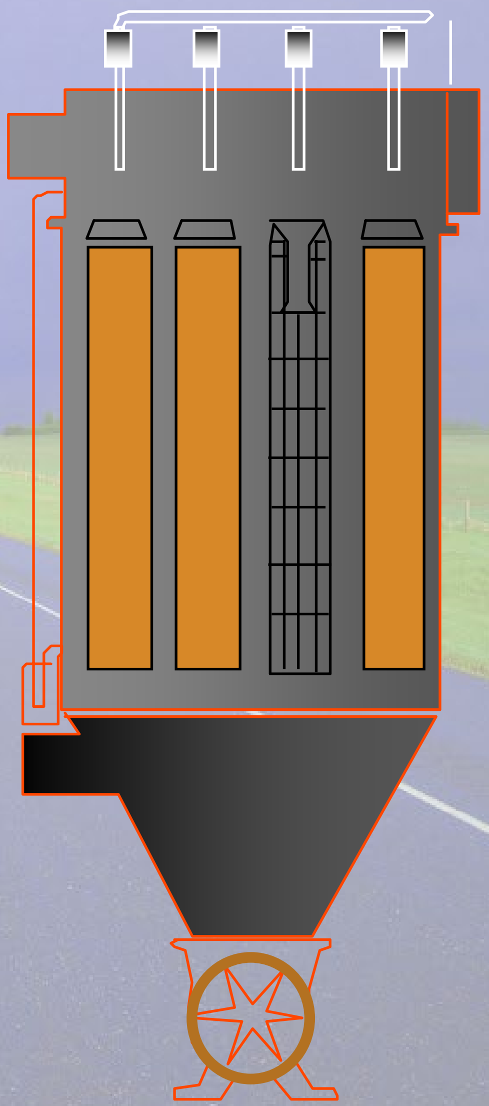

Pulse Jet
Bag

# Measuring Pressure Drop

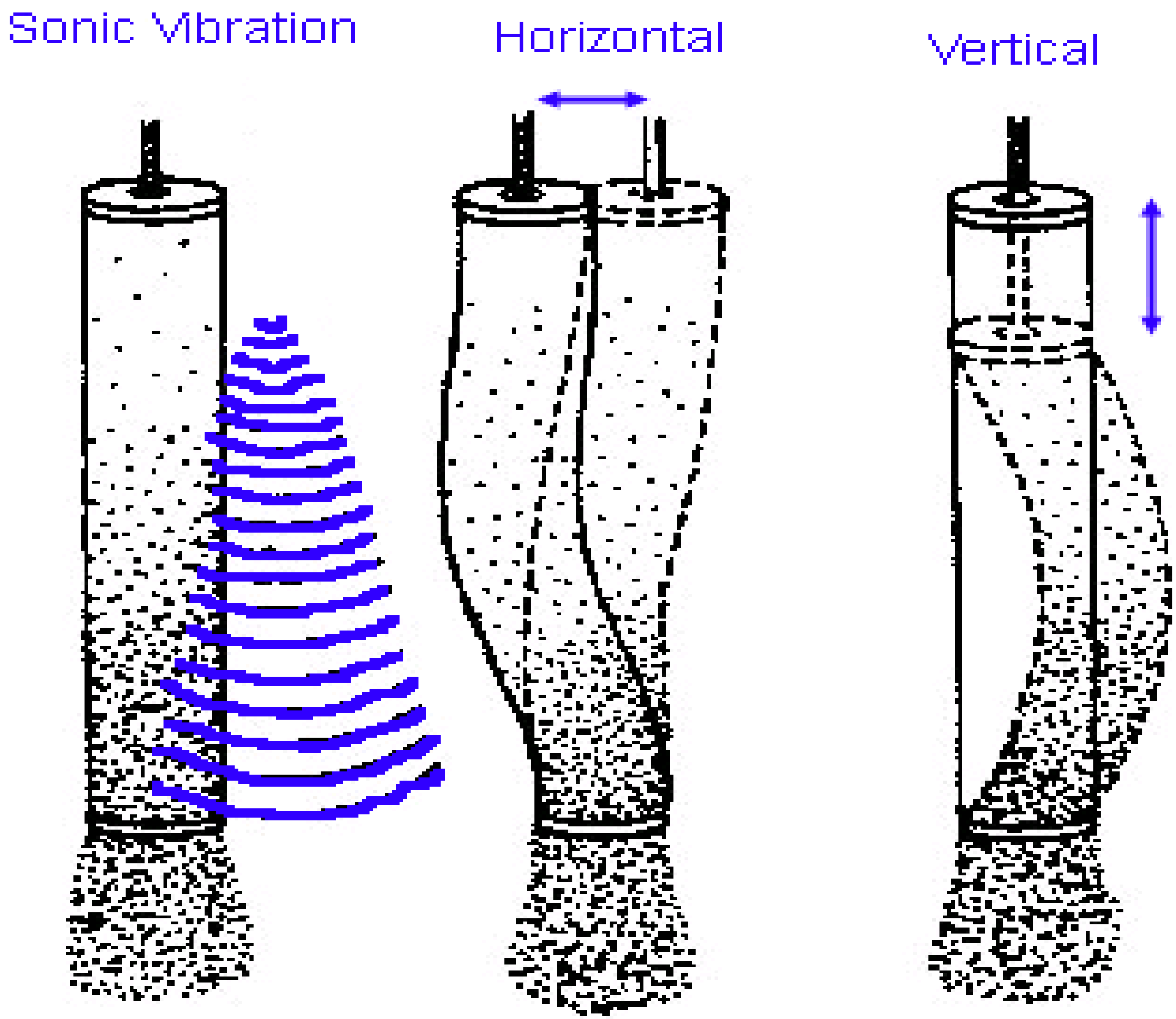


# Baghouse Design Considerations

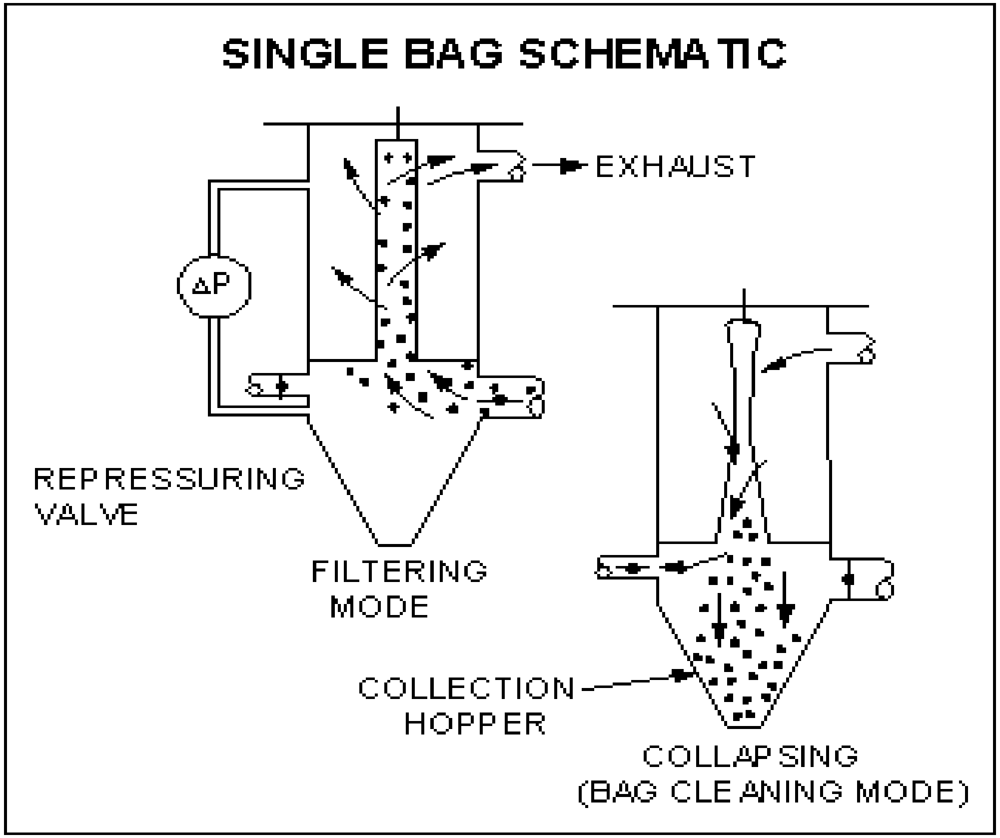
- Pressure Drop
- Air-To-Cloth Ratio
- Collection Efficiency
- Fabric Type
- Cleaning
- Temperature Control
- Bag Spacing
- Compartment Design
- Space and Cost

