NACT 270

Incinerators

INCINERATION

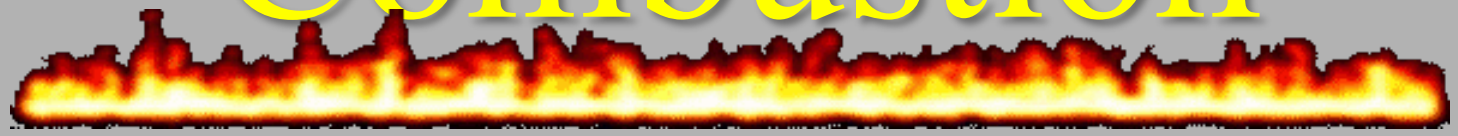
- **“A combustion process, in which the primary purpose is to destroy combustible material.”**
- **Biomedical Incinerators: Hospital, Pathological and Crematory Incinerators.**
- **Heat Stripping Ovens (Burn off ovens)**
- **MSW incinerators**
- **Sewage Sludge incinerators**
- **Hazardous Waste incinerators**
- **Commercial and Industrial Incinerators**
- **Air Curtain Incinerators**

Combustion Efficiency

3 T's

- Time (of residence)
- Temperature
- Turbulence

Combustion



- Stoichiometric Combustion
- Excess Air Combustion
- Substoichiometric Combustion

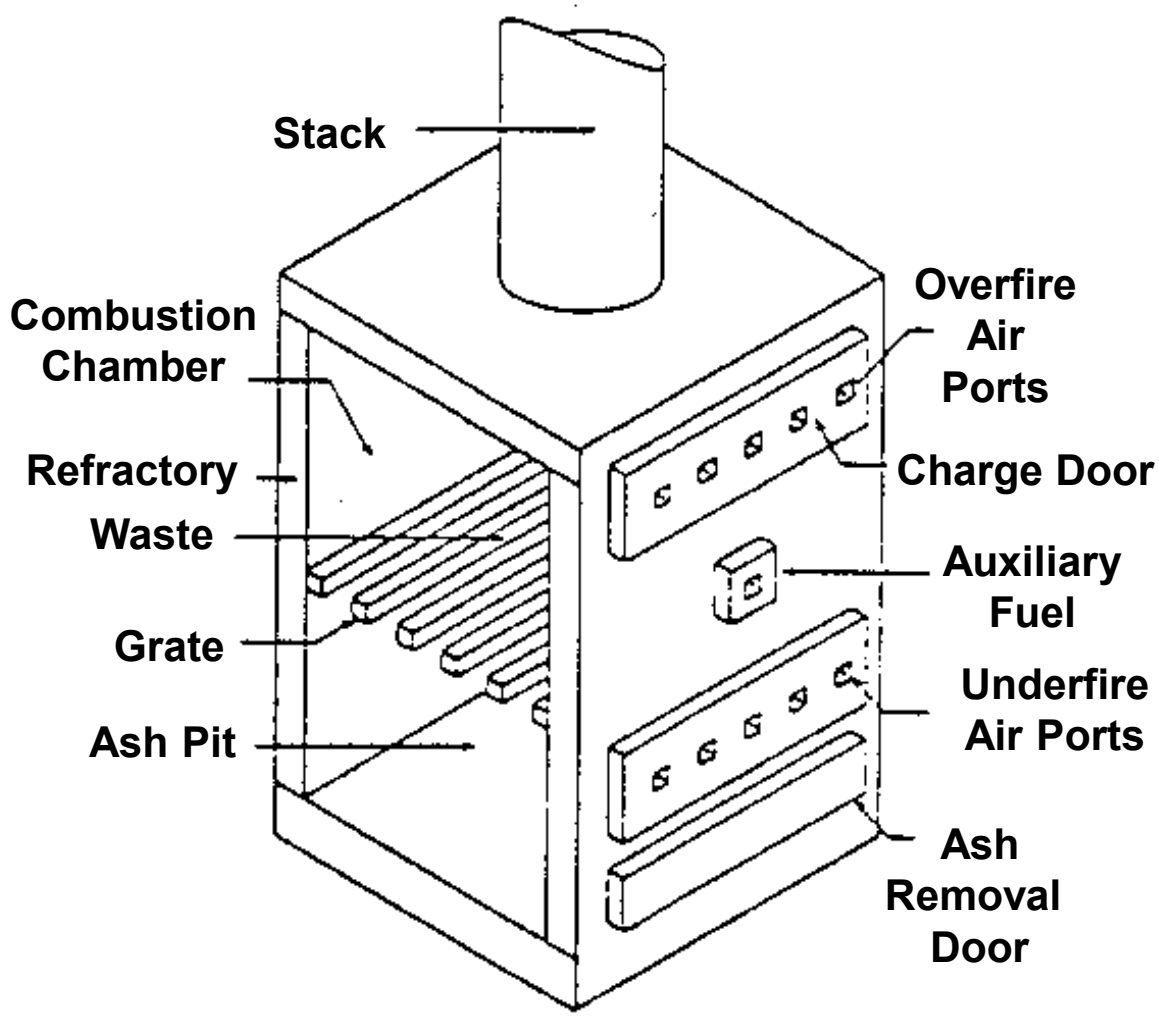
IIA Waste Classification

TYPES 0 - 8

- **Vary by Composition**
- **Vary by Moisture Content**
- **Vary by Btu value per pound fired**

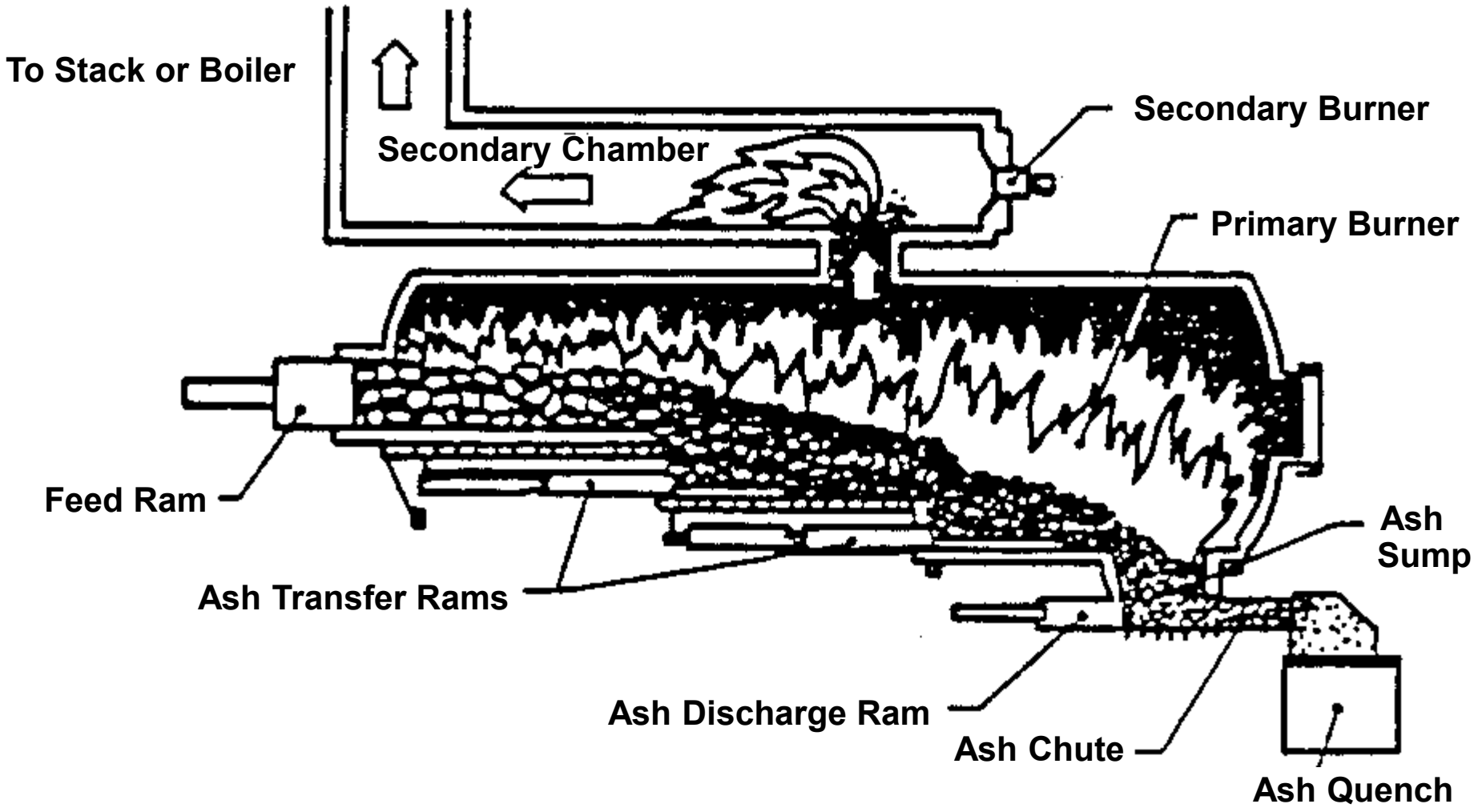
Solid Waste Incinerators

- Open Burning
- Open-Pit Incinerators
- Teepee Burners
- Single Chamber Incinerators
- Multiple Chamber Incinerators
- Controlled Air Incinerators
- Rotary Kiln Incinerators
- Fluidized Bed Incinerators
- Multiple Hearth Incinerators
- Air Curtain Incinerators



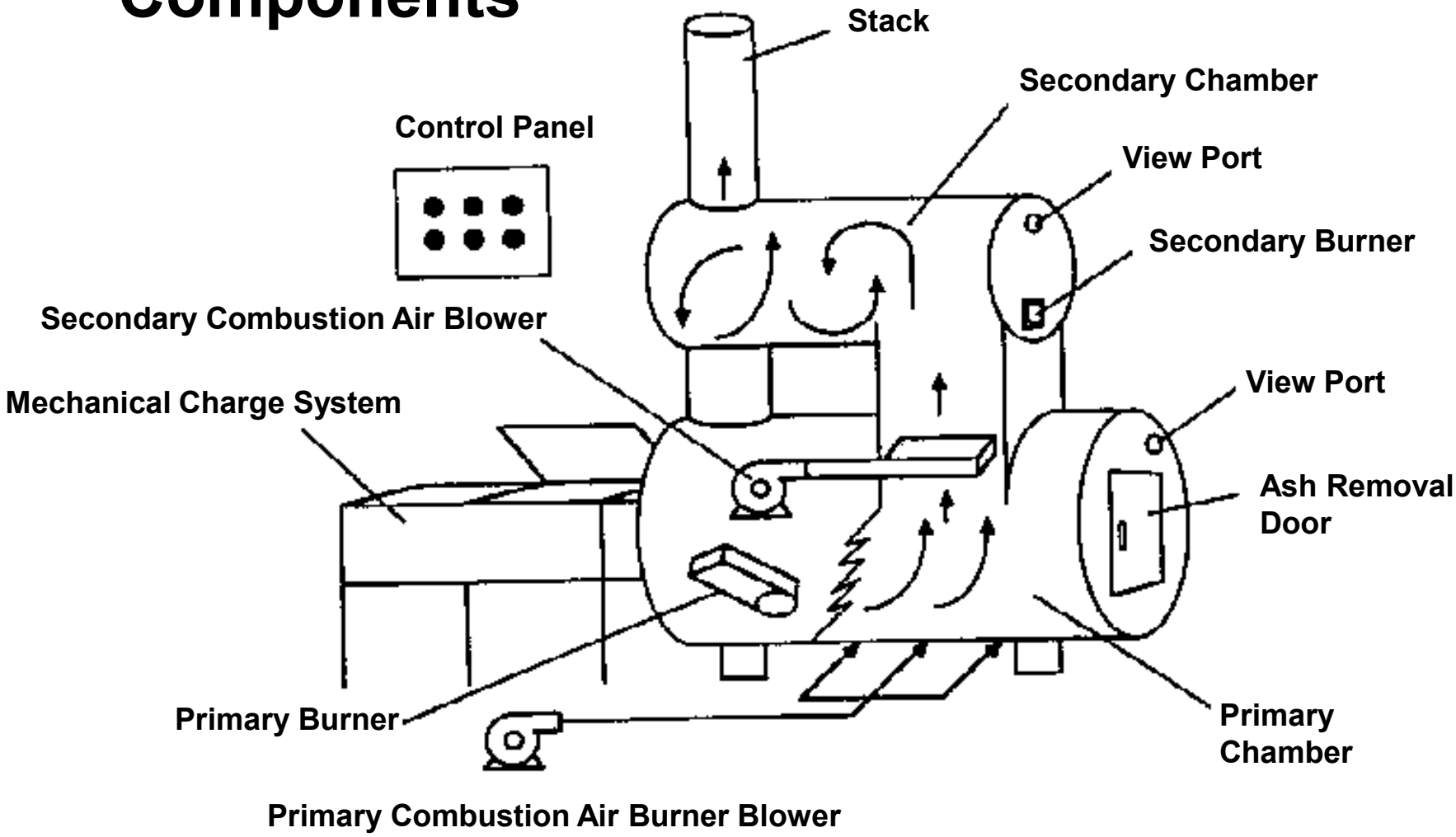
Single Chamber Incinerator

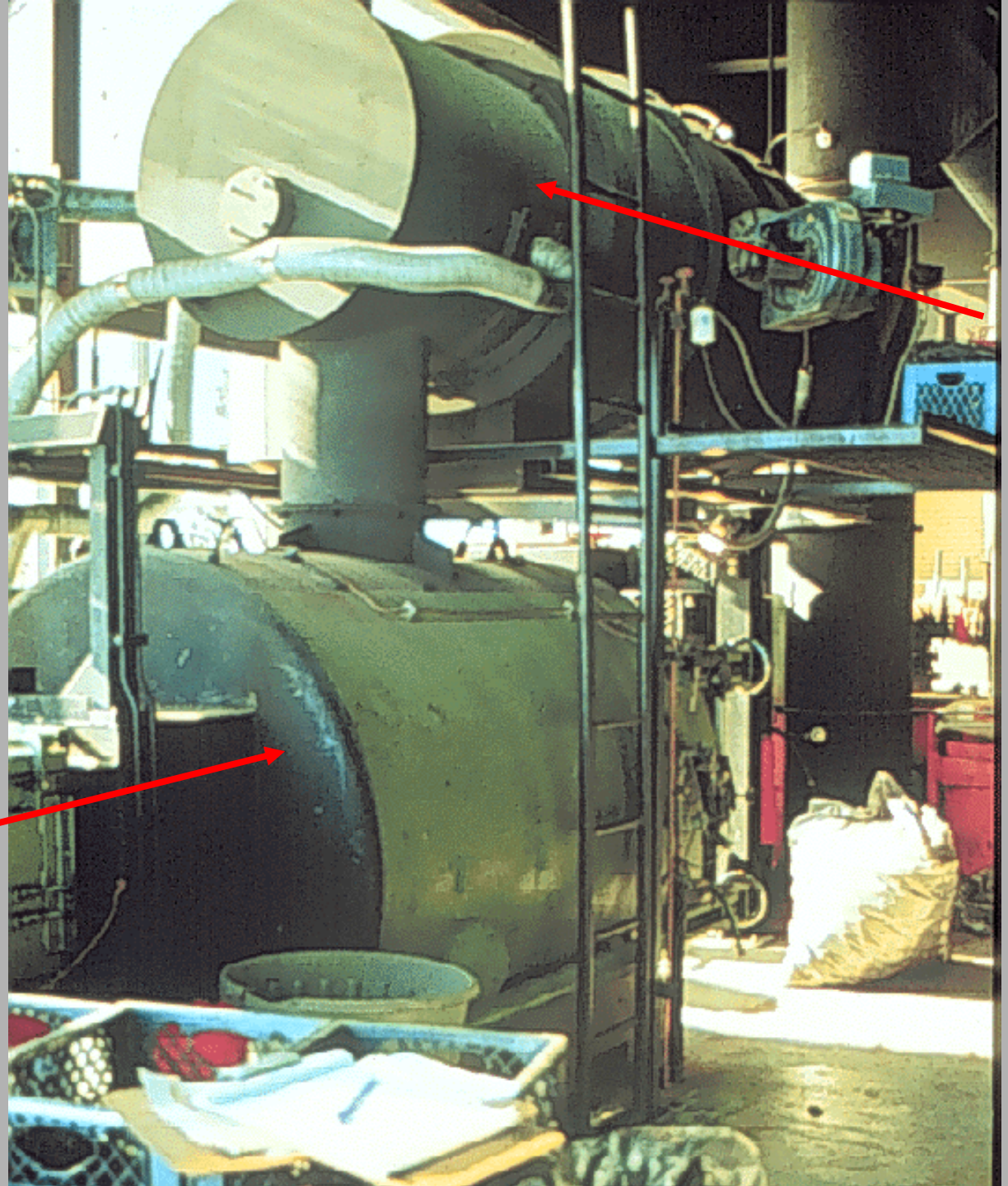
Controlled-Air Incinerator with Staged Hearth and Automatic Ash Removal