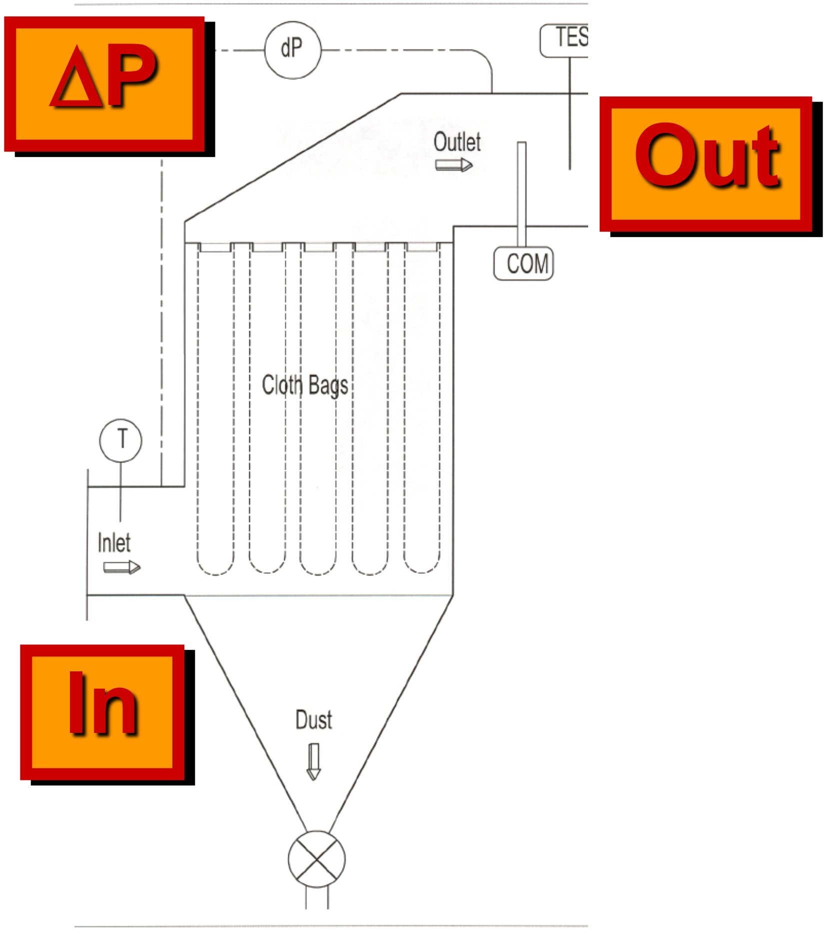


# Secondary Control
# Shaker Method



# Secondary Control
# PM Control Techniques – Fabric Filter



# Secondary Control
# PM Control Techniques – Fabric Filter

- Factors affecting efficiency
  - Filter media
    - Abrasion
    - High temperature
    - Chemical attack
  - Gas flow
  - Broken or worn bags

# Secondary Control PM Control Techniques – Fabric Filter

- Factors affecting efficiency (continued)
  - ✓Cleaning system failure
  - ✓Leaks
  - ✓Re-entrainment
  - ✓Damper or discharge equipment malfunction
  - ✓Corrosion

# Secondary Control PM Control Techniques – Fabric Filter

- Performance indicators
  - ✓Outlet PM concentration
  - ✓Bag leak detectors
  - ✓Outlet opacity
  - ✓Pressure differential
  - ✓Inlet temperature
  - ✓Temperature differential

# Secondary Control PM Control Techniques – Fabric Filter

- Performance indicators (continued)
  - ✓ Exhaust gas flow rate
  - ✓ Cleaning mechanism operation
  - ✓ Fan current
  - ✓ Inspections and maintenance

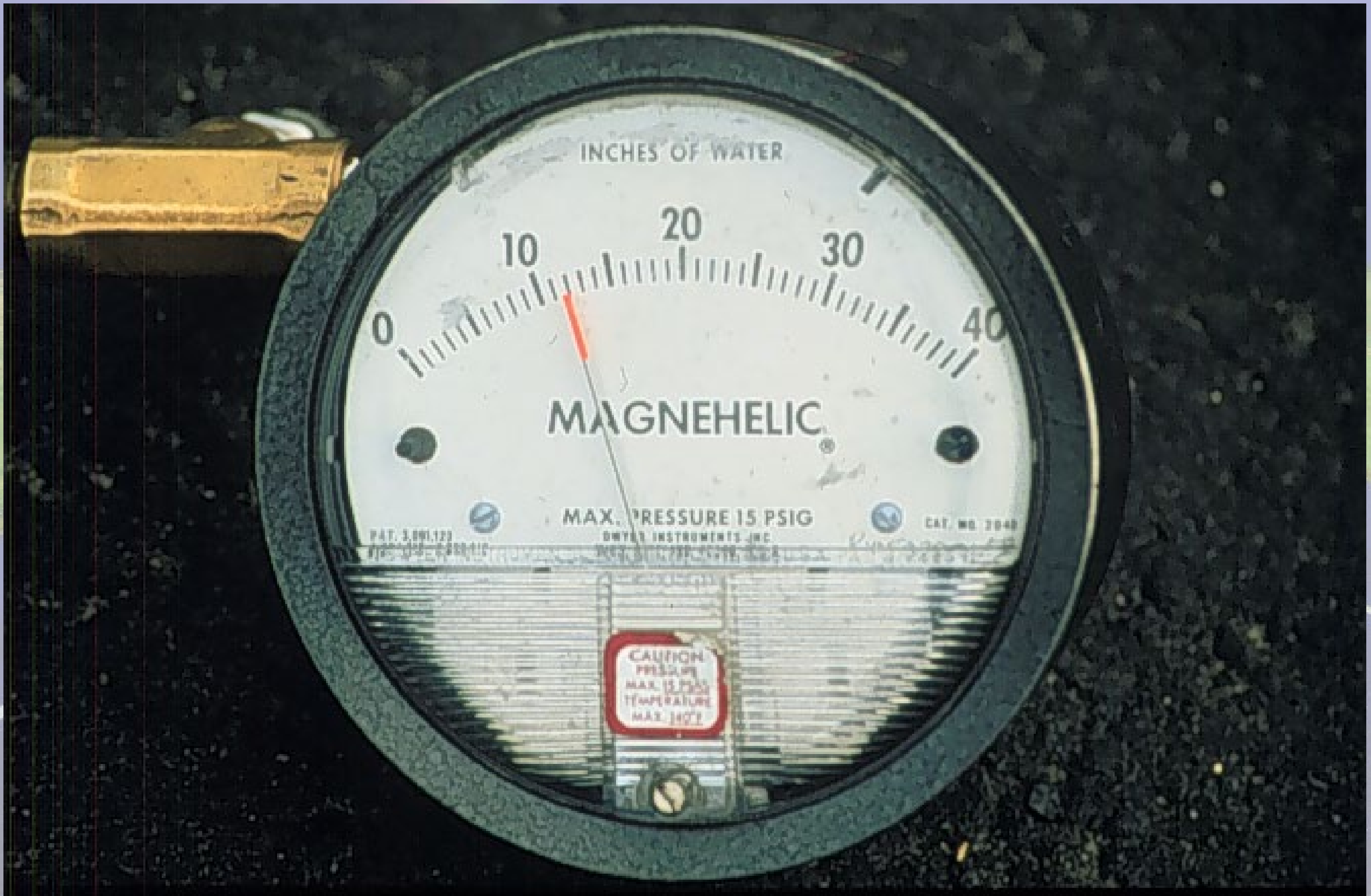
# Secondary Control
# Bag House Monitoring

- Normal bag house emissions are very low.
  - Opacity sensors (COM) aren't very good below 1-2%, so they don't detect initial problems.
  - Opacity will show a major particulate emissions increase.
  - COM or Method 9 may be OK for loose emission limits.

# Inspection Procedures Instrumentation

- What types of instruments are being used to monitor for permit conditions?
  - ✓ Magnehelic Gauge
  - ✓ Triboelectric Monitor

# Inspection Procedures
# Magnehelic Gauge



# Inspection Procedures


## What's wrong with this picture?

# Baghouse Monitoring Triboelectric Sensor

- TESs are a newer technology
  - ✓ Primary use cement, coal fired power plants, and food manufacturing
  - ✓ US EPA encouraging use of TESs as CAM (compliance assistance monitoring, 40 CFR 64) or
  - ✓ As a performance indicator in lieu of a source test
- Districts are adopting as BACT or compliance measurement tool

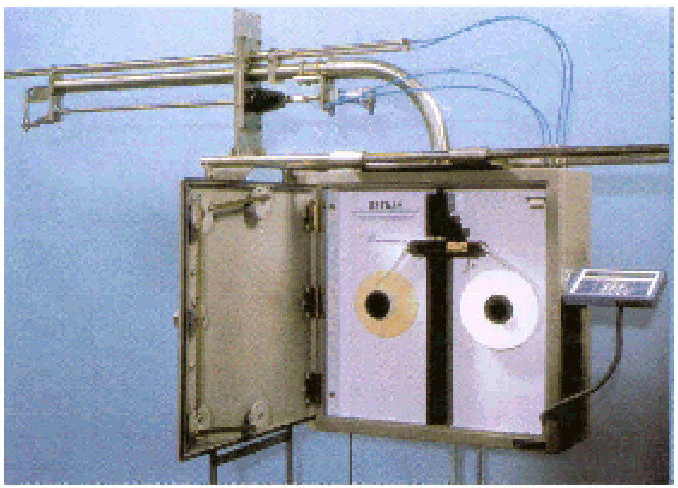
# Baghouse Monitoring Triboelectric Sensor

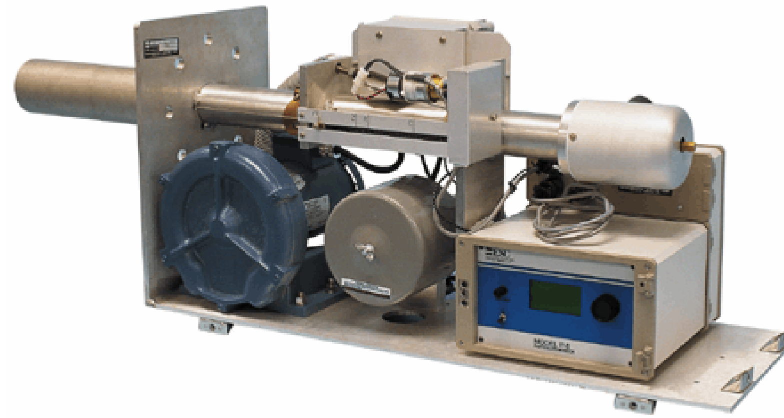
- Tribo electric sensors (TES) work well at very low particle concentrations (very sensitive).
- TES detects micro amp current from particles hitting a metal probe.
- TES is simple and inexpensive.
- TES is an effective monitor when a small to moderate increase in emissions is of concern.

# Baghouse Monitoring Triboelectric Sensor

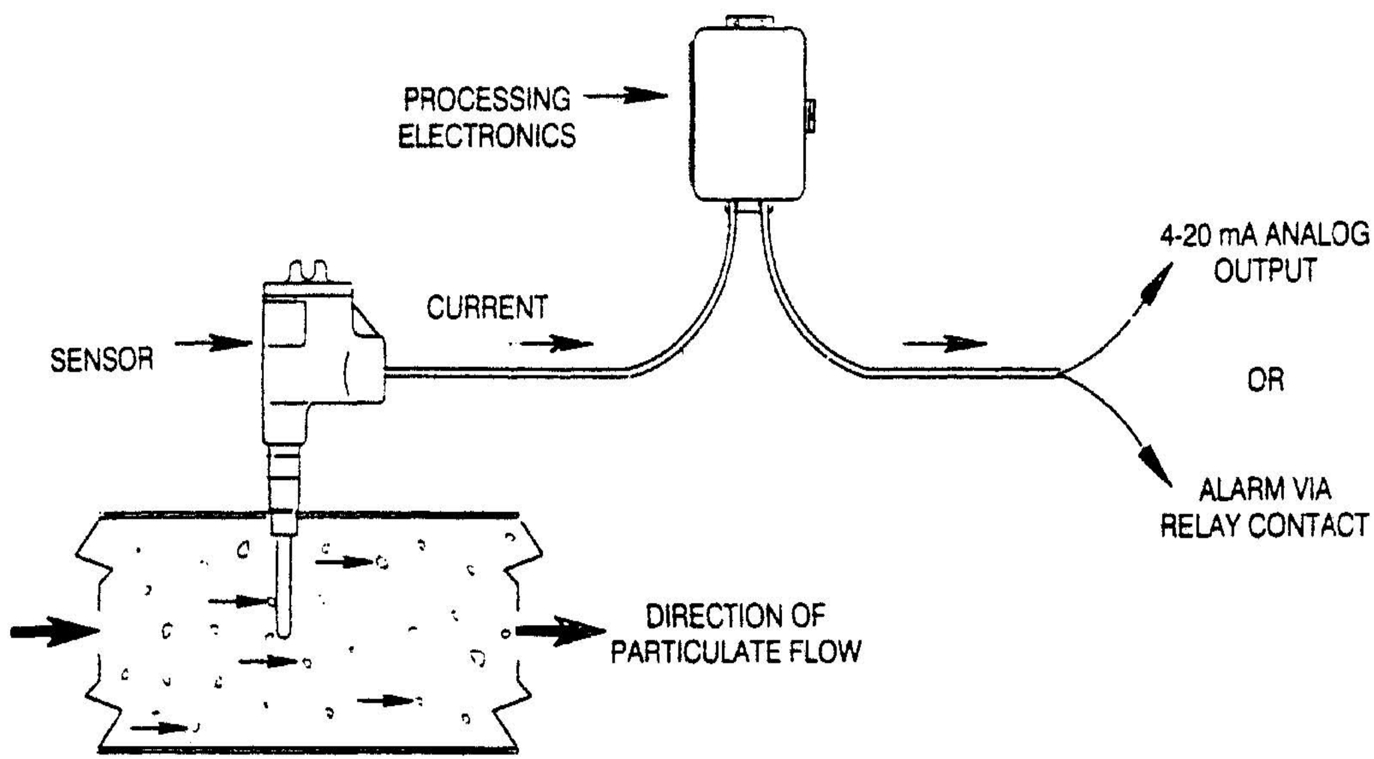
- Operates on the principle of electric conductivity
  - ✓ Triboelectric Principle: When 2 solids contact an electrical charge is transferred between the 2
  - ✓ Current generated is proportional to the particulate mass flow rate
  - ✓ Instrument tuned to produce continuous analog output and/or an alarm at a specific signal level