Stages
Al
Rams

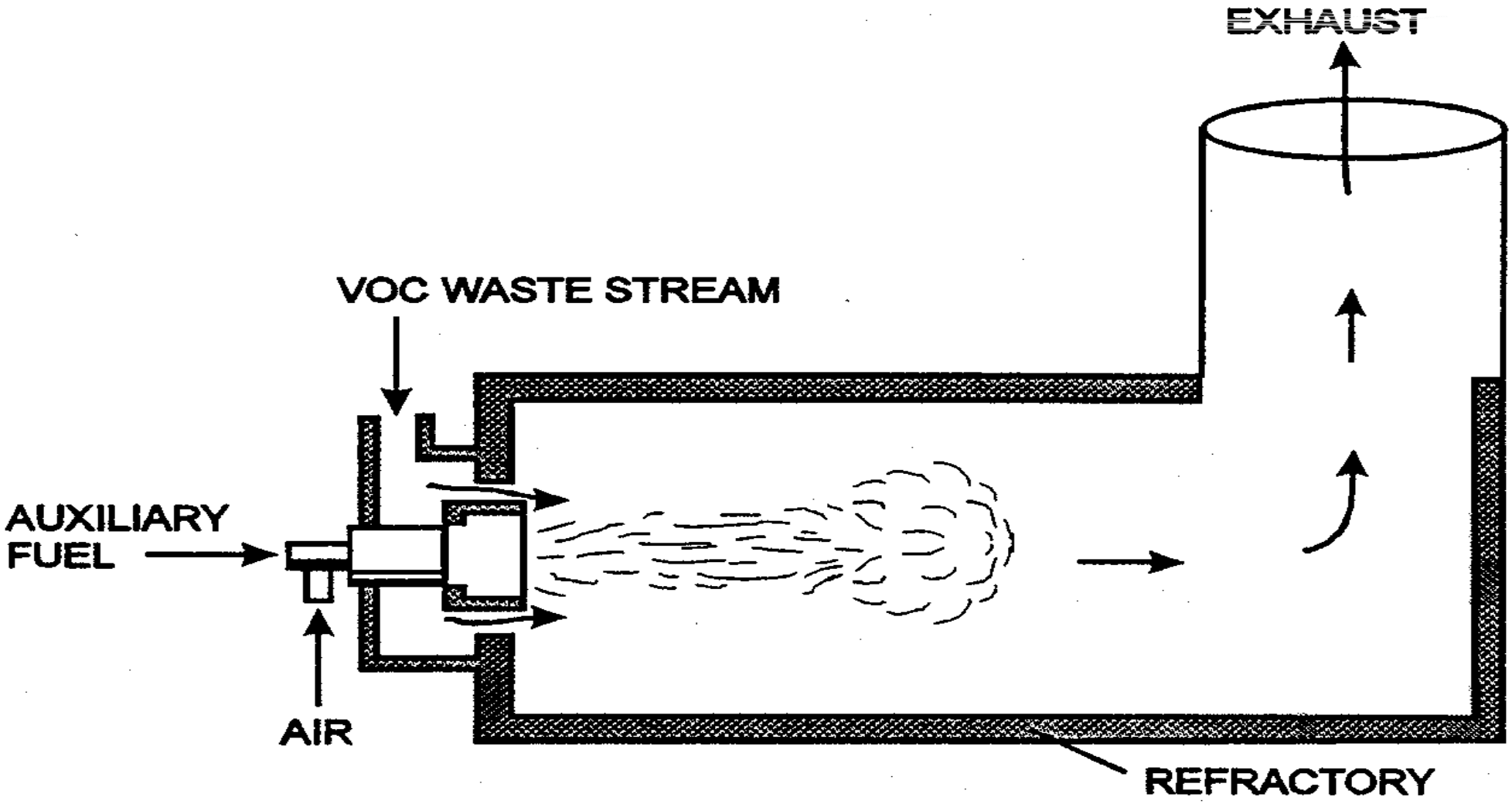
Controlled Air Incinerator Components



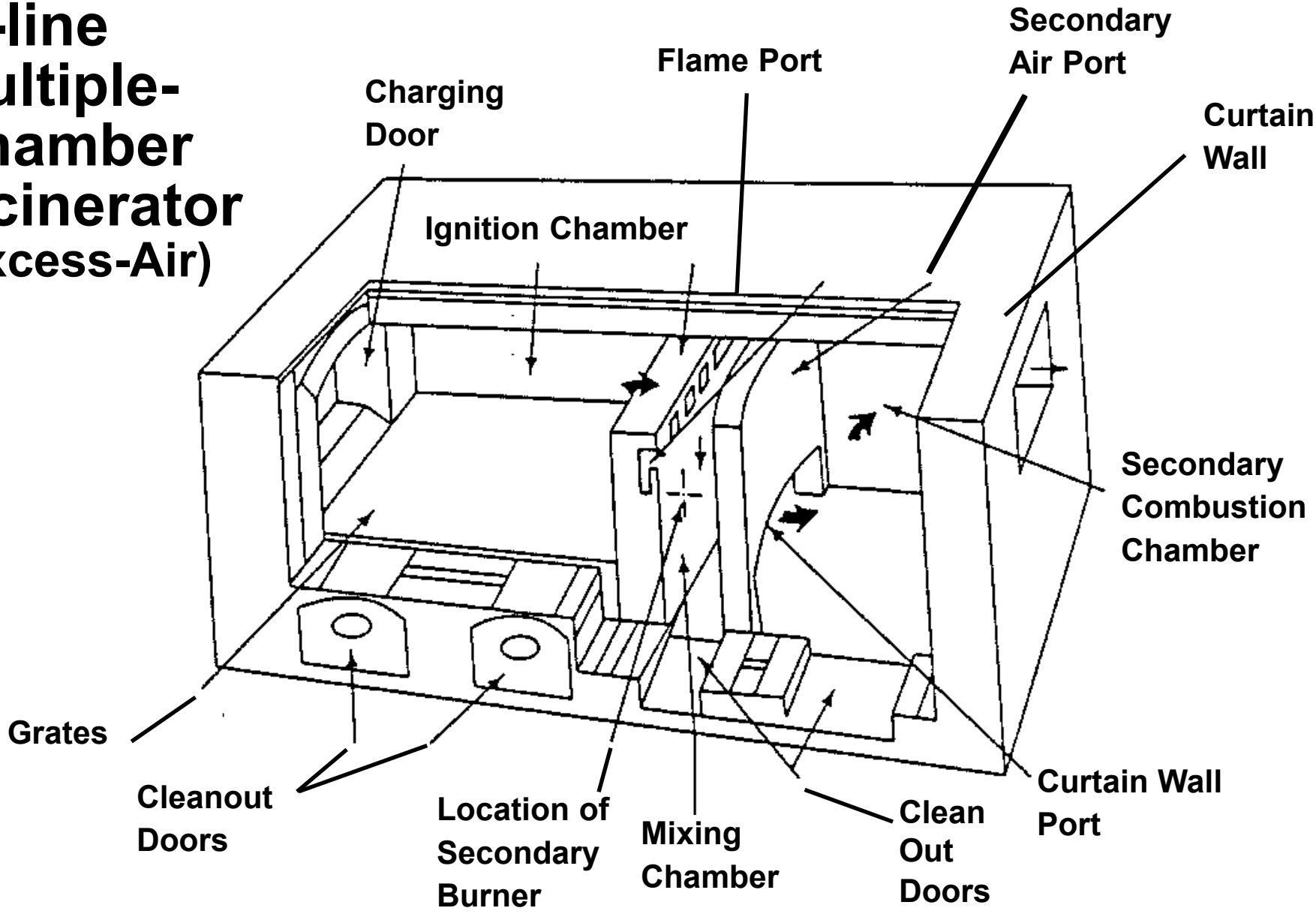

Secondary
Primary


Blower

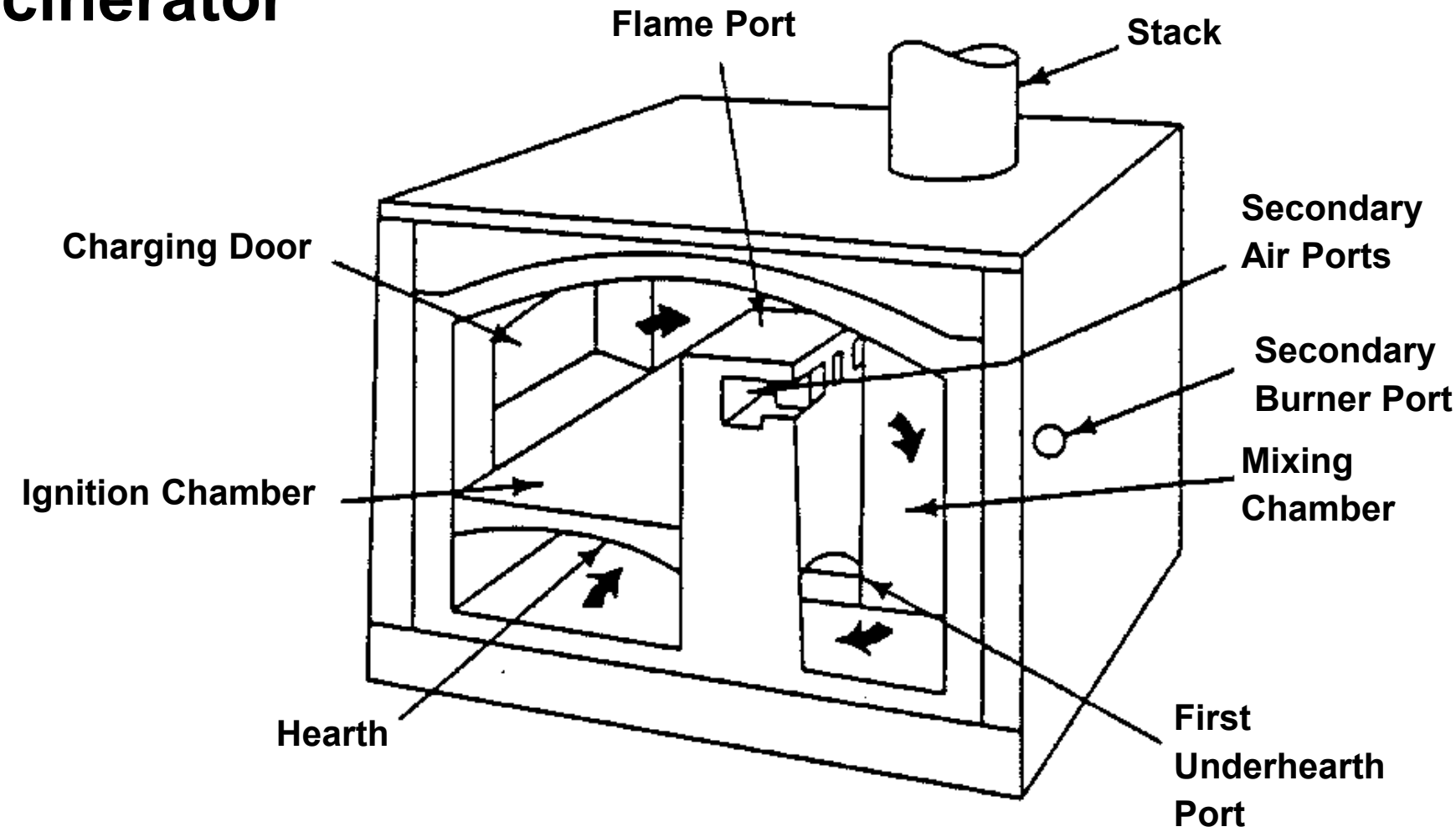
AFTERBURNER

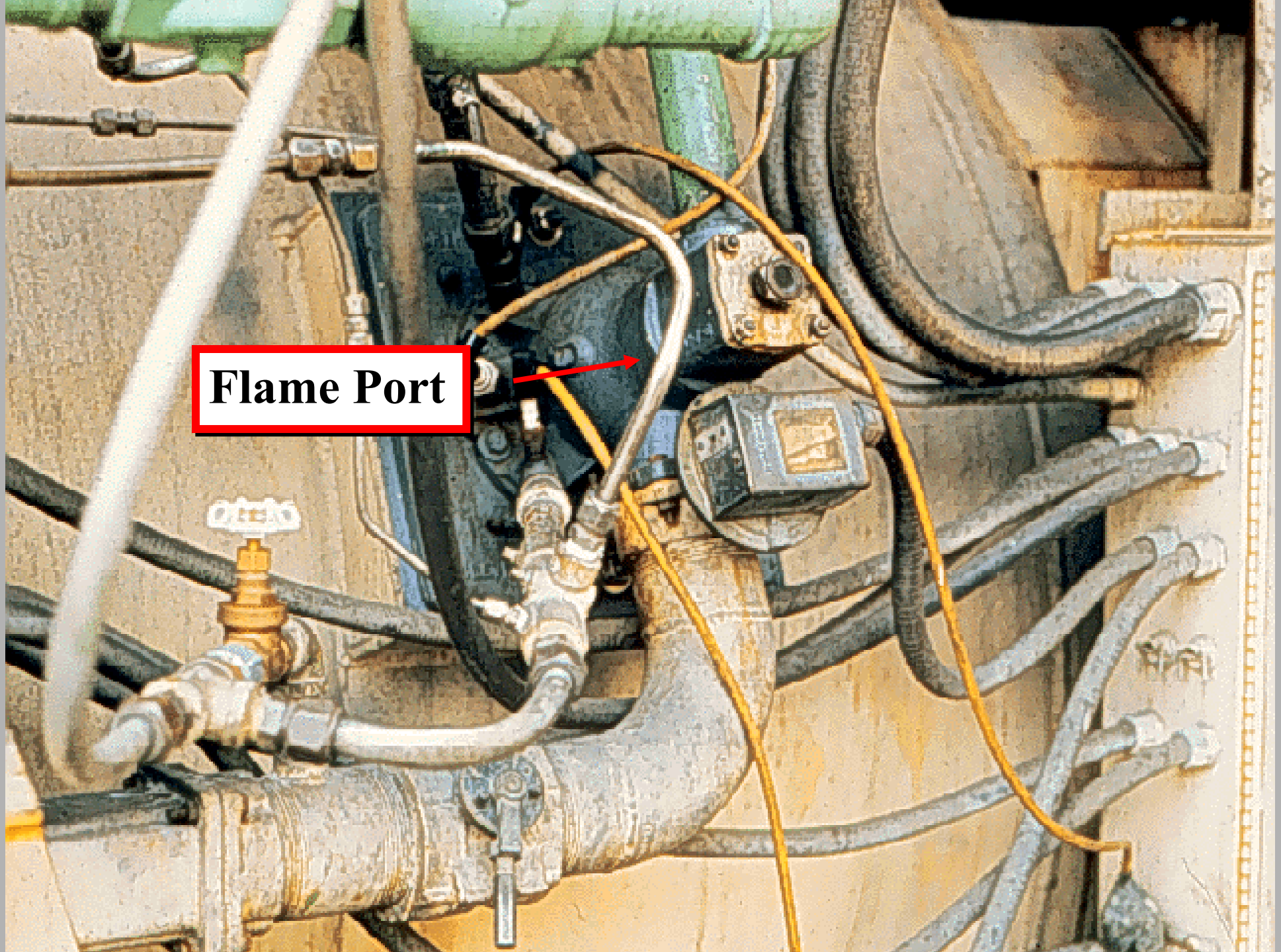


In-line Multiple-Chamber Incinerator (Excess-Air)

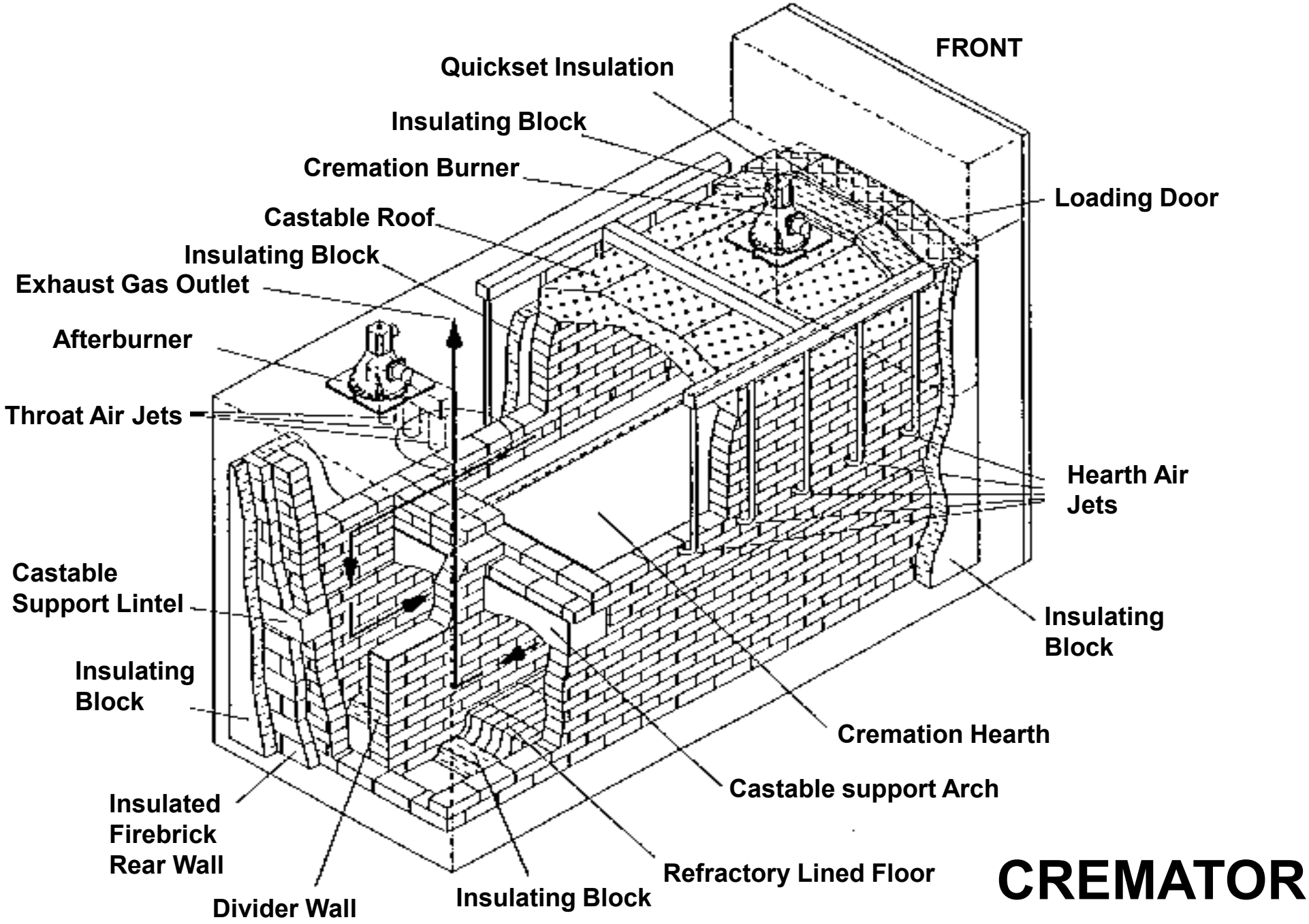


Retort
Multiple Chamber
Incinerator




Flame Port


LEAVE
OPEN
1/4


FRONT
Quickset Insulation
Insulating Block
Cremation Burner
Castable Roof
Insulating Block
Exhaust Gas Outlet
Afterburner
Throat Air Jets
Loading Door
Hearth Air Jets
Castable Support Lintel
Insulating Block
Insulating Block
Cremation Hearth
Castable support Arch
Insulated Firebrick Rear Wall
Divider Wall
Insulating Block
Refractory Lined Floor
CREMATOR

Stainless Steel Stack

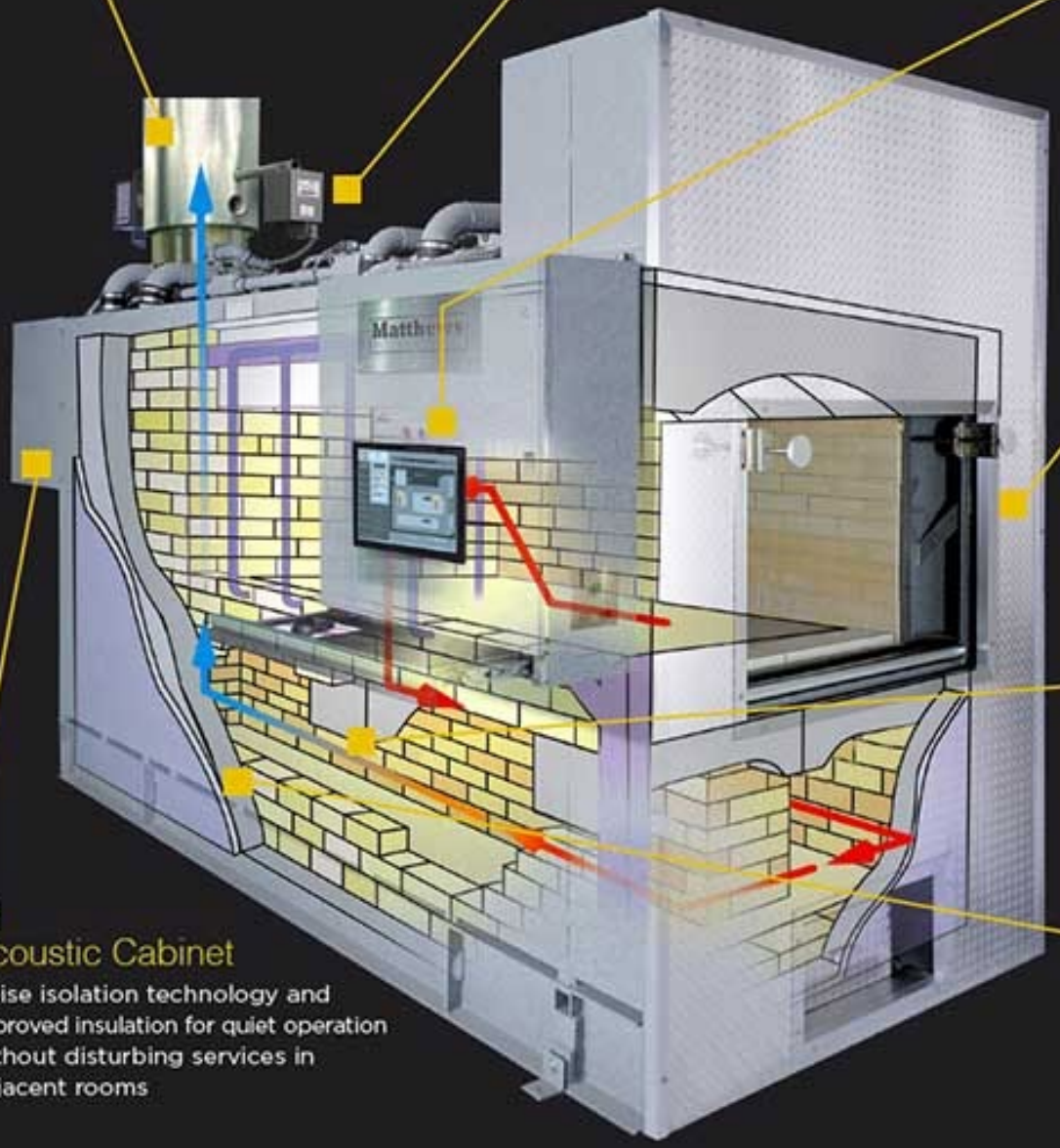
Non-Corrosive, with 4½" refractory lining for strength, durability and facility safety.