# Control Devices
# PM CEMS/TES Devices

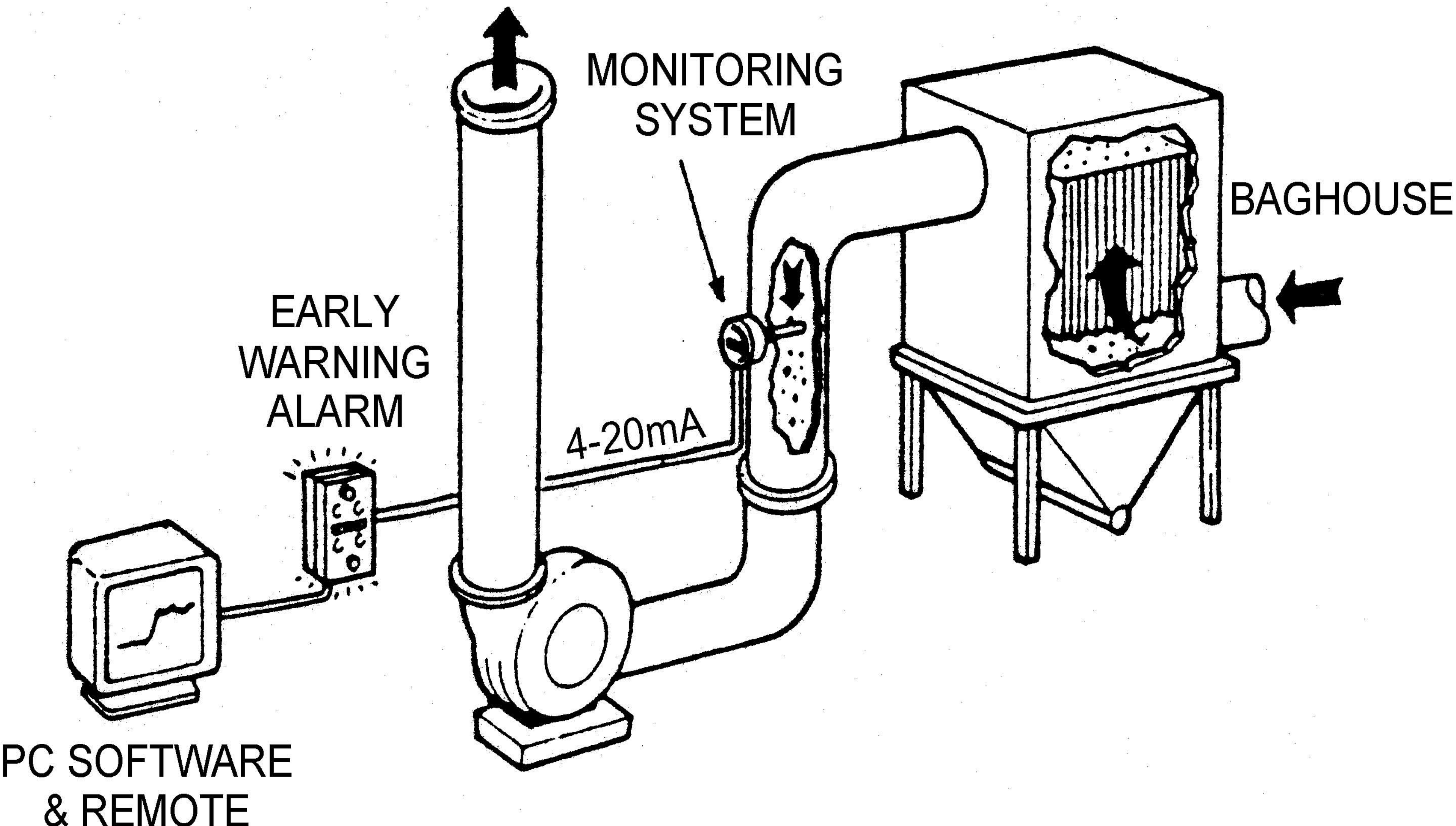





# Control Device Triboelectric Sensor Schematic



# Triboelectric Sensor Installation for a Negative Pressure Monitoring System



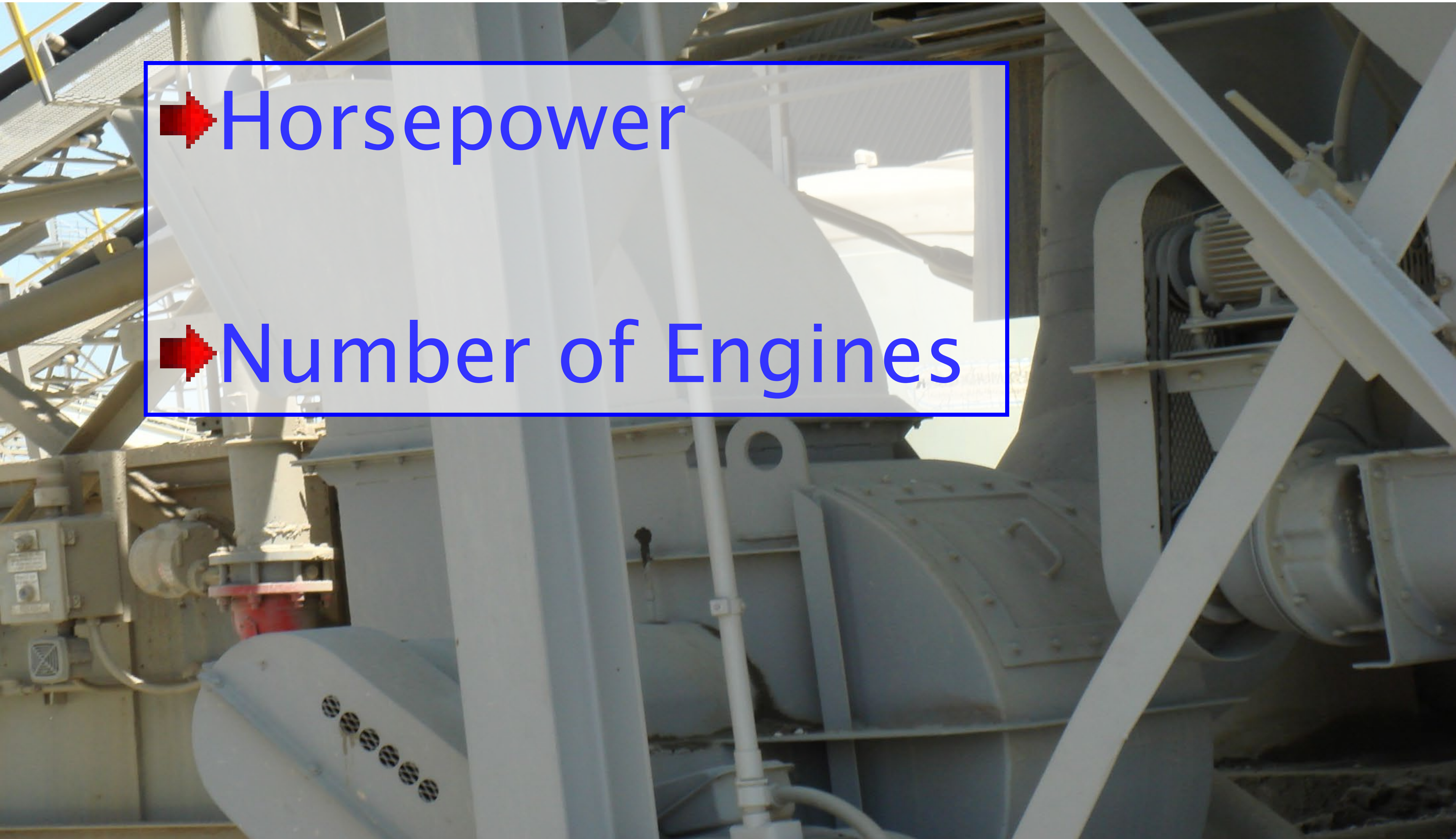
# Monitoring Device Triboelectric Sensor

- TES work well at low particulate concentrations
- Detects micro amp current from particles hitting a metal probe
- Simple and inexpensive
- Effective monitor when a small to moderate increase in emissions is of concern

# Baghouse Monitoring Device Triboelectric Sensor

- Establish baseline
- Monitor detects gradual or instantaneous increases in the signal from baseline
- Baseline emissions can be as low as 0.1 mg/dscm (0.00005 gr/dscf)

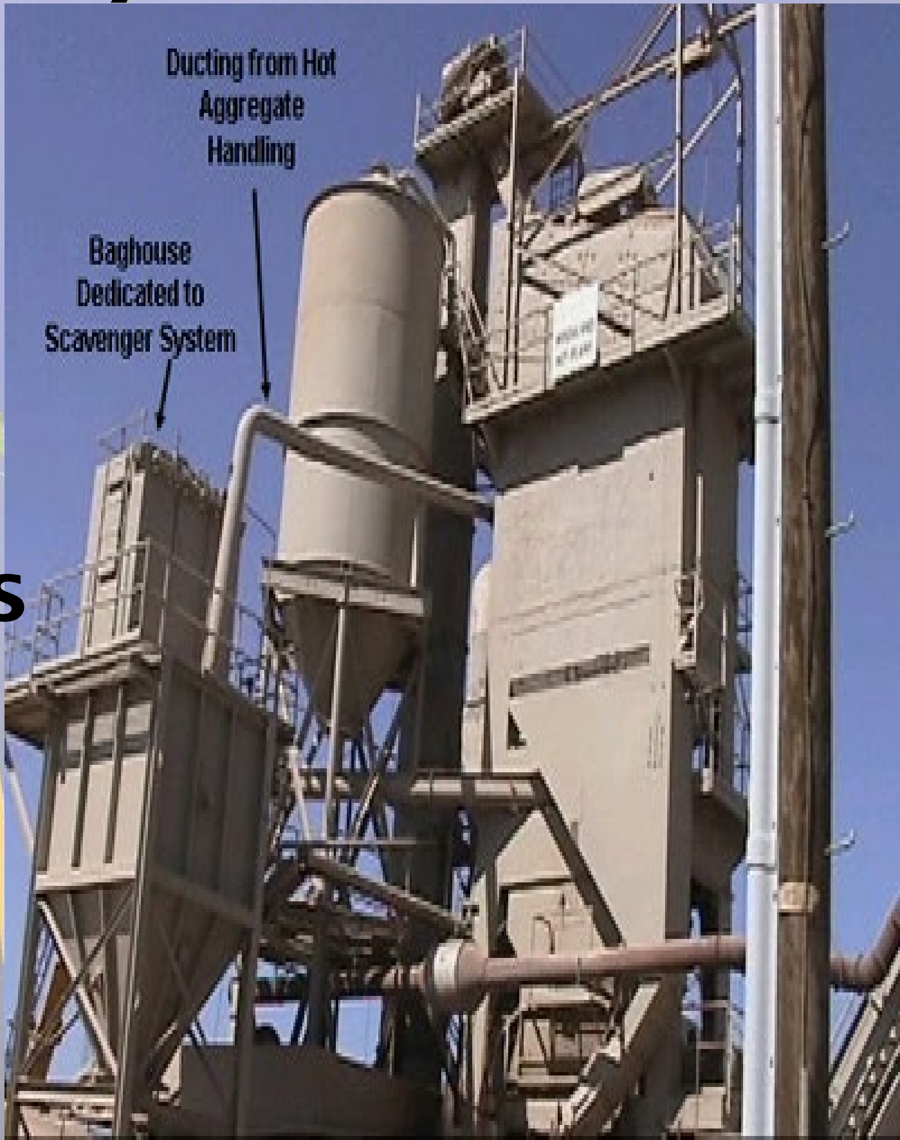
# Inspection Procedures
# Fans/Blowers



- Horsepower
- Number of Engines

# Control
# Scavenger System

- Collects fugitive emissions from:
  - ✓Hot aggregate elevator
  - ✓Vibrating screens
  - ✓Hot bins



# Control
# Asphalt Binder Storage

- May or may not be controlled
- Controls include
  - ✓ Condensers,
  - ✓ Vapor recovery system (similar to gas station)
    - Vapors returned to refinery for incineration
- Delivery truck lines are flushed with non-hazardous cleaners

# Control
# Asphalt Binder Storage

# Control
# Blue Smoke

# Control
# Blue Smoke

- An aerosol of condensed organic particles adsorbed to dust or water particles

# Control
# Blue Smoke

- Some organic compounds begin to

1. vaporize at 300 F
2. Condense in ambient air
3. Adsorb to dust and water particles

- To form visible emissions
- Visible emissions are formed until the air becomes saturated




# Blue Smoke Emission Points

# Control
# Blue Smoke Emissions Points

- Drop points of HMA from pugmill
- On top of surge bins/silos
- At the base of surge bins/silos
- Drag slat conveyors
- Truck loadout

- Challenge to capture and control
- Primary reason for complaints
- Perception !!


Blue Smoke Collection System
Blue Smoke Collection System to Dryer
Induction Fan of Blue Smoke Collection System