Emission Monitoring System

Opacity sensor automatically monitors and corrects any visible smoke leaving the system.

M-pyre® 2.0 Operating Controls

18.5 inch Hi-Definition color monitor with keyboard, mouse and PC interface. Web-based system with live operating graphics.



Oversize Loading Door

43" wide for larger cases. Automatic, self-locking, self-sealing, pressurized door system to control oxygen and maximize combustion.

Smoke-Buster™ System

Largest secondary combustion chamber in its class — 96 cu. ft. — for complete combustion of smoke and odor.

Air-Cooled Side Panels

Operational safety of the equipment to protect both your staff and the facility.

Acoustic Cabinet

Noise isolation technology and improved insulation for quiet operation without disturbing services in adjacent rooms

*PowerPak II PLUS shown with standard configuration.

Categories of Industrial Incinerators

- **Volume Reduction (trash, wood, solid waste streams)**
- **Toxicity Reduction (any toxic waste stream)**
- **Resource Recovery (copper wire, steel drums, electric motors)**
- **Energy Recovery**

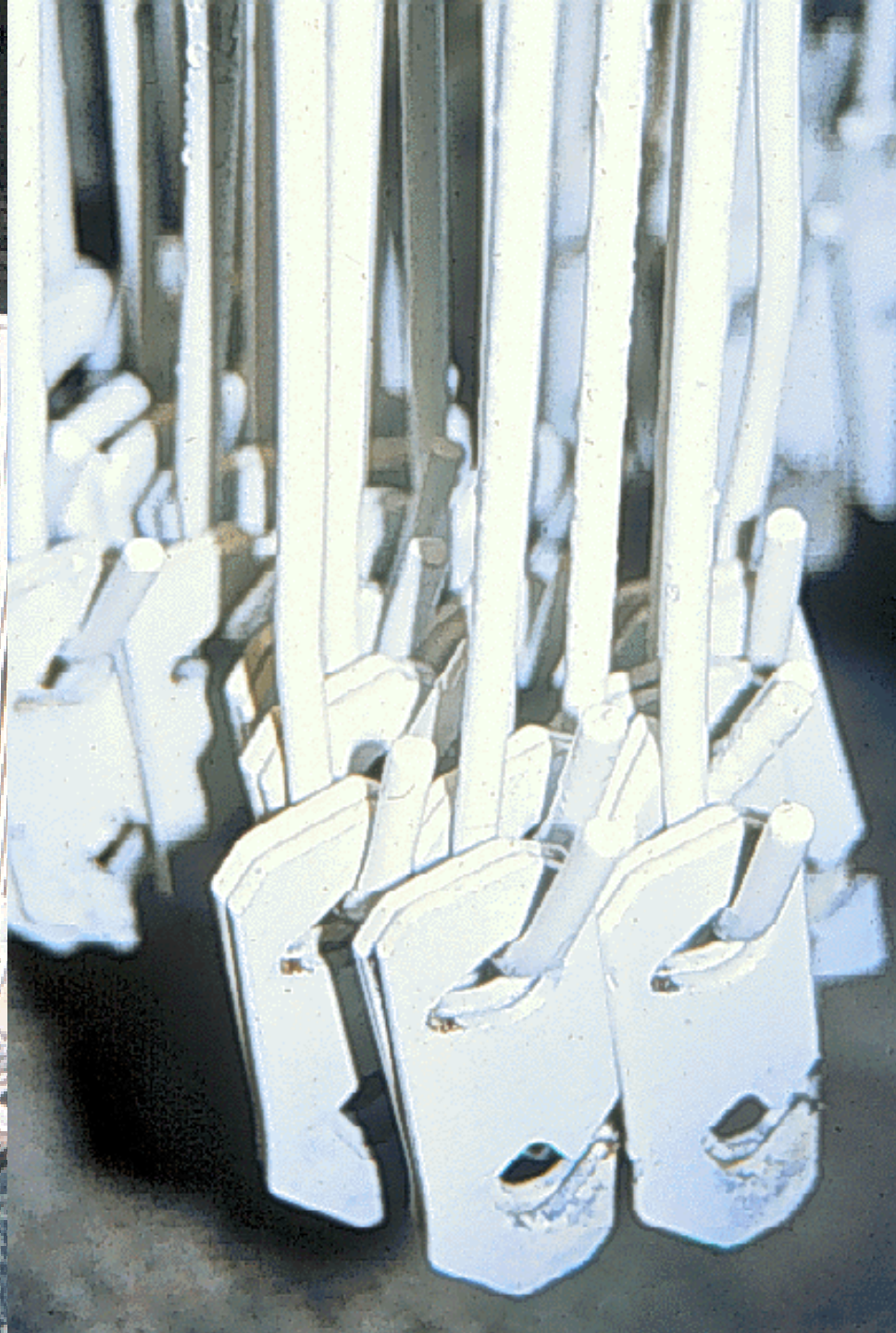
Industrial Heat Cleaning (Burnout) Ovens

- **Primary Chamber 700 - 750 F**
- **Secondary Chamber 1200 -1400 F**
- **Roasting Condition in Primary**
- **Low Oxygen Environment**
- **Volatiles & Smoke go to Afterburner**
- **Water Mist Injection in Primary**


SAFETY
FIRST
EYE PROTECTION
MUST BE WORN
IN THIS AREA


750 DEG. MAX.
FAHRENHEIT
400
800
1200
1600
2000
0
200
400
600
800
1000
CENTIGRADE


BAYCO

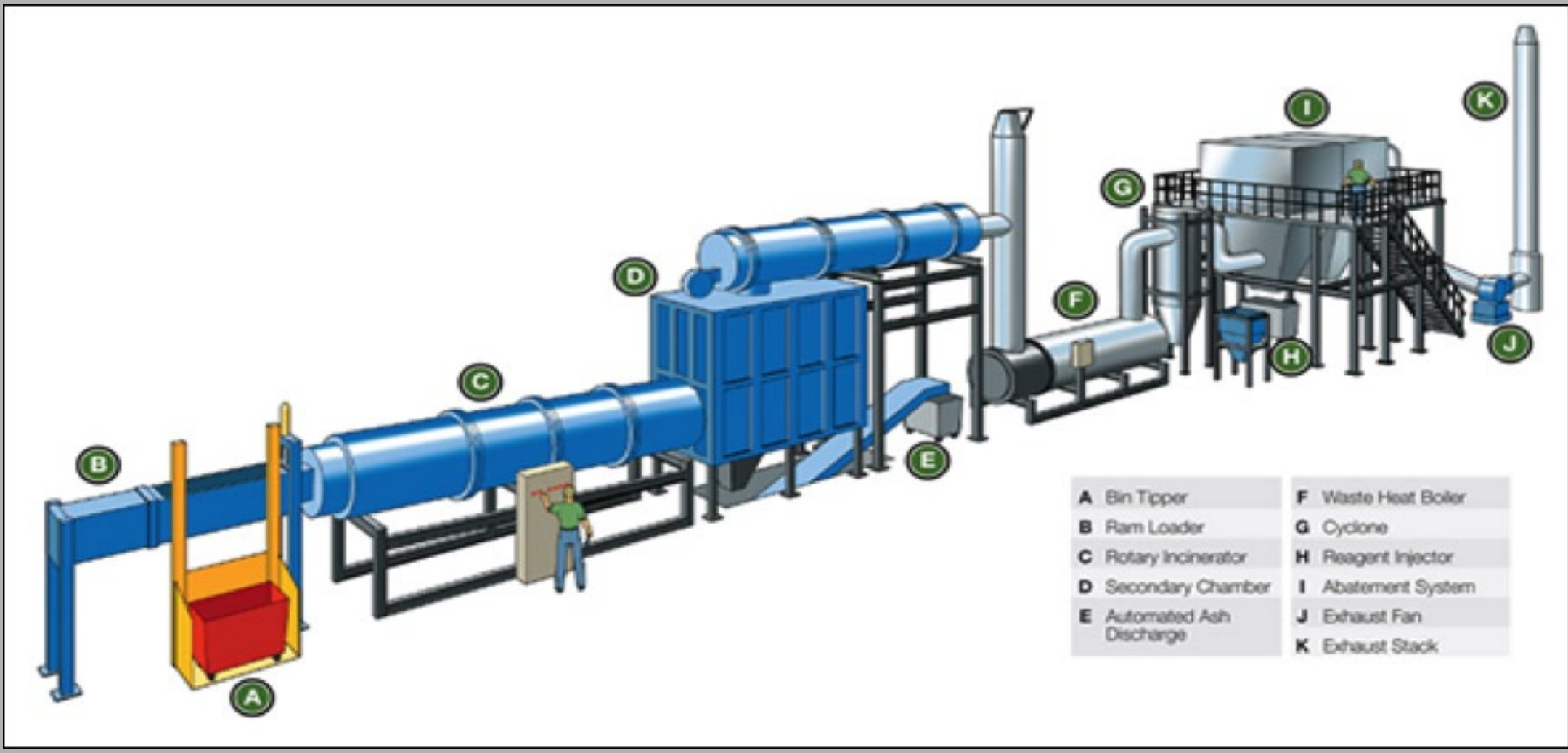



addfield
Incinerate • Cremate

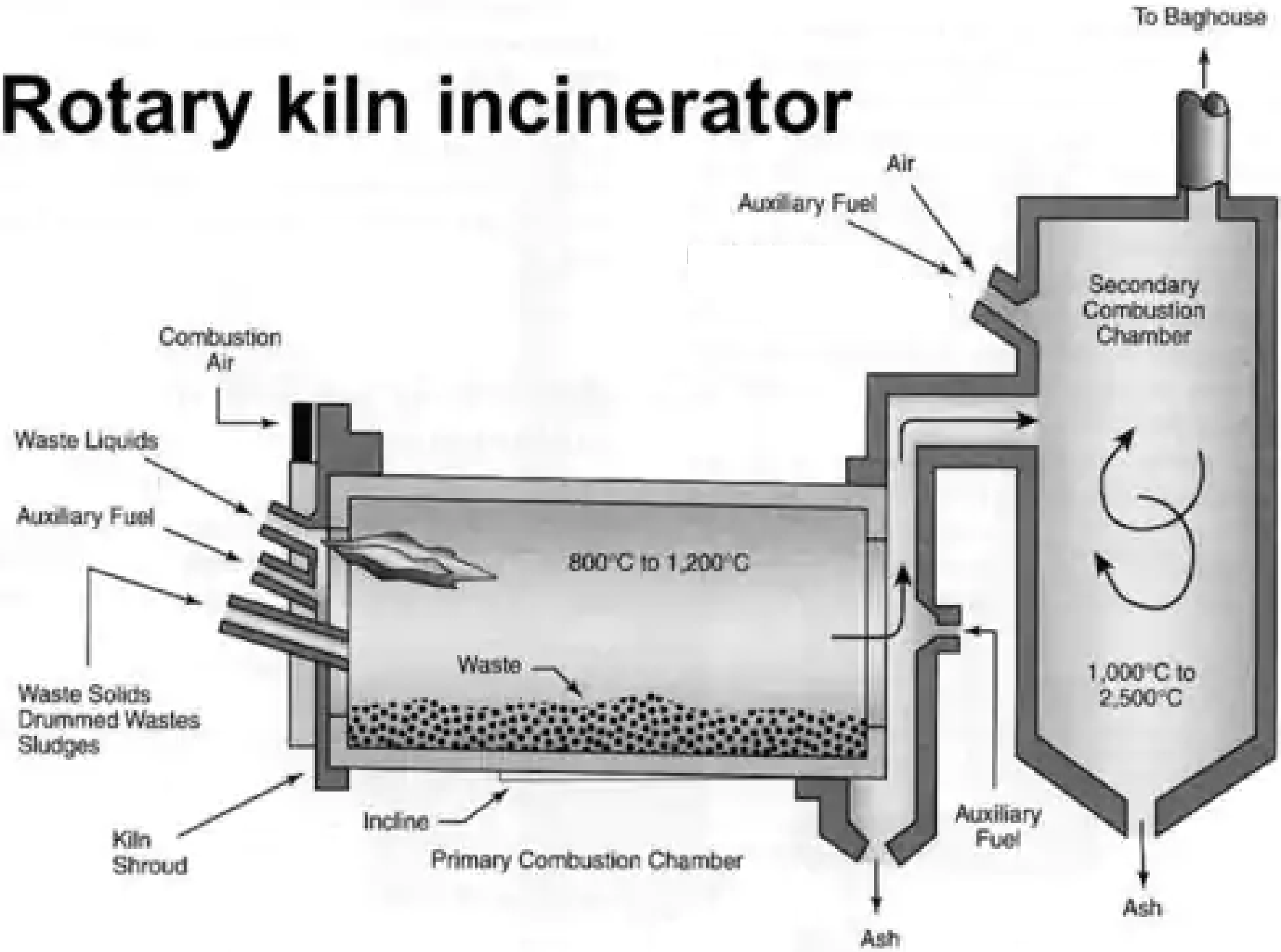

CAT
Air Burners


Air Burners LLC

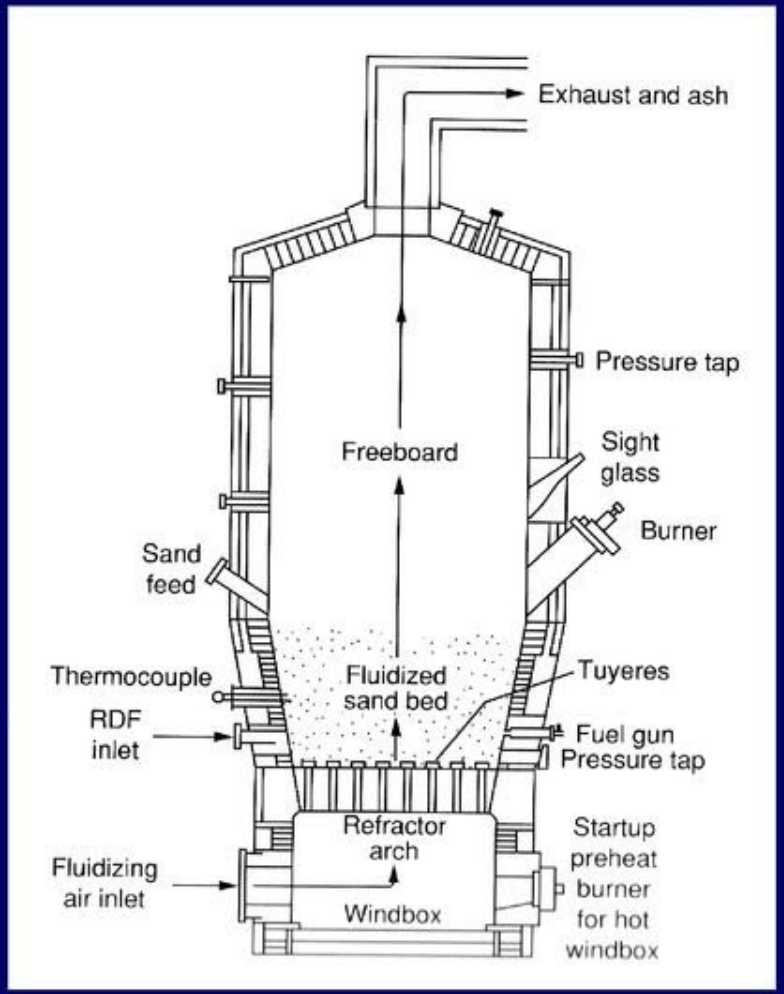
Rotary kiln

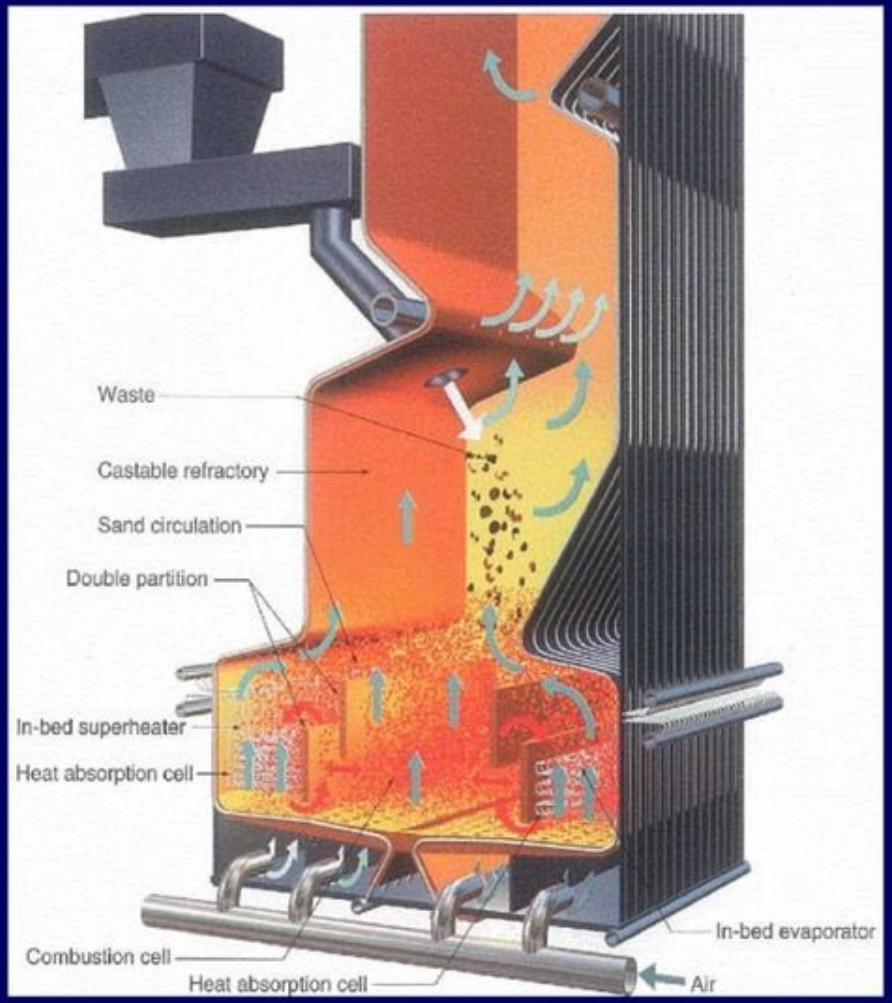

A
B
C
D
E
F
G
H
I
J
K
A Bin Tipper
B Ram Loader
C Rotary Incinerator
D Secondary Chamber
E Automated Ash Discharge
F Waste Heat Boiler
G Cyclone
H Reagent Injector
I Abatement System
J Exhaust Fan
K Exhaust Stack