**Blue Smoke Control Device??**

## Blue Smoke Controls

# Truck Loadout & Blue Smoke Controls

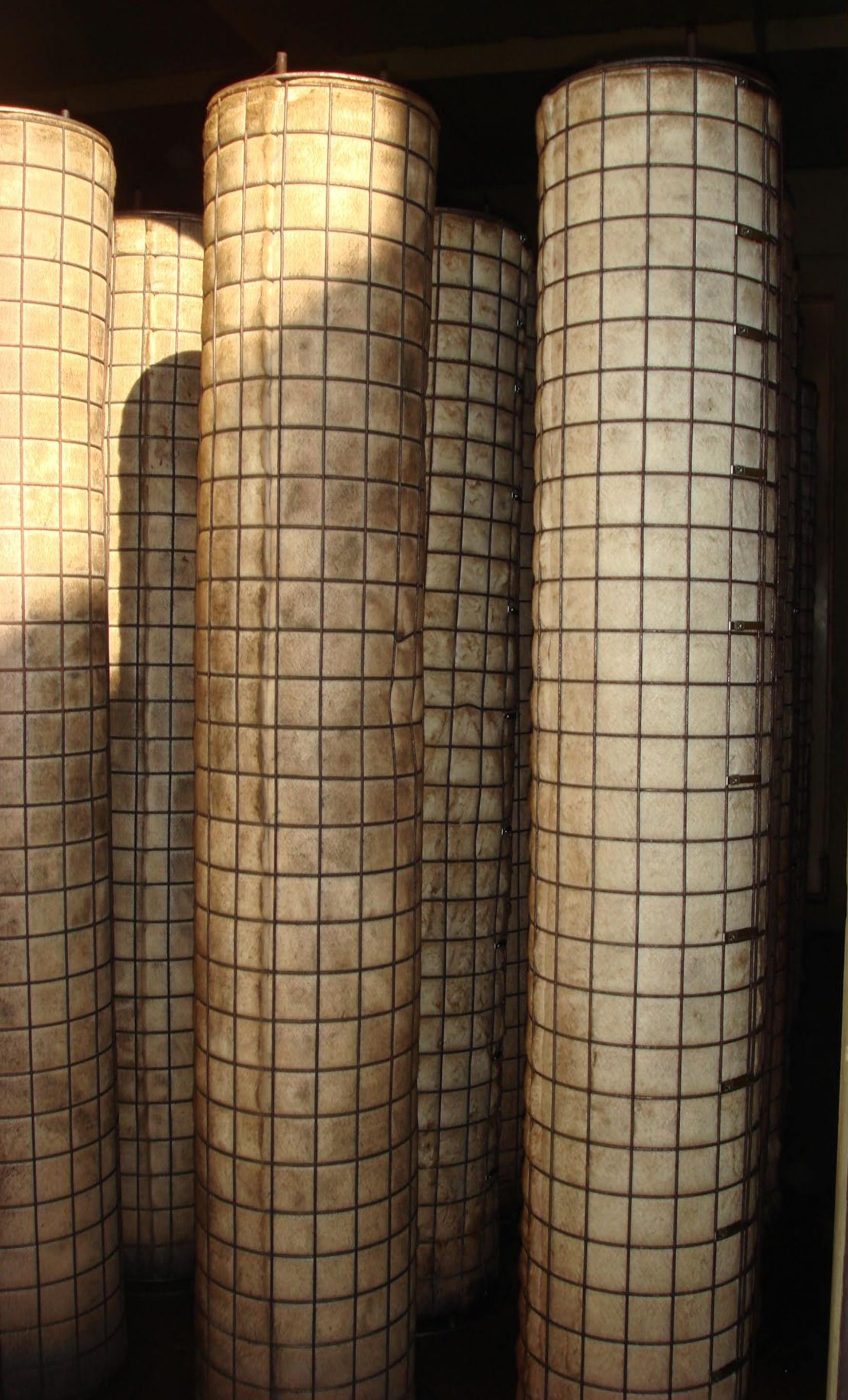


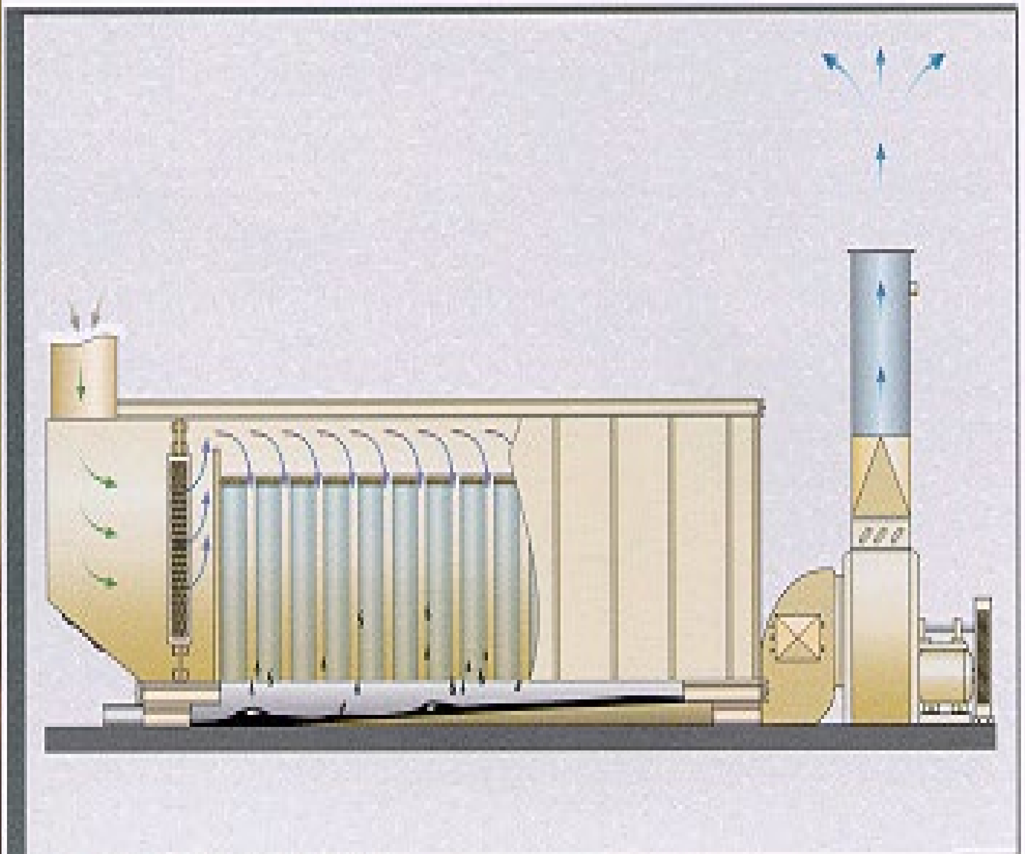
**Silo/Truck Loadout & Blue Smoke Controls??**

# Blue Smoke Controls


# Blue Smoke Control Device

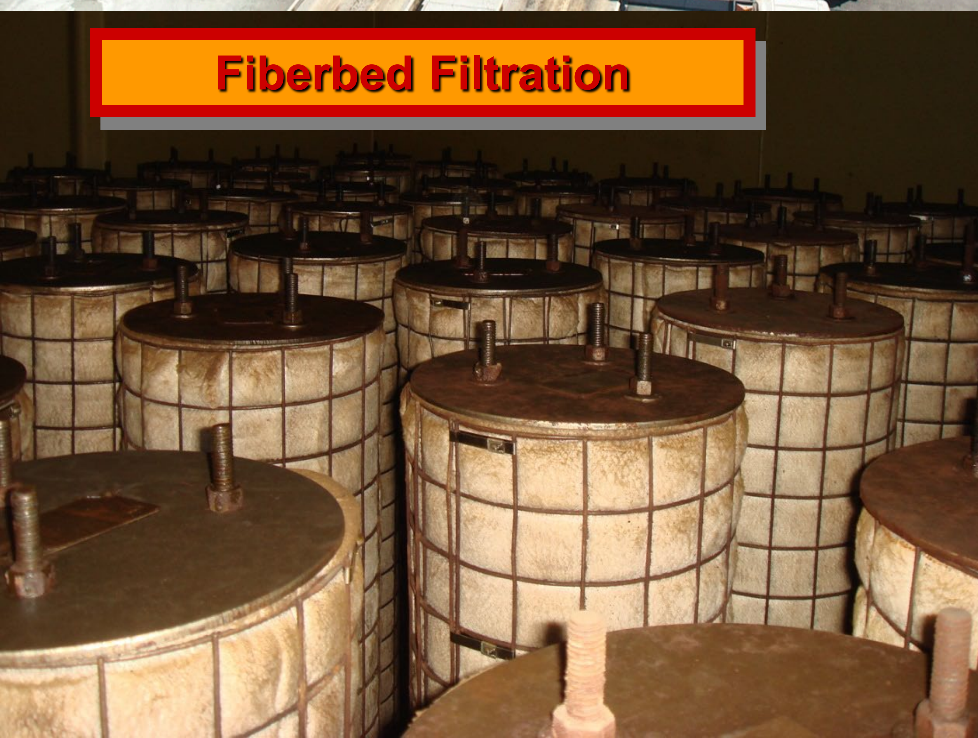
# Fiberbed Filtration





FIBERBED MIST COLLECTOR


ASTEC
ASTEC


Fiberbed Filtration

# Control of Blue Smoke
# Truck Entrance

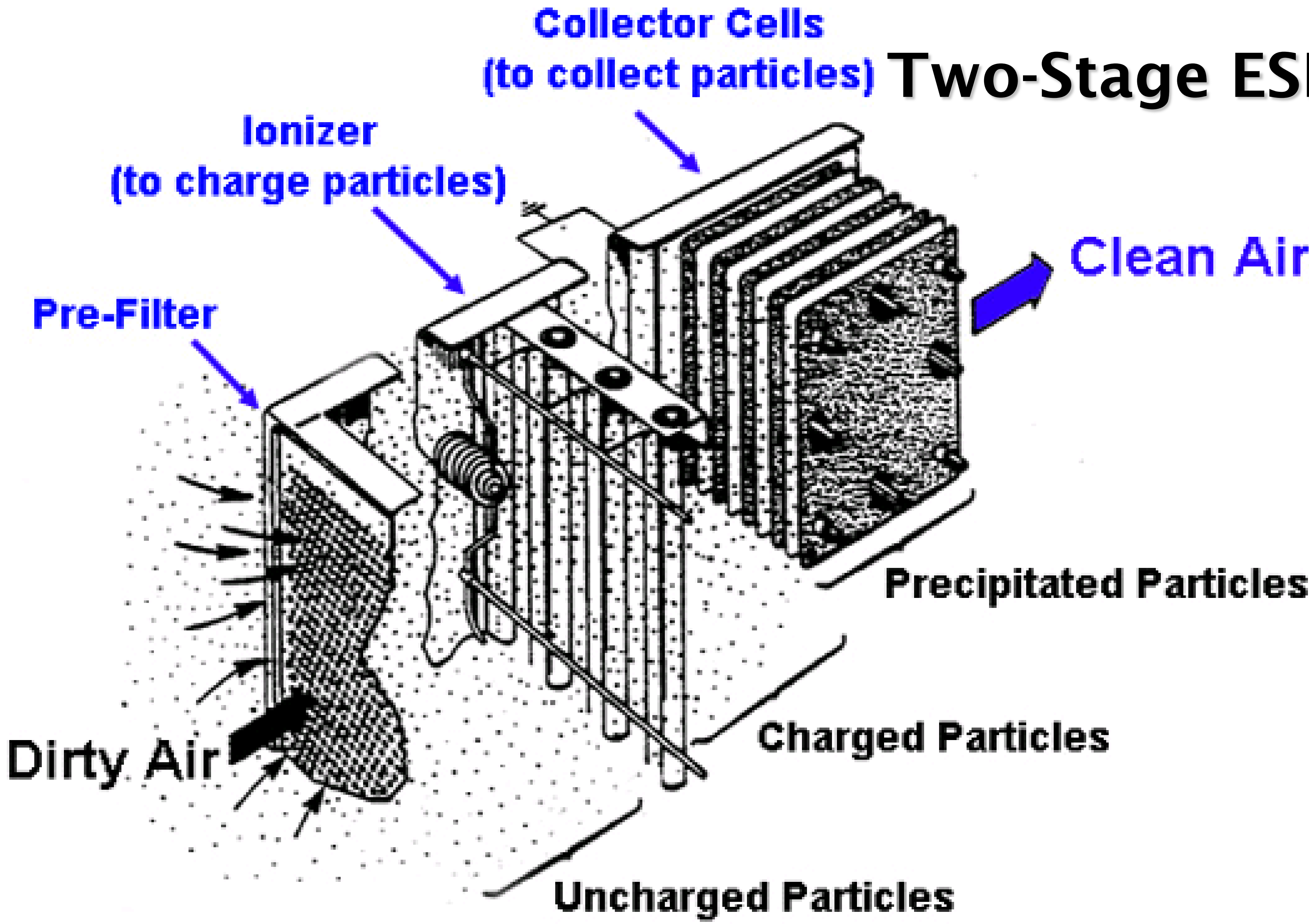
# Control Blue Smoke
# Enclosed Load Out


DUCTWORK TO ELECTROSTATIC PRECIPITATOR

# Control
# Side View of HMA Drop with ESP/Smog Hog for Blue Smoke

# Control
# Ducting to ESP/Smog Hog

# Two-Stage ESP



# Controls
# Innovations in HMA Production

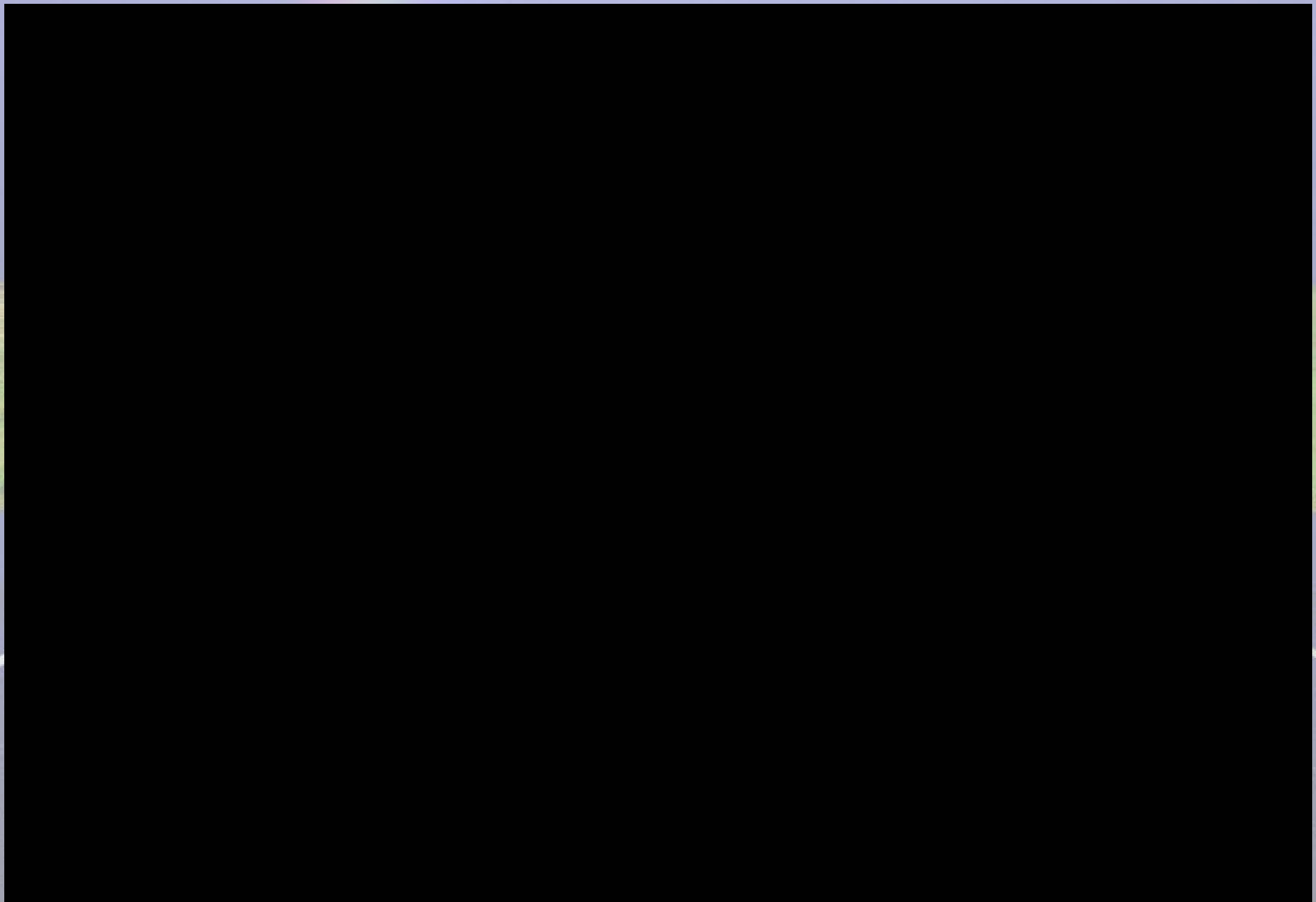
- Four areas where the technology has improved
  - ✓burner design,
  - ✓fuels,
  - ✓dryer/drum design, and
  - ✓blue smoke controls

# Controls
# Triple-Drum Mixer

# ASPHALT SEAL COAT AND PAVING

## Reading a Moving Plume

# Moving Source



# Permit Conditions


- Emission Controls
  - ✓ Emission Limits
  - ✓ Process Limits
  - ✓ Emission Rate Limits
  - ✓ Requirements to Minimize Emissions
  - ✓ Source Test
  - ✓ CAM (gauges on baghouse)

# Permit Conditions cont.

- **Fuel Requirements**
  - ✓ Type
  - ✓ Nitrogen or Sulfur content
  - ✓ Amount of fuel
  - ✓ Type of backup fuel
  - ✓ Method of measurement
  - ✓ Recordkeeping of fuels purchased and used

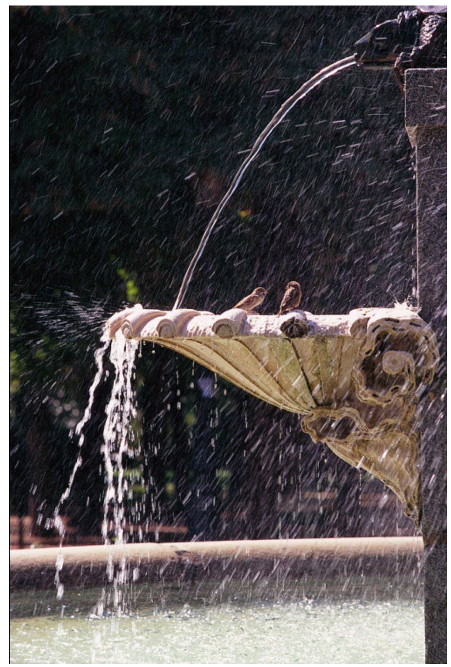
# Permit Conditions cont.

- Visible Emissions Limits
  - ✓ NSR lists are 20% or No. 1 on Ringleman
  - ✓ Sources permitted before NSR maybe 40% or No. 2 on Ringleman