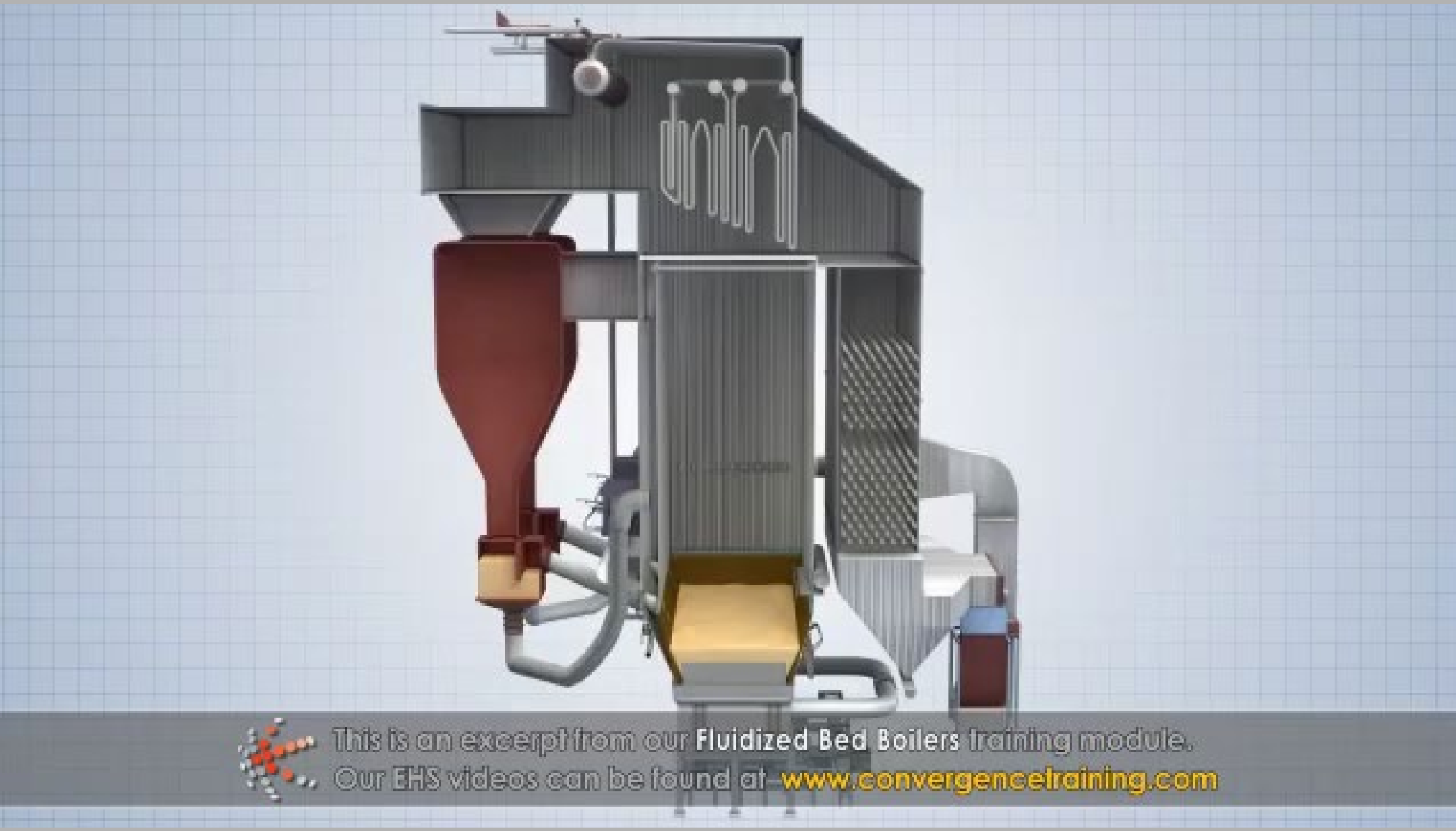
Rotary kiln incinerator

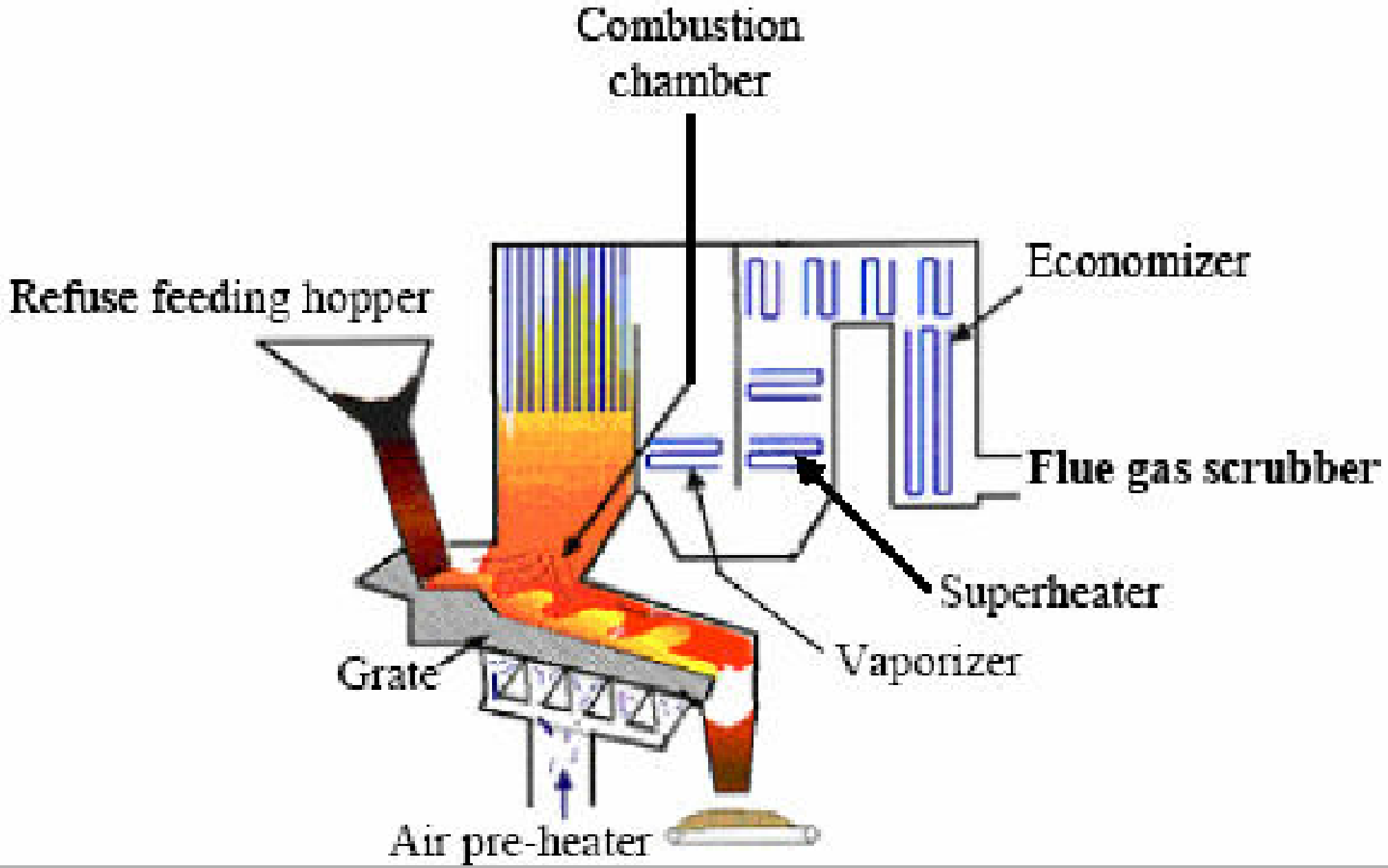


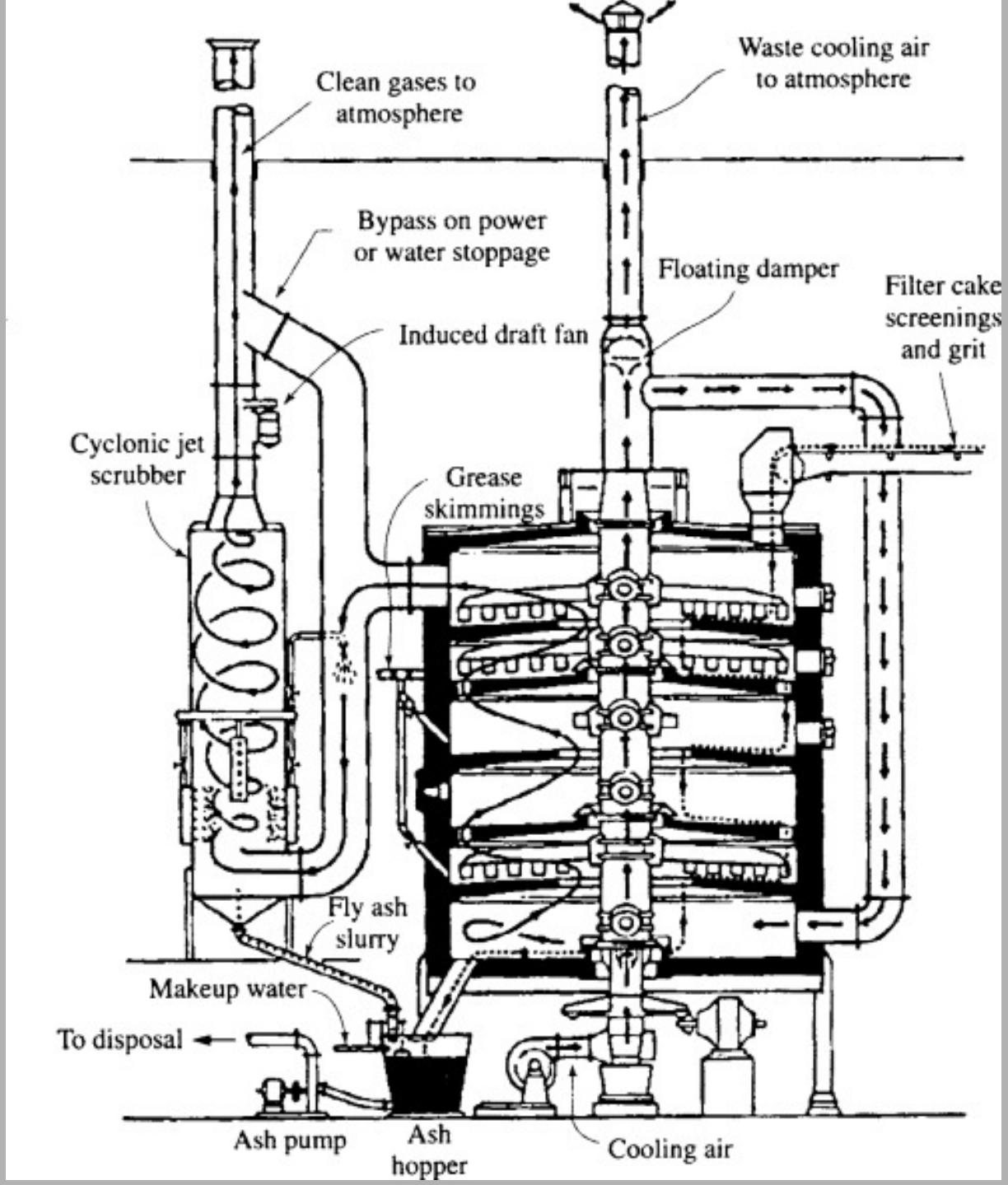
Fluidized bed combustion (FBC)






This is an excerpt from our Fluidized Bed Boilers training module.
Our EHS videos can be found at www.convergencetraining.com


Combustion chamber
Refuse feeding hopper
Economizer
Flue gas scrubber
Superheater
Vaporizer
Grate
Air pre-heater


Clean gases to atmosphere
Waste cooling air to atmosphere
Bypass on power or water stoppage
Floating damper
Filter cake screenings and grit
Induced draft fan
Cyclonic jet scrubber
Grease skimmings
Fly ash slurry
Makeup water
To disposal
Ash pump
Ash hopper
Cooling air

Modes of Operation

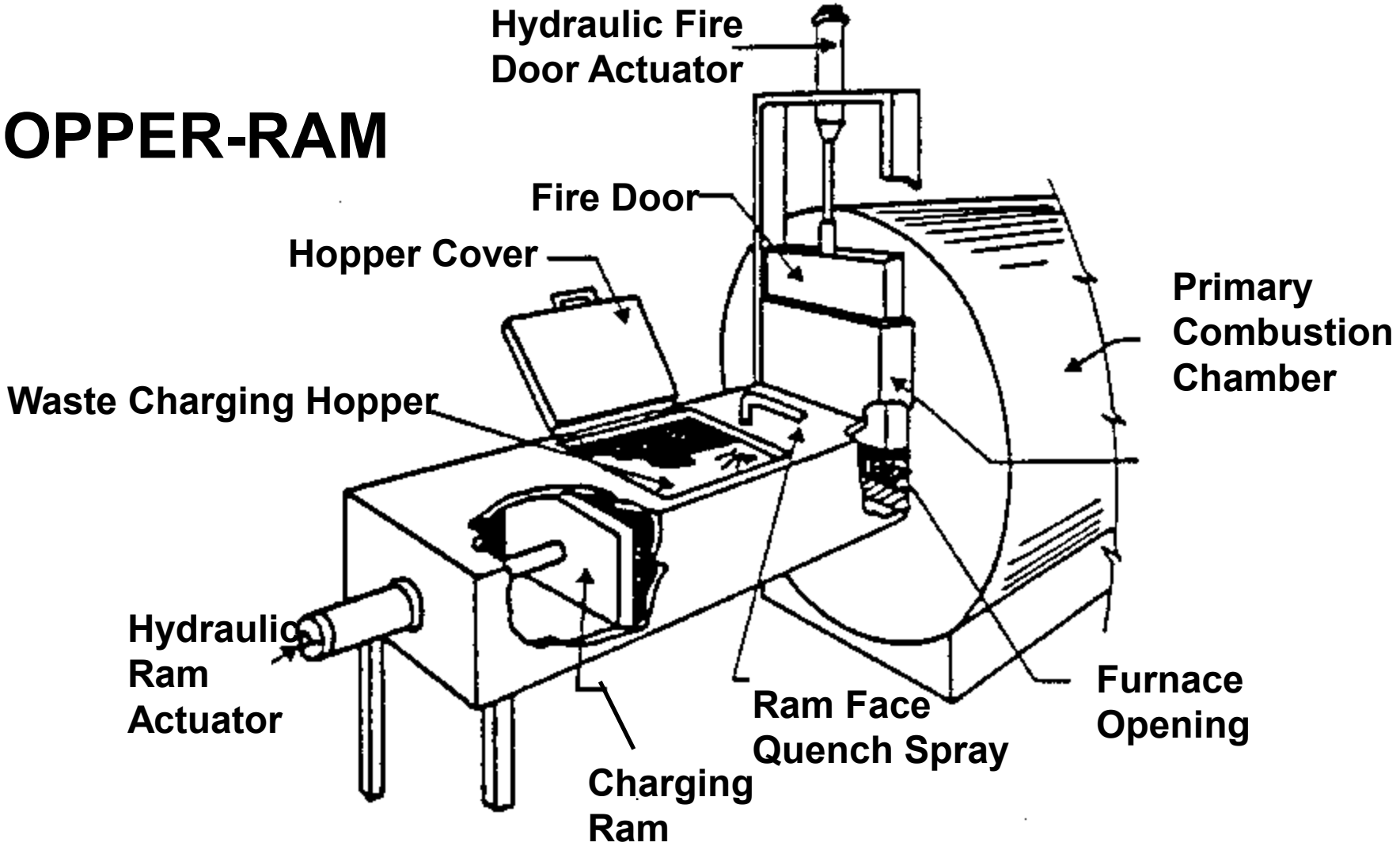
WASTE CHARGING:

- Batch
- Intermittent
- Continuous

ASH REMOVAL:

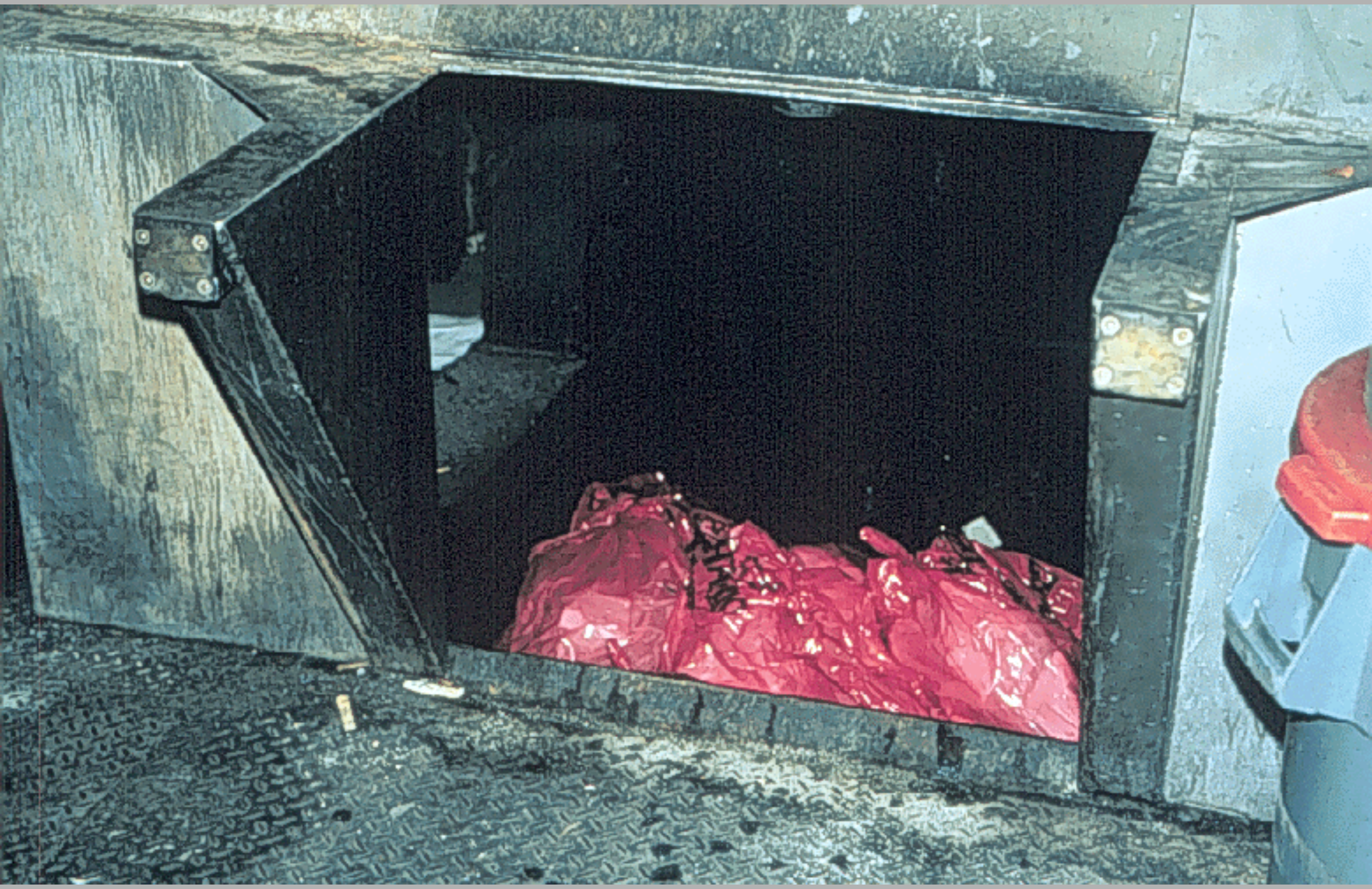
- Manual
- Automatic

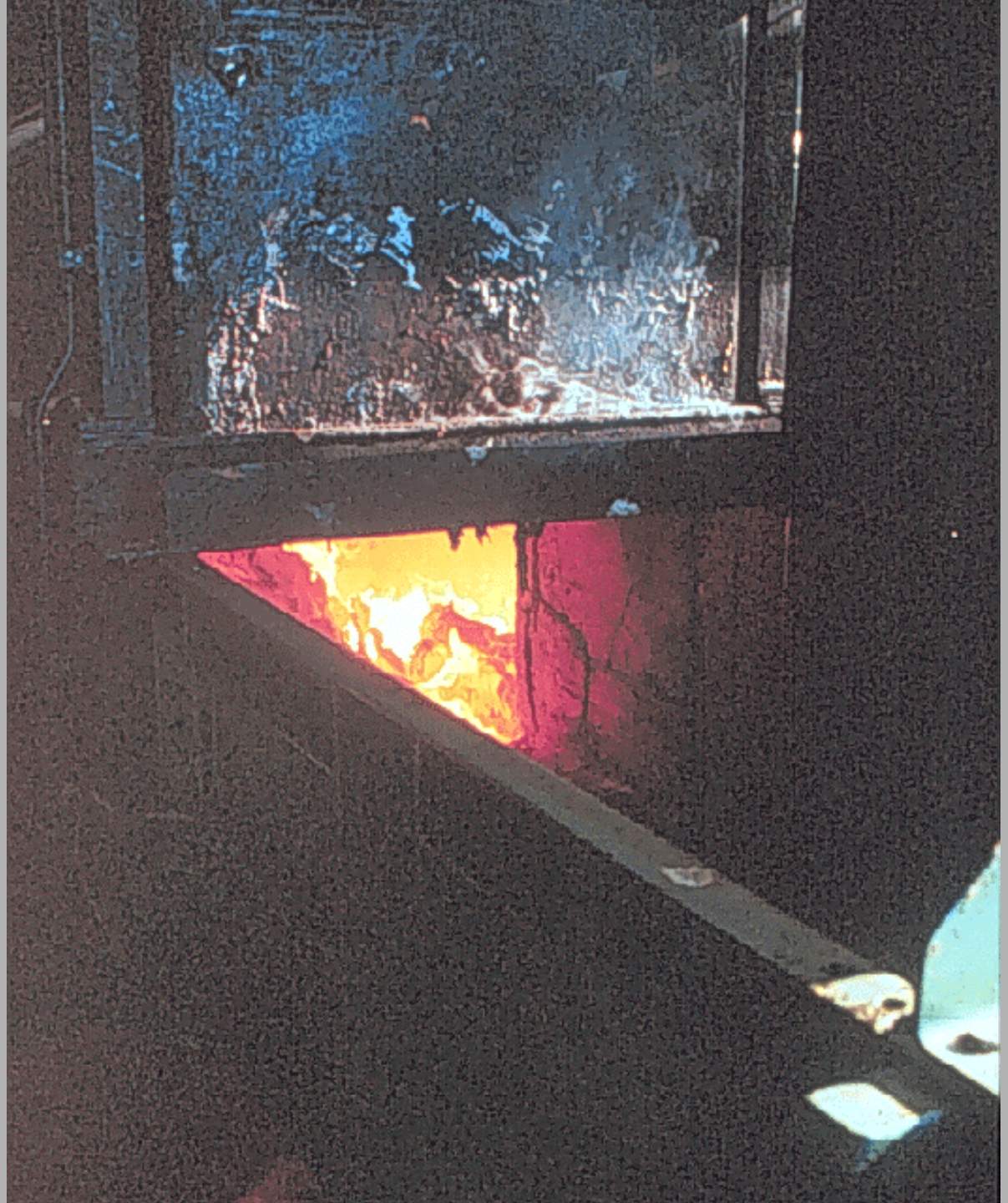
HOPPER-RAM

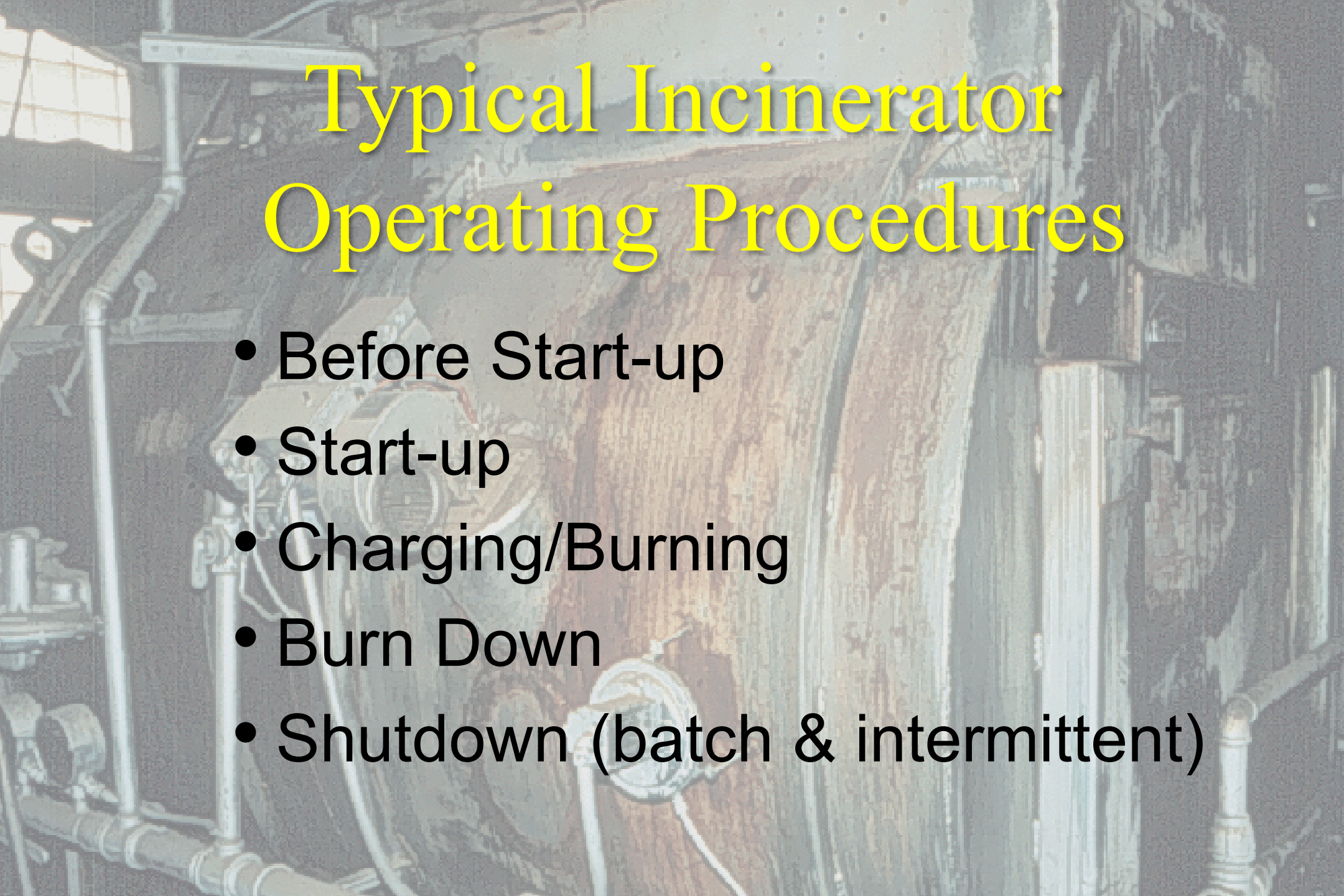

Hydraulic Fire Door Actuator
Fire Door
Hopper Cover
Primary Combustion Chamber
Waste Charging Hopper
Hydraulic Ram Actuator
Charging Ram
Ram Face Quench Spray
Furnace Opening


BIO-WASTE


ardous
ste
ESF







Typical Incinerator Operating Procedures

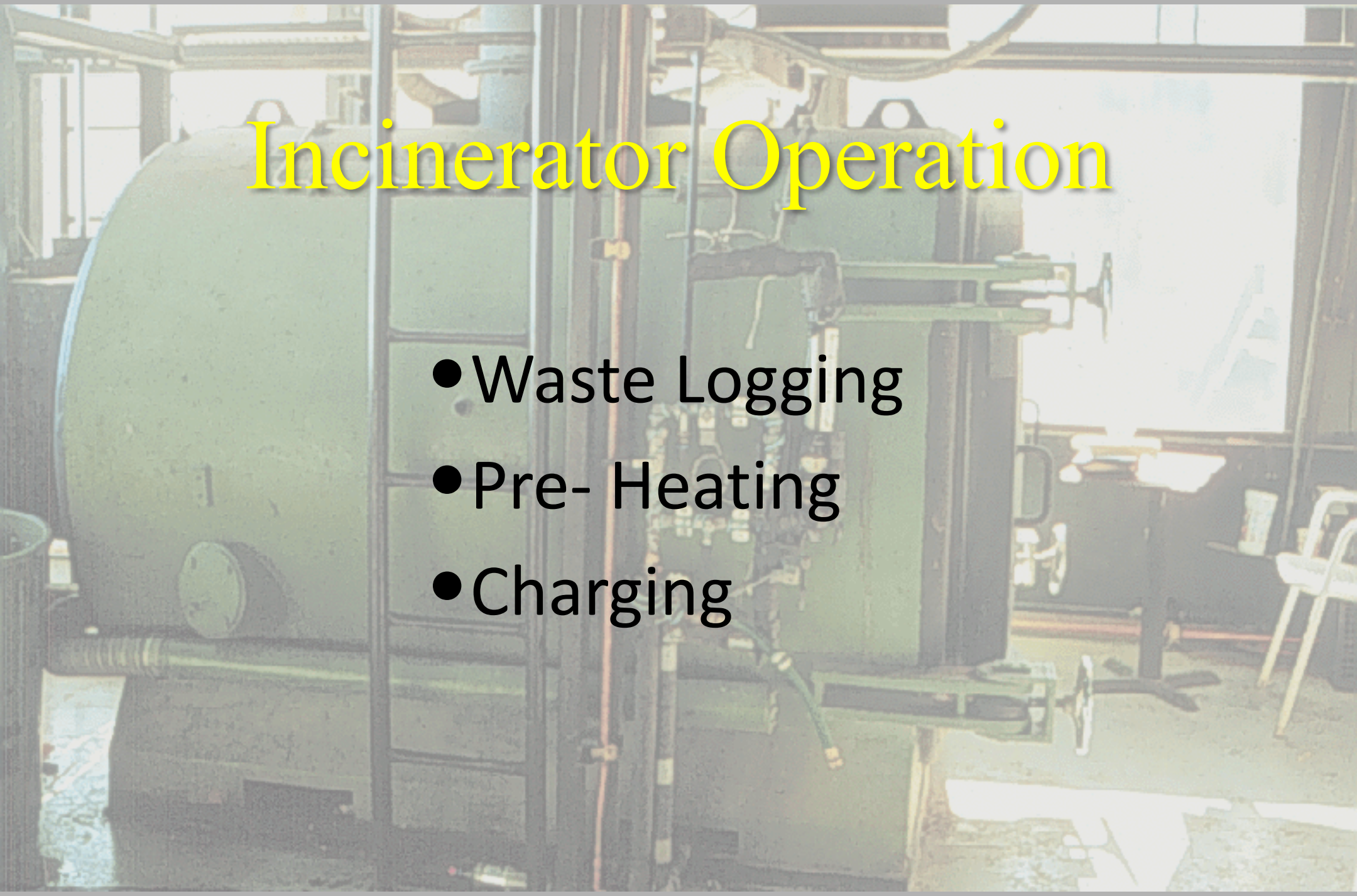
- Before Start-up
- Start-up
- Charging/Burning
- Burn Down
- Shutdown (batch & intermittent)

Before Incinerator Start-up

- Manual Ash Removal
- Automatic Ash Removal
- Routine Daily Inspection
- Burner & Blower Check

Typical Incinerator Operating Procedures

Operating Step	Typical Duration
1. Ash Cleanout	15 to 30 minutes
2. Pre-Heat	15 to 60 minutes
3. Charging & Burning	Up to 14 hours
4. Burndown	2 to 4 hours
5. Cooldown	5 to 8 hours



Incinerator Operation

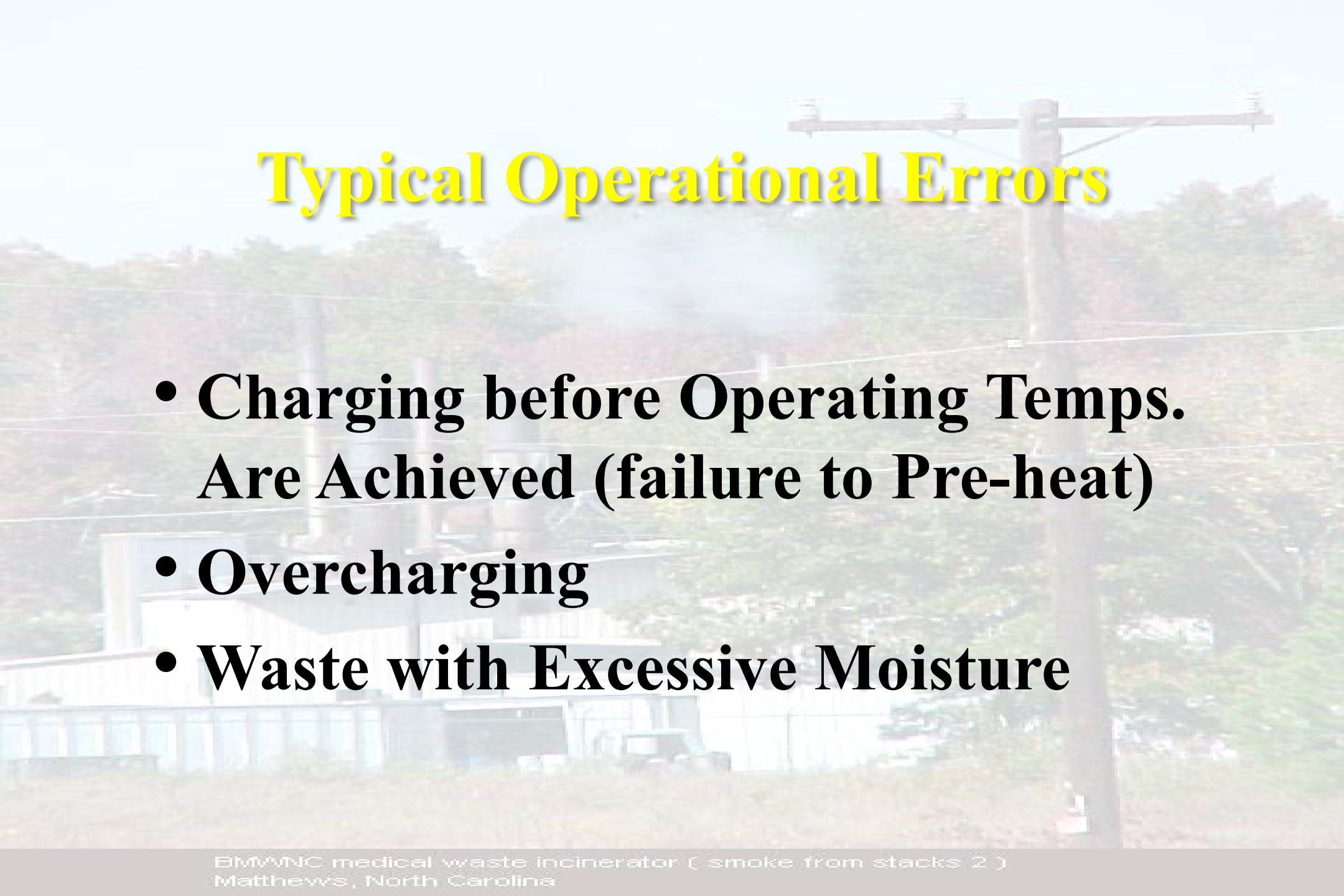
- Waste Logging
- Pre- Heating
- Charging