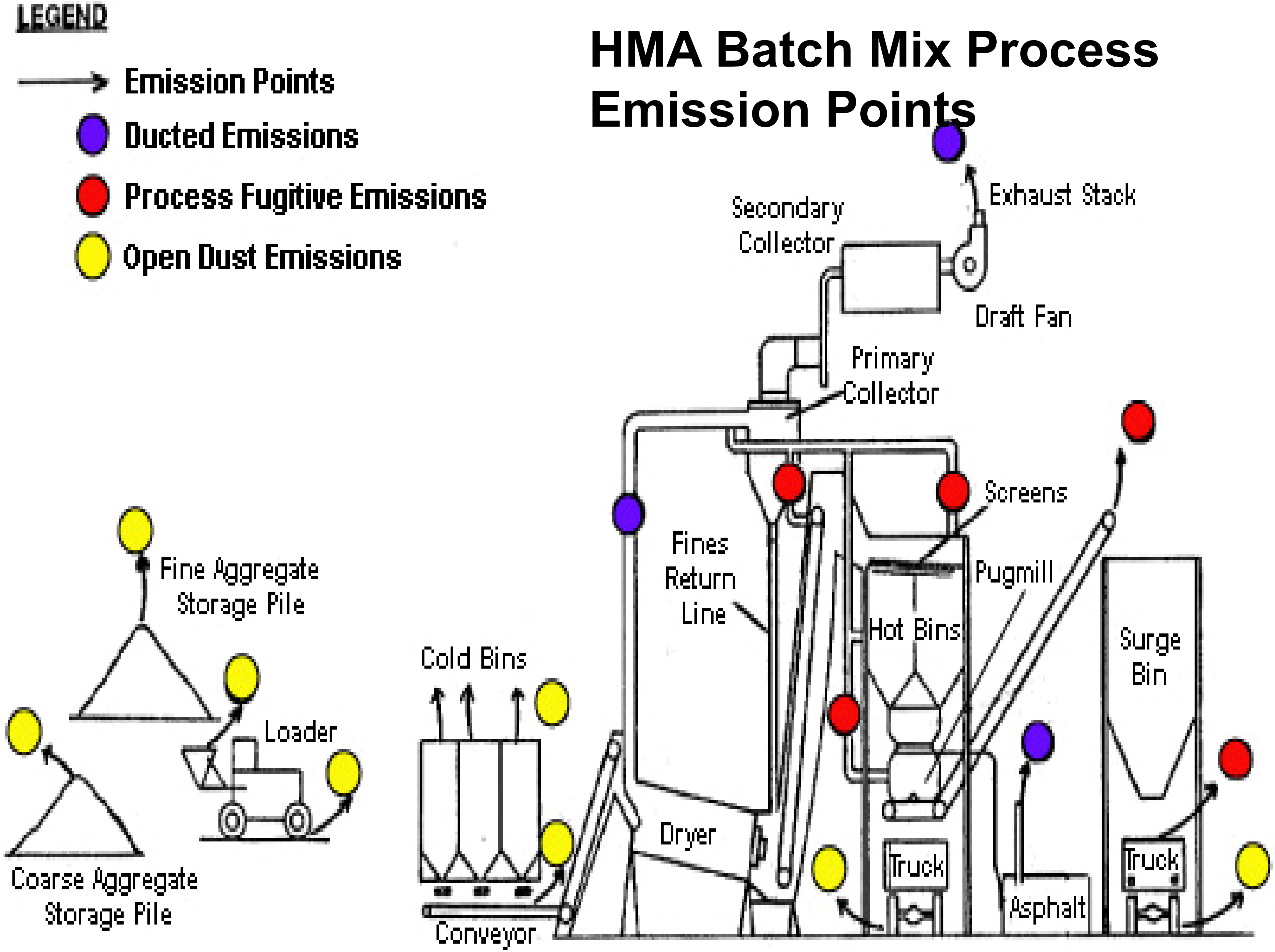
# Process/Control
# Dry Collection Systems

- Baghouses are regulated in terms of
  - ✓ Source Test Requirements and Methods
  - ✓ Visual Test Method?

# Permitting/Inspection HMA Source Test



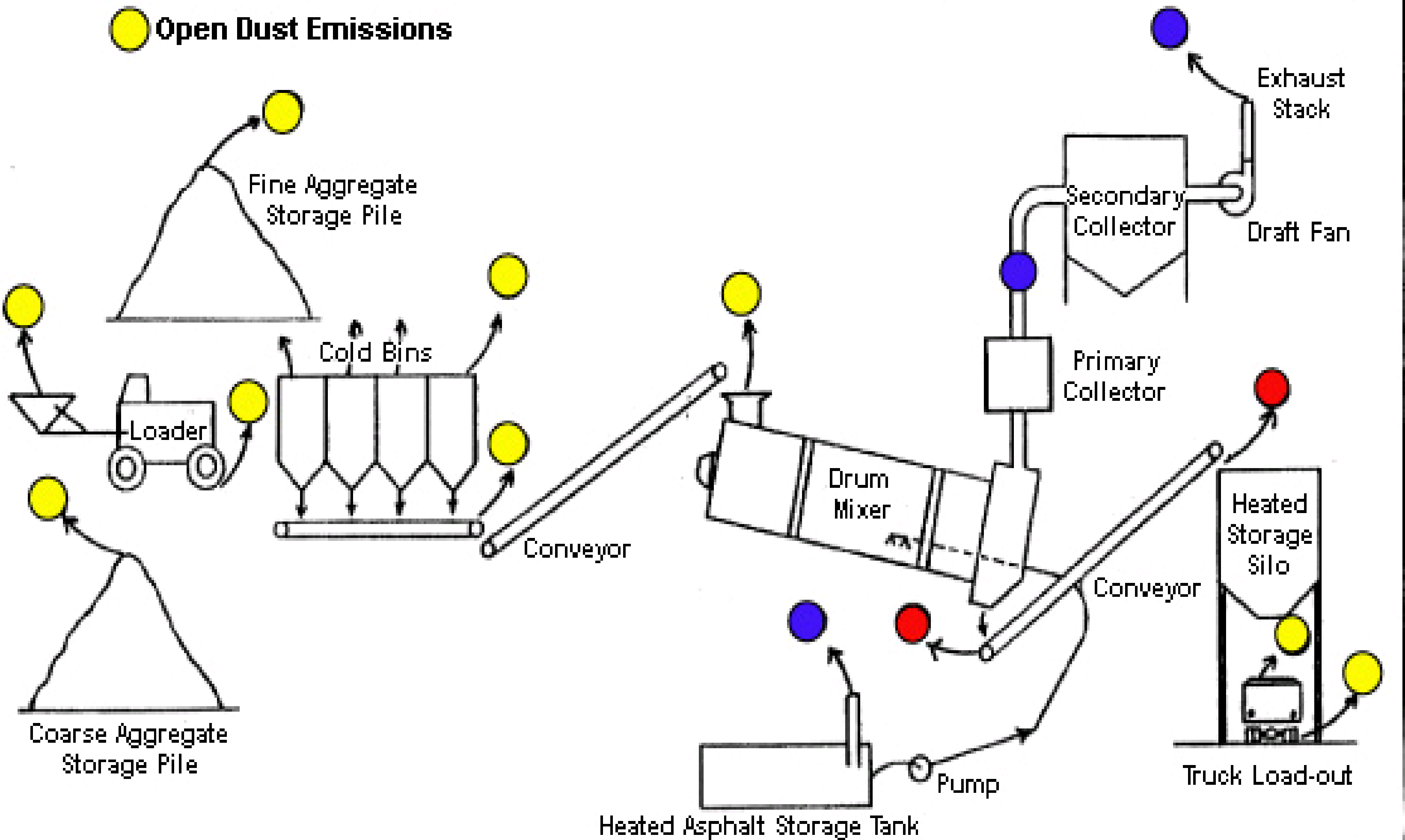
# HMA Batch Mix Process Emission Points



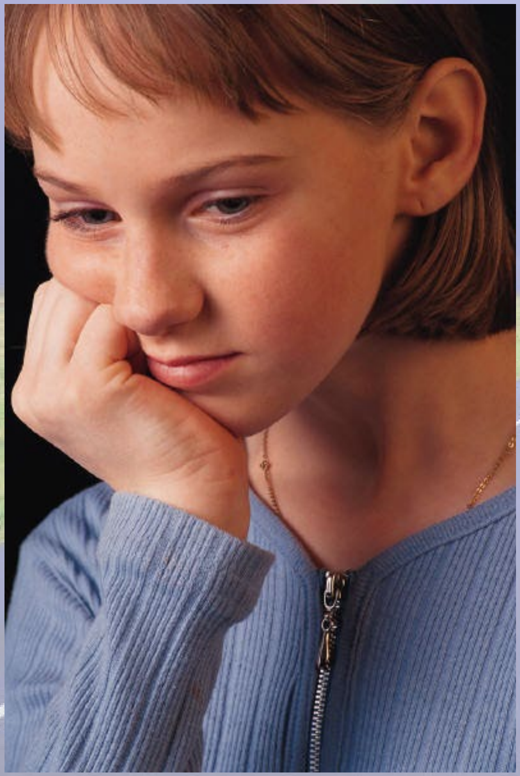
# HMA Continuous Mix Process Emission Points

**LEGEND**

- → Emission Points
- Ducted Emissions (blue)
- Process Fugitive Emissions (red)
- Open Dust Emissions (yellow)



# Permit/Inspection Objectives



Determine compliance with District, Federal regulations & permit conditions

- Fugitive emissions
- Stack emissions
- Visible emission tests
- Oxides of nitrogen (for fuel burning equipment)