Shutdown

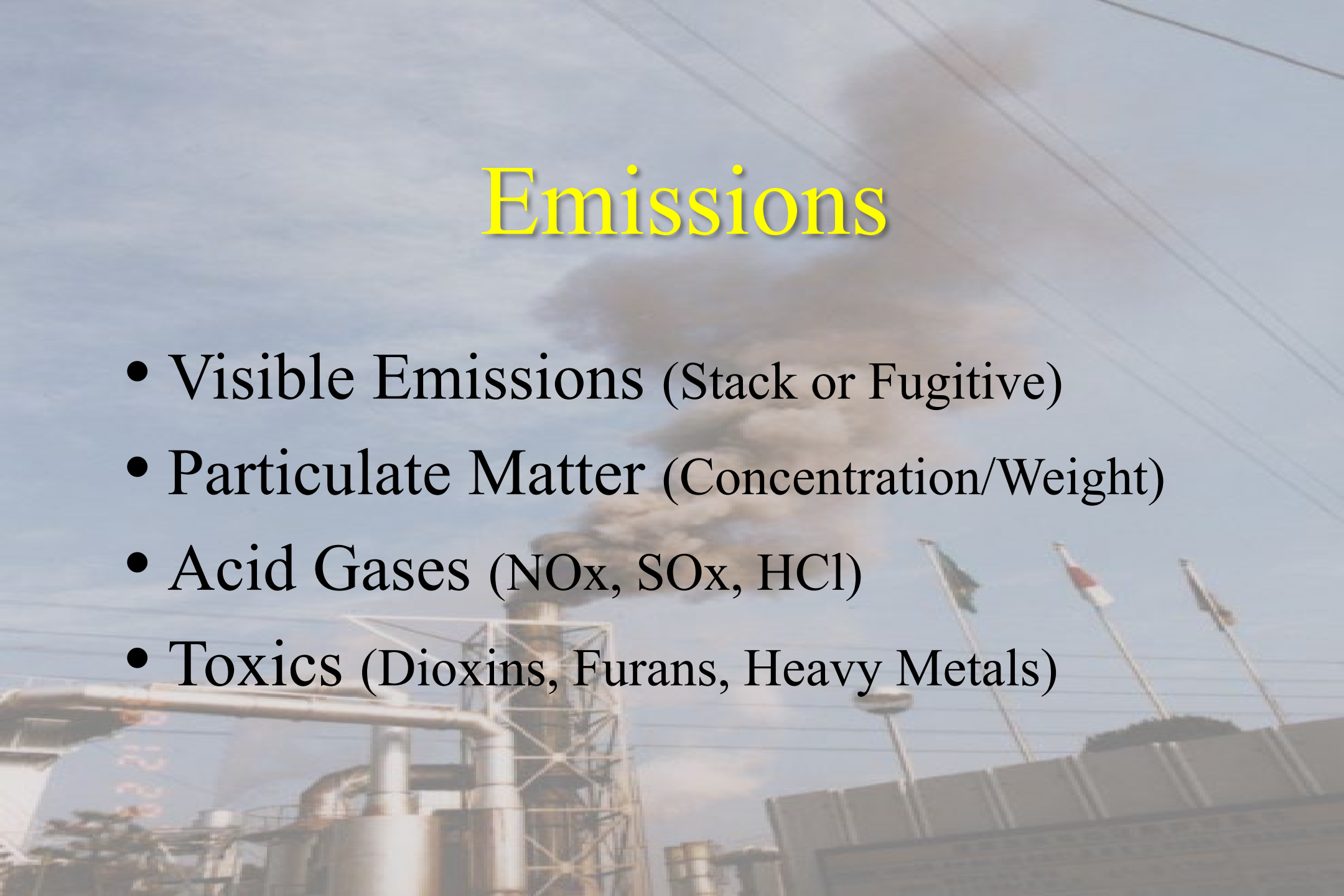
- Batch or Intermittent Duty:
  - Combustion Blowers left on to cool
  - Typically lasts 5 to 8 hours
  - Ash removed and inspected

Typical Operational Errors

- **Charging before Operating Temps. Are Achieved (failure to Pre-heat)**
- **Overcharging**
- **Waste with Excessive Moisture**




Incinerator
Emissions
&
Control

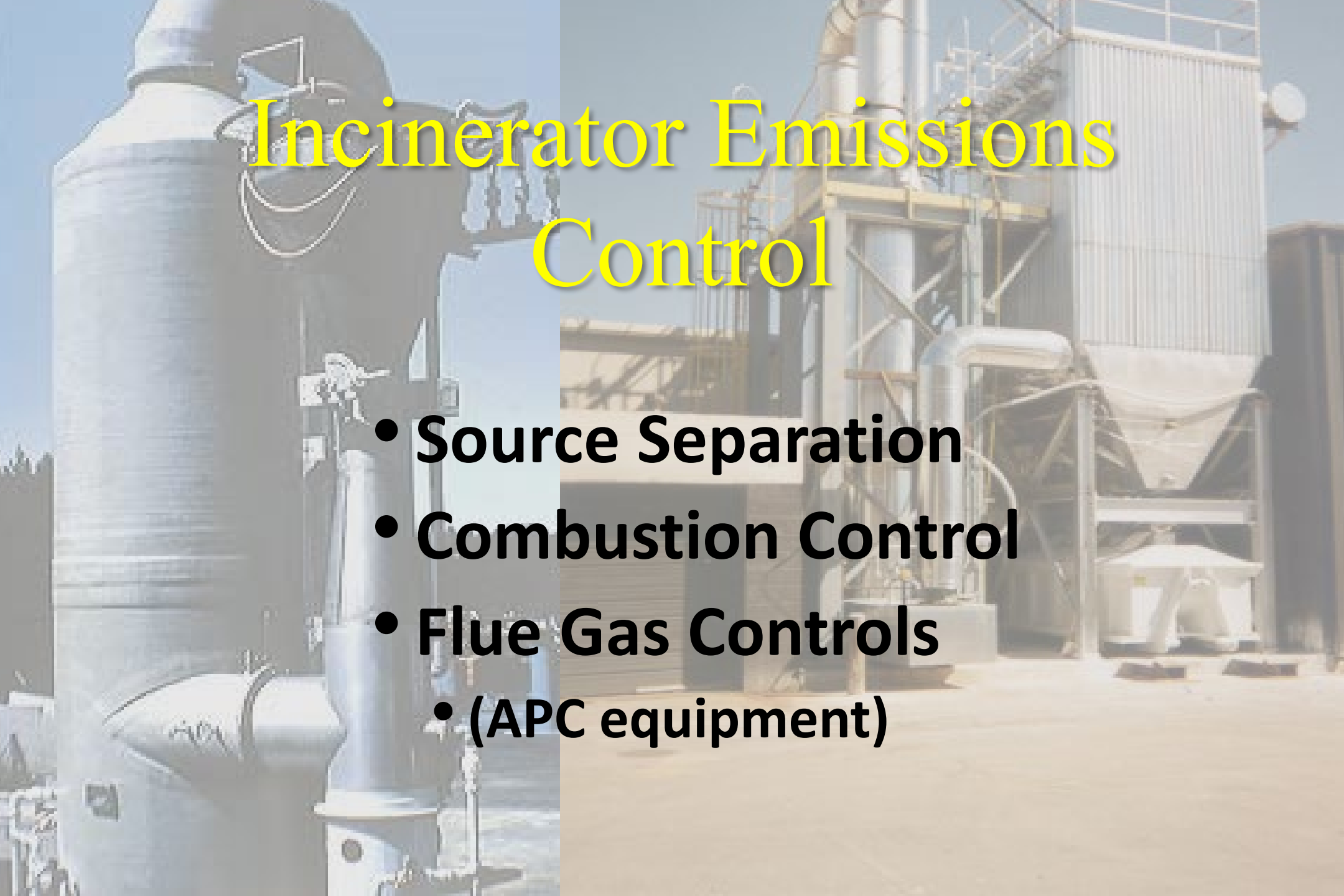


Emissions

- Visible Emissions (Stack or Fugitive)
- Particulate Matter (Concentration/Weight)
- Acid Gases (NOx, SOx, HCl)
- Toxics (Dioxins, Furans, Heavy Metals)

Pollutant Formation Factors

- Fuel Composition
- Charging Method and Rate
- Incinerator Type and Design
- Combustion Conditions (3 T's)
- Excess Air



Incinerator Emissions Control

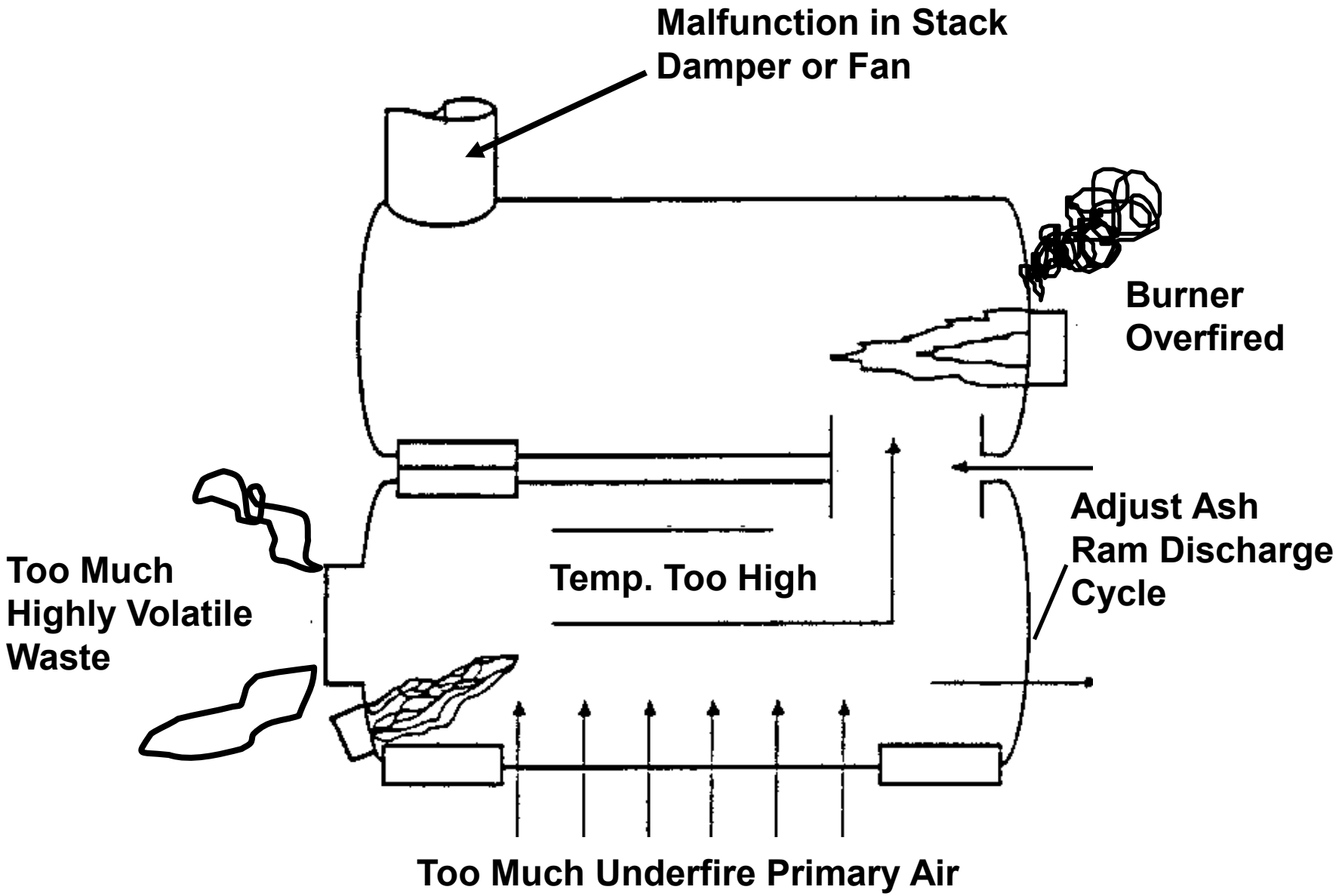
- Source Separation
- Combustion Control
- Flue Gas Controls
  - (APC equipment)

Particulate Matter Formation

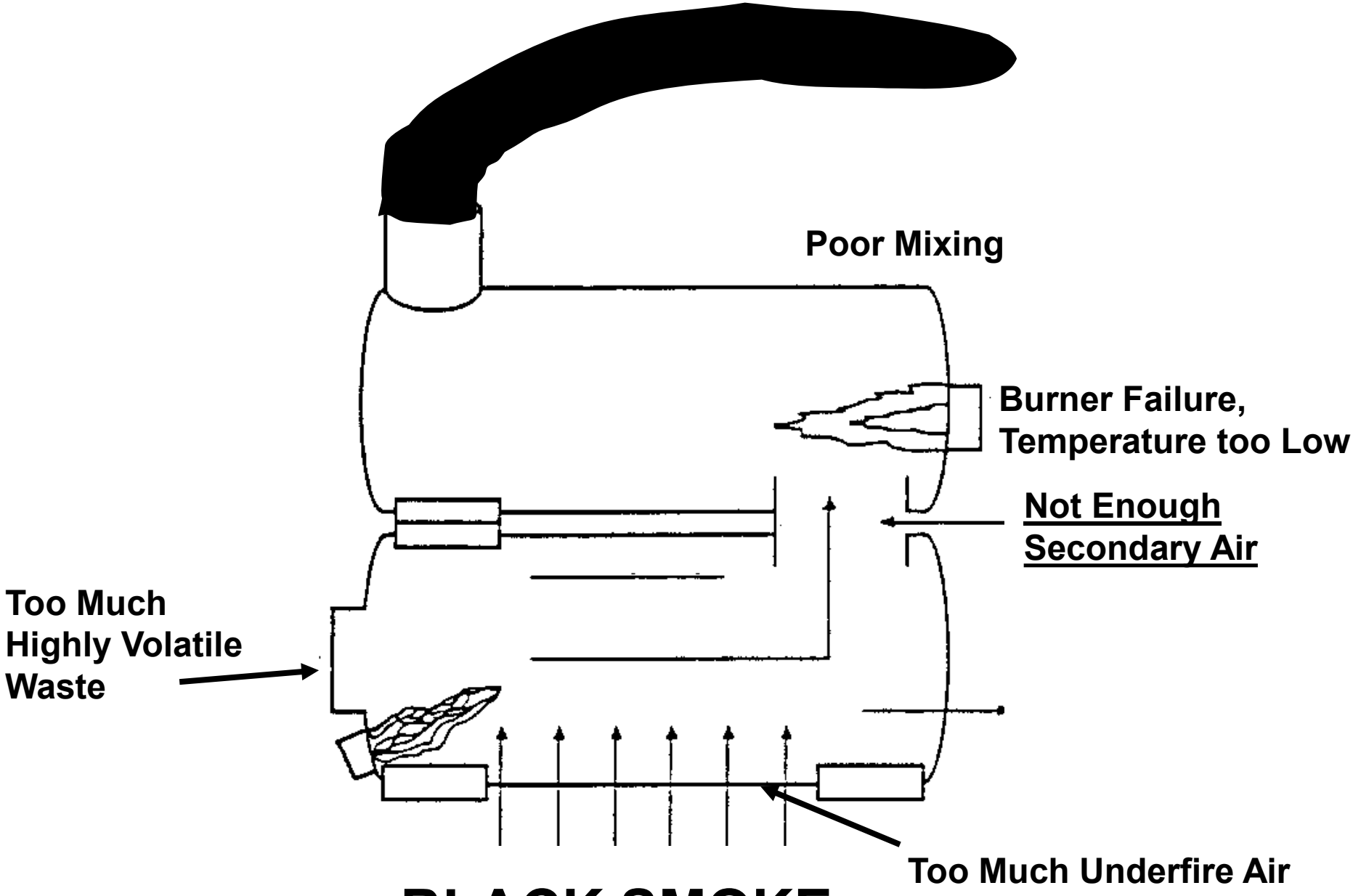
- Suspension of Inorganic Substances
- Incomplete Combustion of Fuel Materials
- Condensation of Vaporous Metals

Smoke Formation

- Black Smoke
  - Too Little Oxygen Relative to Fuel
  - Usually Caused by Overcharging
- White Smoke
  - Premature Cooling of Flue Gas
  - Excessive Air
  - Inorganic Particles

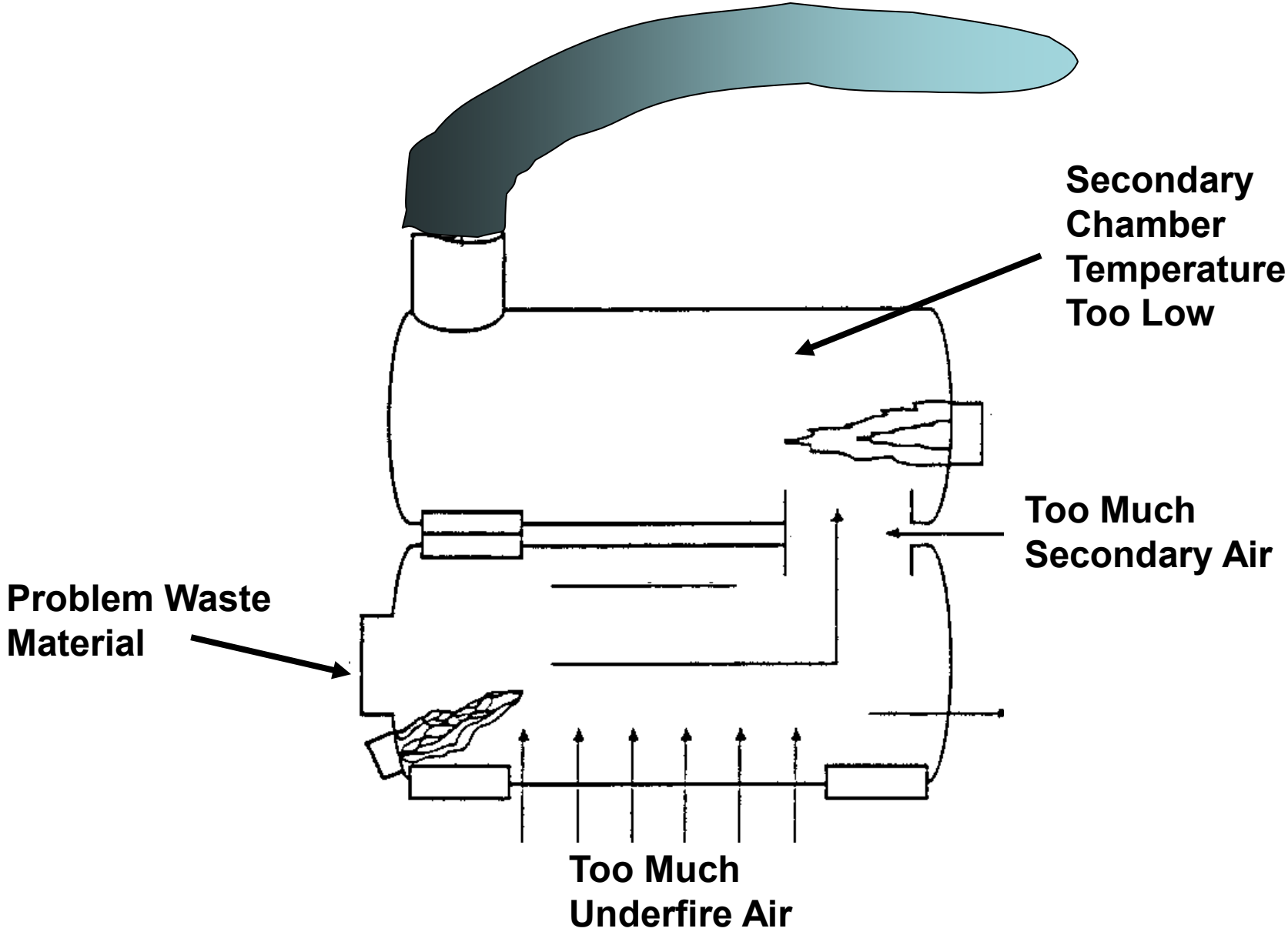


"POSITIVE" CONDITION - SMOKE LEAKING



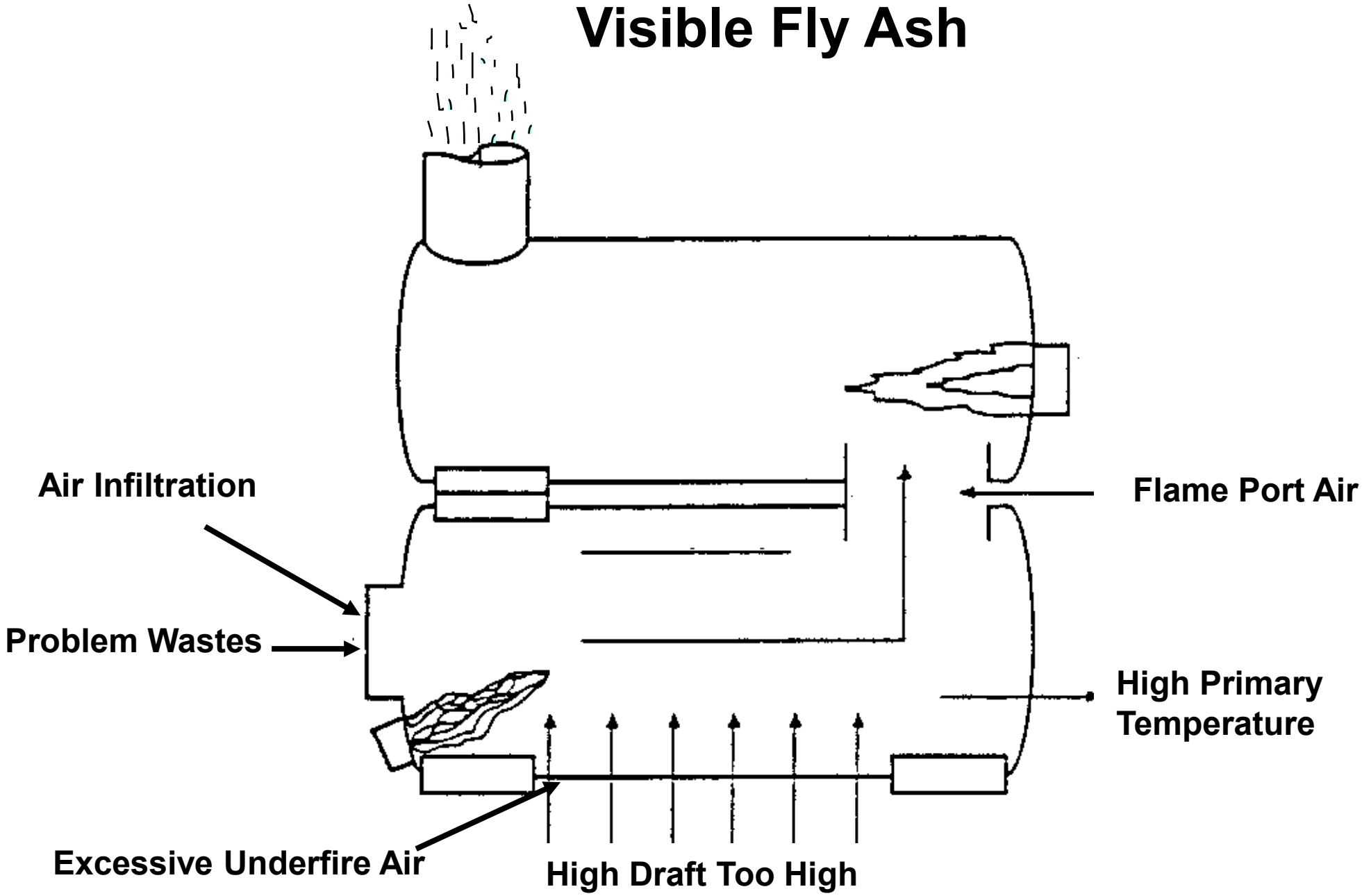
BLACK SMOKE

(Incomplete Burning - Soot Formation)



WHITE/BLUE SMOKE

Visible Fly Ash



Carbon Monoxide Formation

- Insufficient Oxygen for Complete Combustion
- Indicator of Inadequate Combustion Air Turbulence
- Indicator of Combustion Efficiency

Products of Incomplete Combustion (PIC's)

- Greater Combustion Efficiency = Lower Dioxins
- Can occur when charging PVC plastics
- Dioxins are some of the most toxic man-made substances
- Polycyclic Aromatic Hydrocarbons (PAH's)
- Polychlorinated Biphenyls (PCB's)

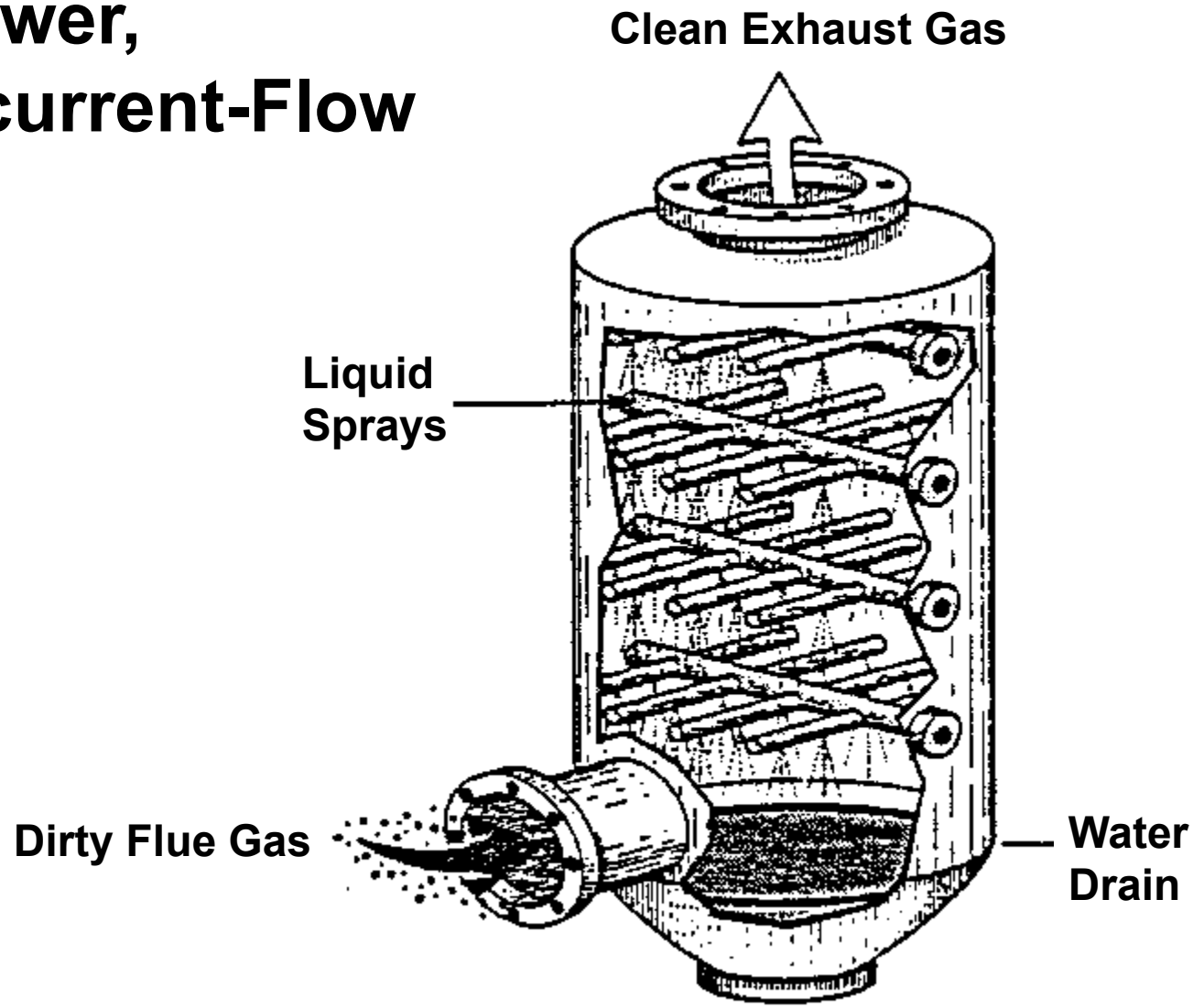
Wet Scrubbers

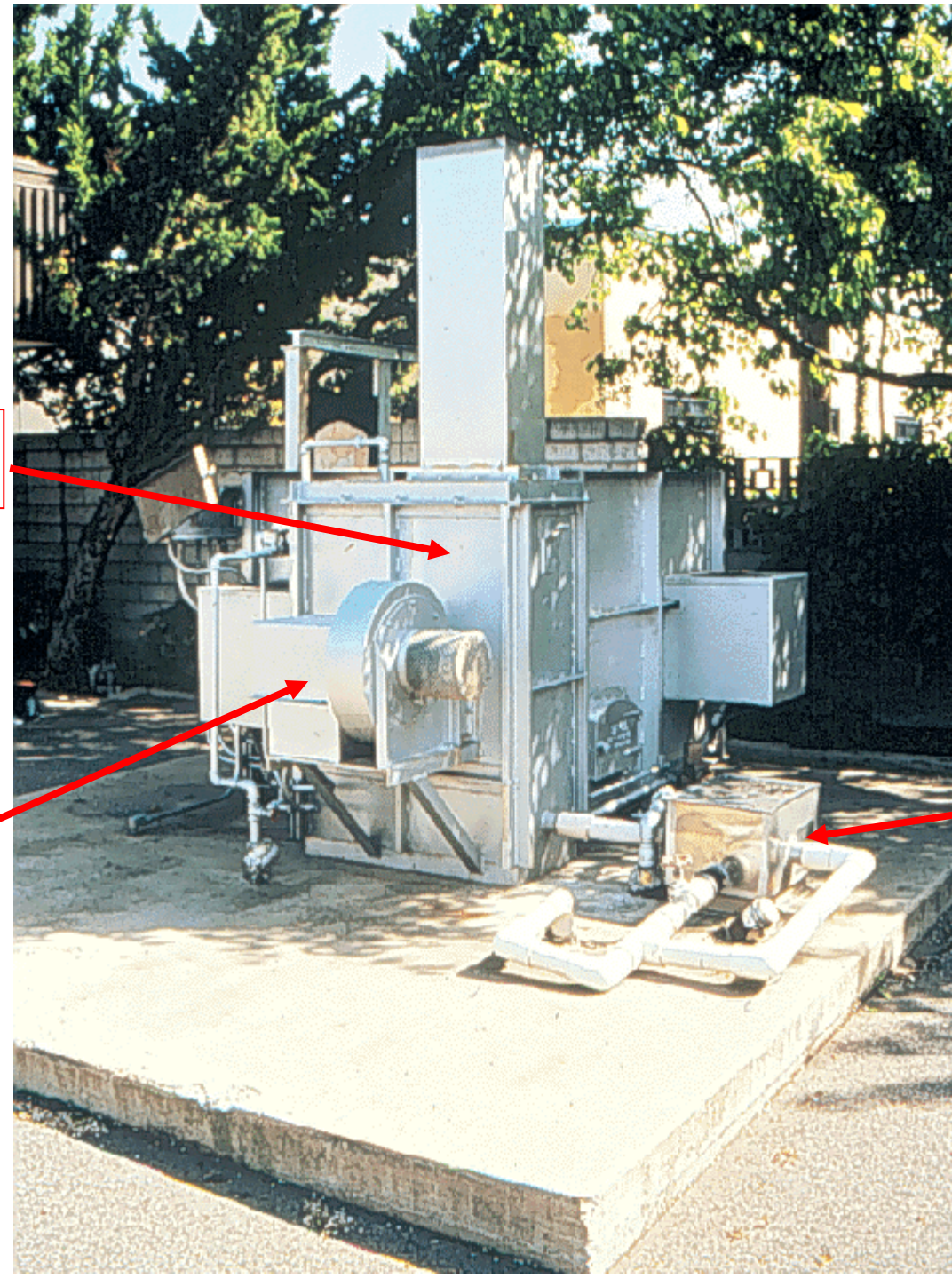
- Remove both Particulates & Acid Gases
- Rely on Flue Gas Pressure Drop for Particulate Removal with Alkali Reagent for Acid Gas Removal.
- Categories of scrubbers:
  - Spray Chambers
  - Packed Towers (Beds)
  - Venturi

Wet Scrubber
Acid Gas Removal

- Sodium Hydroxide (NaOH - Caustic Soda) or Sodium Carbonate (Na_2CO_3)
- Alkali Added to Re-circulation Tank Water (pH of 8-9).

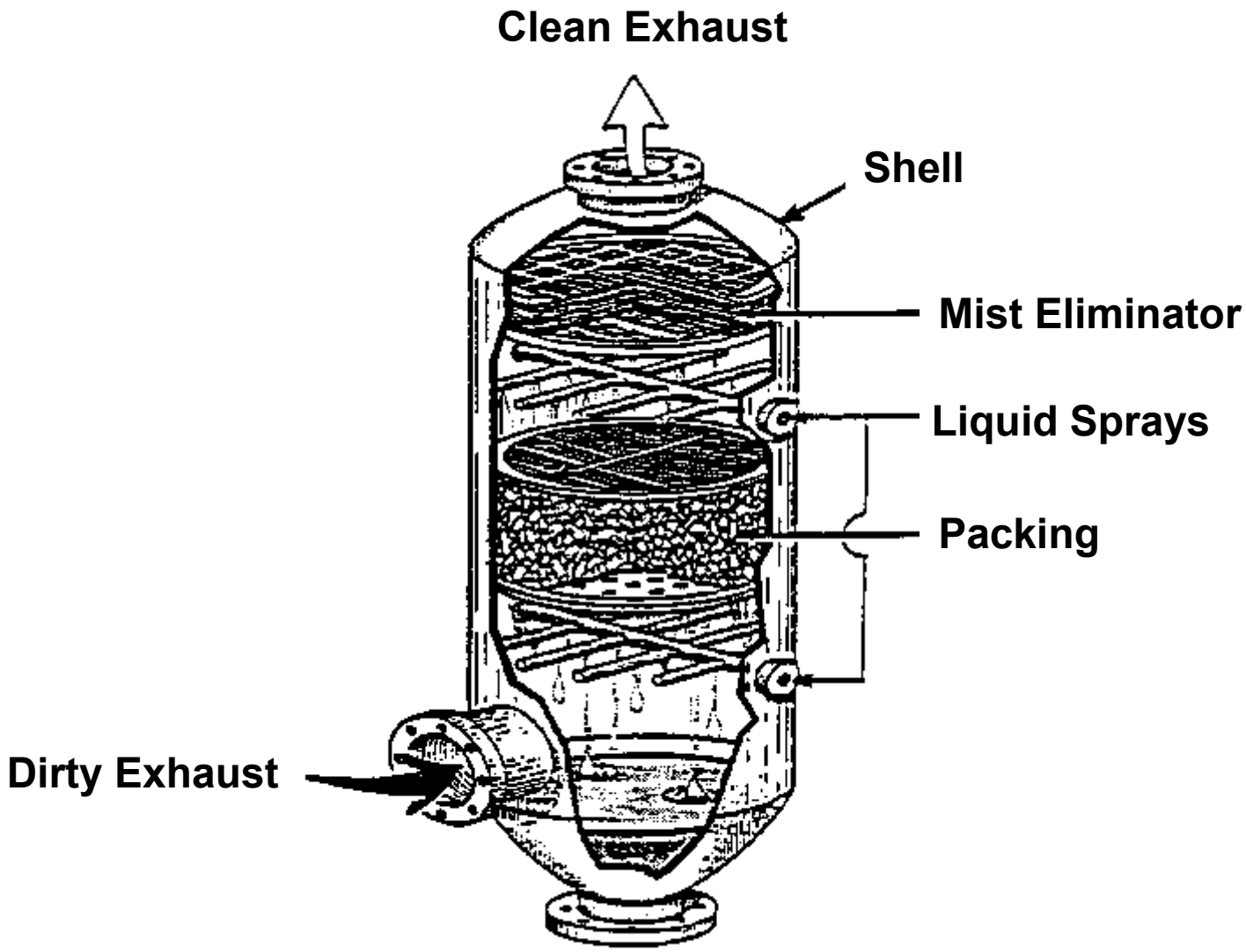
Spray Tower, Countercurrent-Flow Type




Spray Tower
Blower Motor
Filtration & Pumps

Common Spray Tower Scrubber Problems

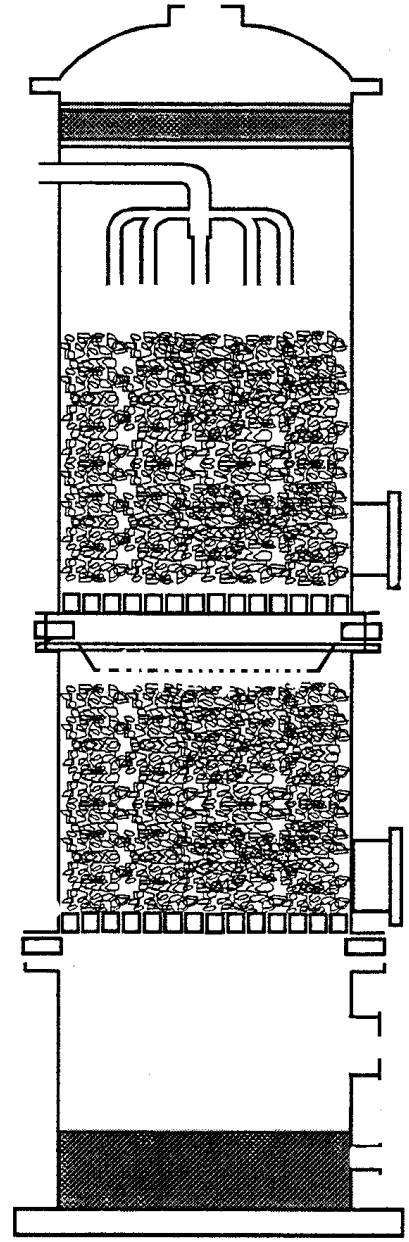
- Liquor Spray Nozzles Plugged
- Erosion of Spray Nozzles
- Corrosion of Shell
- Mist Re-entrainment
- pH too low or high



Countercurrent- Flow Packed-Bed Scrubber

PACKED BED SCRUBBER

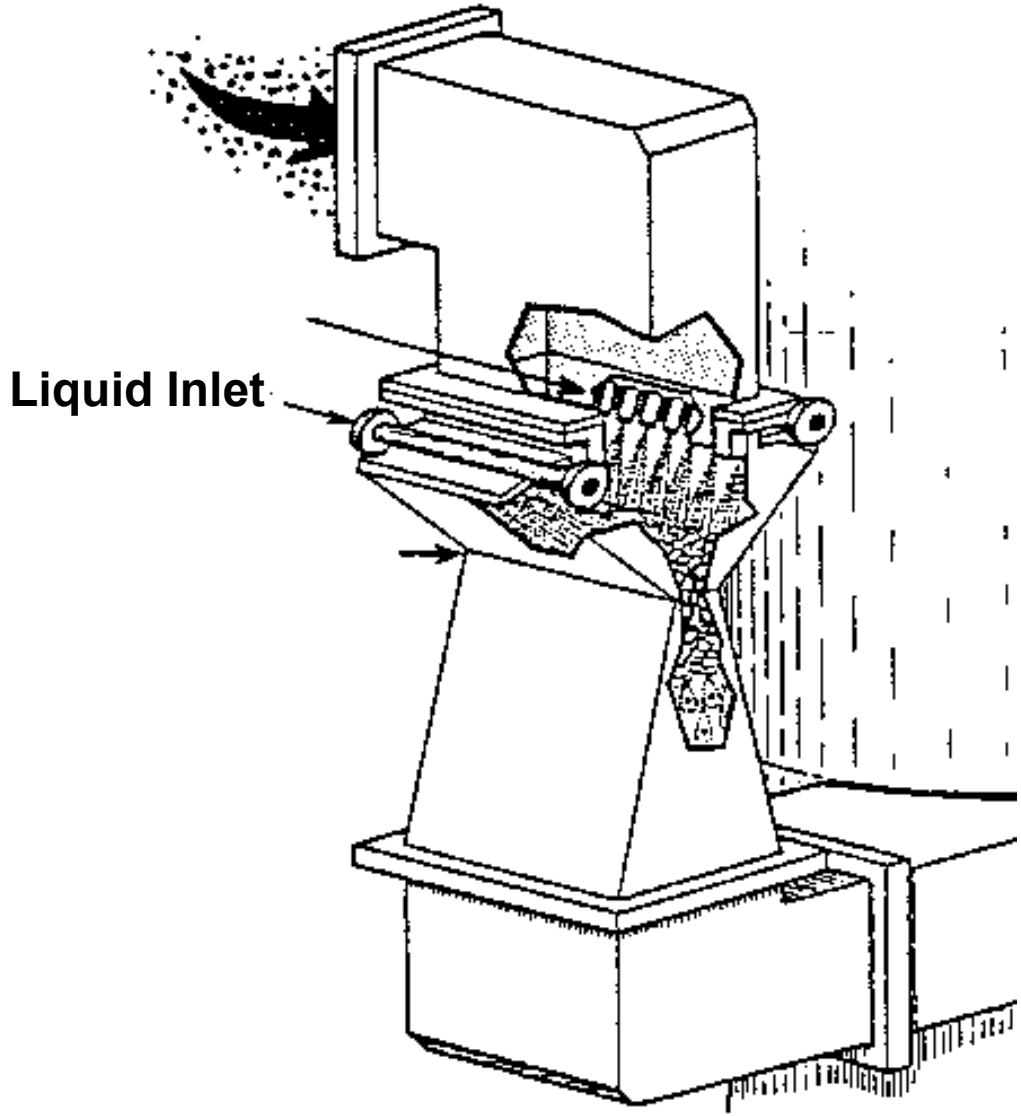
Liquor inlet



Exhaust Gas Inlet

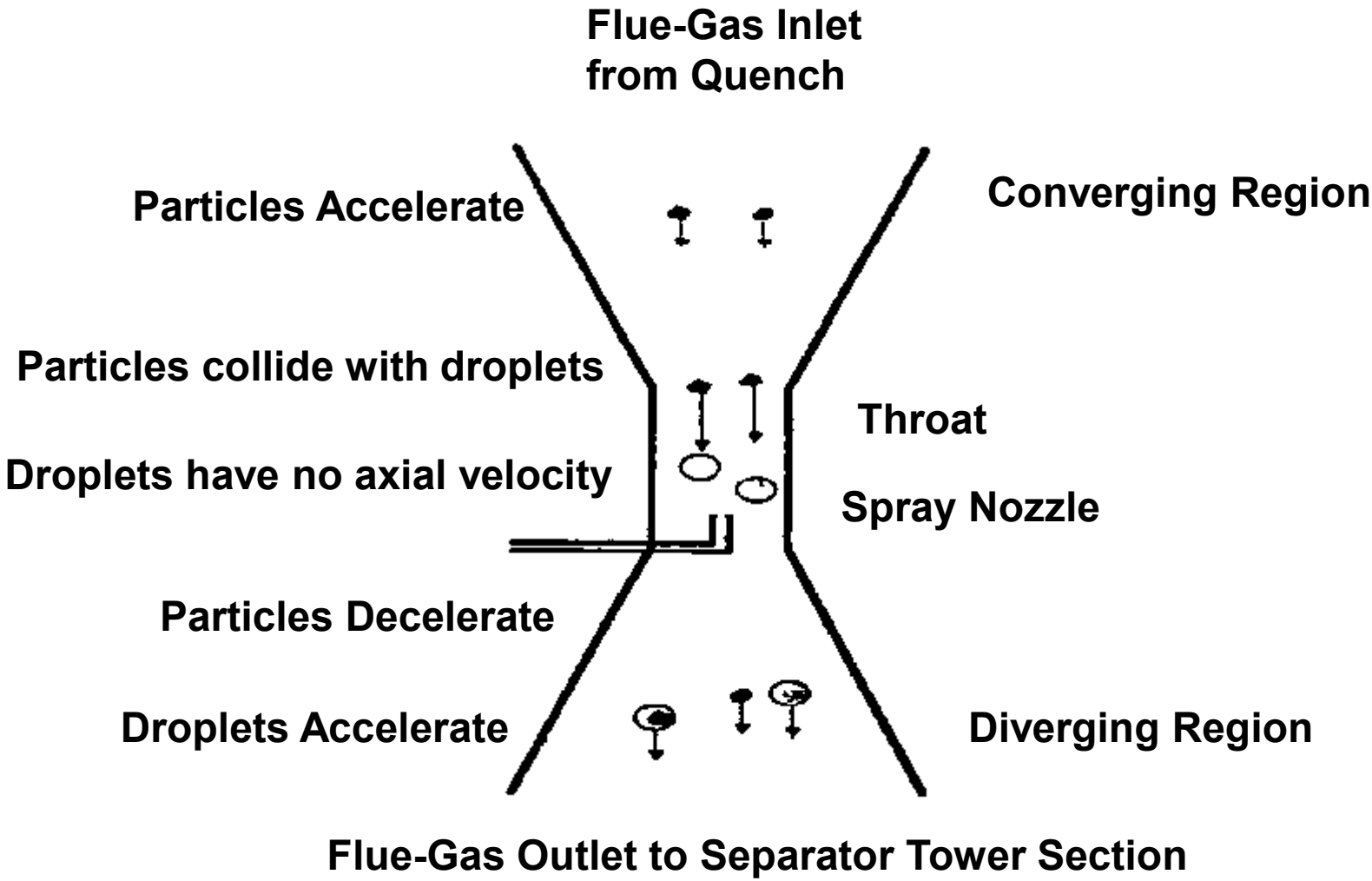
Packed-Bed Operating Problems

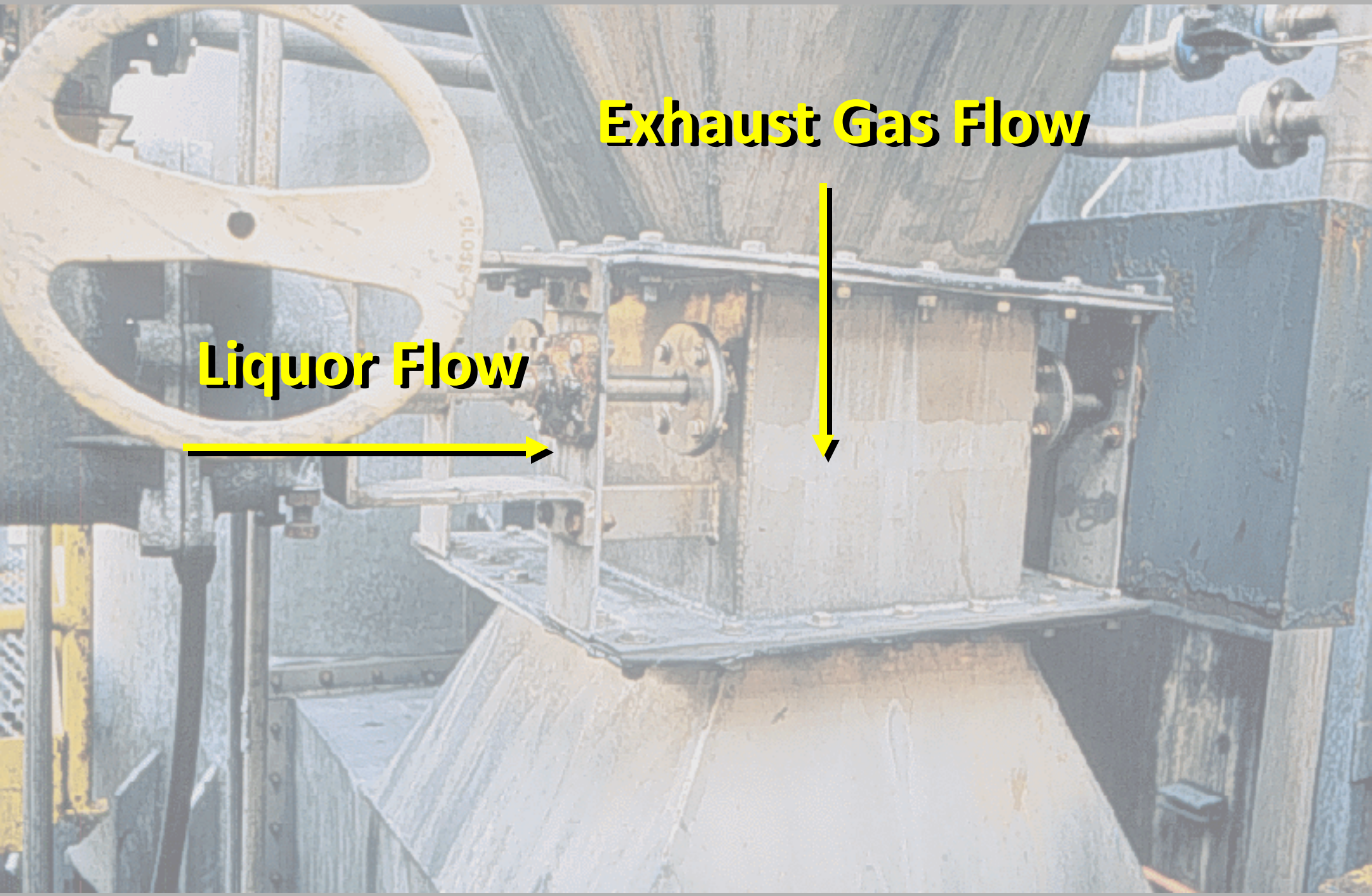
- Accumulation of Solids
- Settling of Packing Material
- Liquor pH (between 5.5-10)



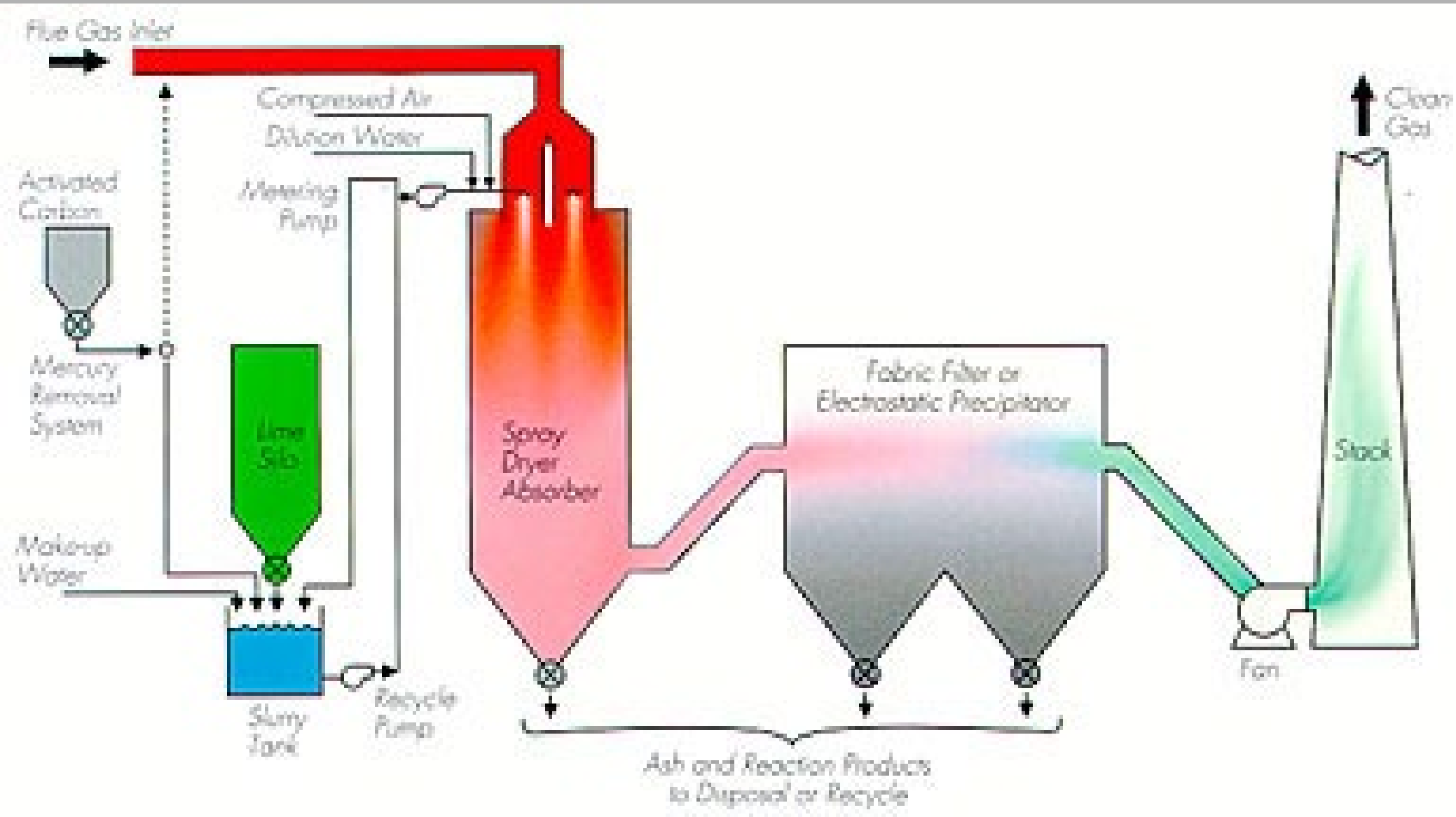
SPRAY VENTURI WITH RECTANGULAR THROAT

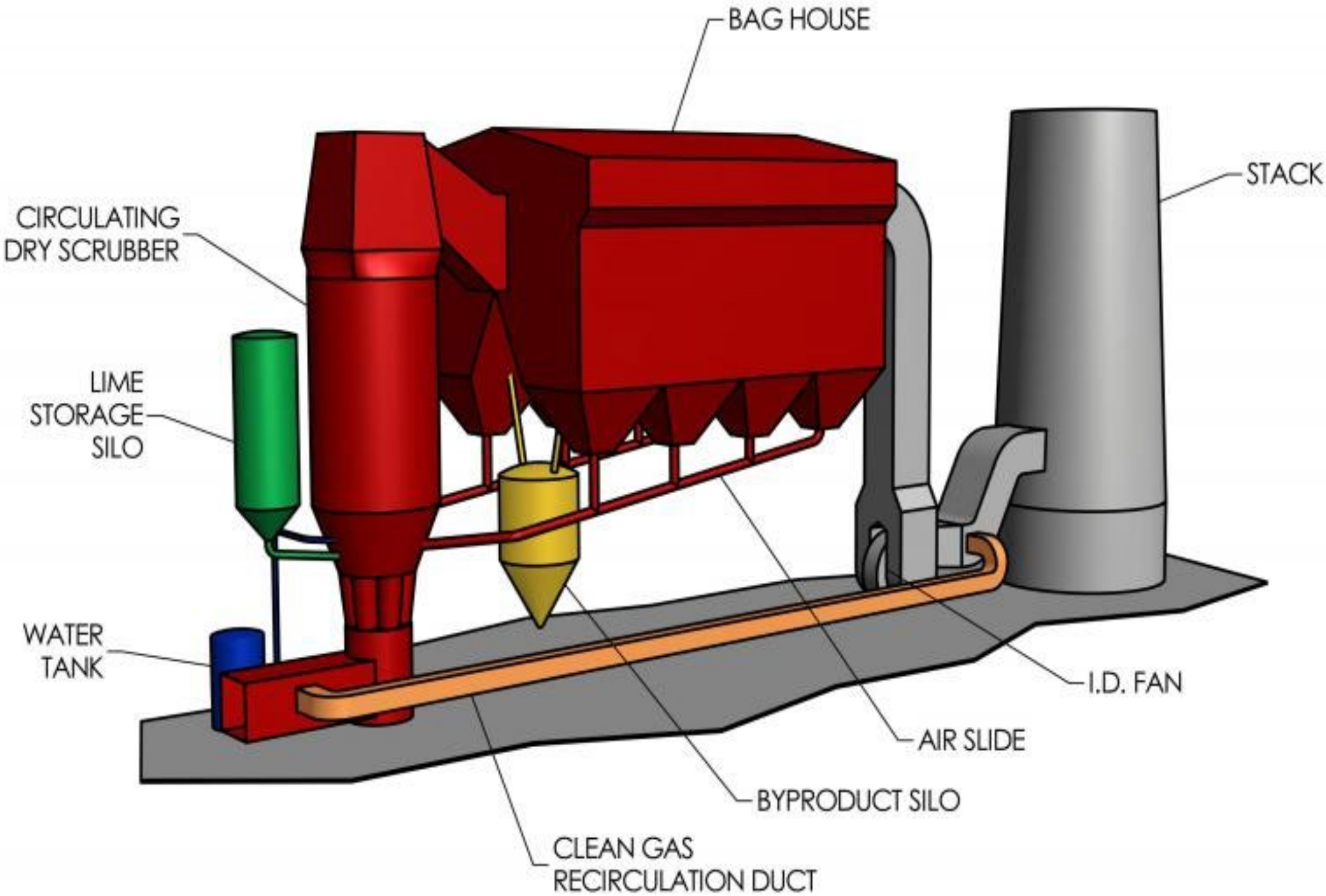
Particle Behavior in Venturi-Scrubber Section



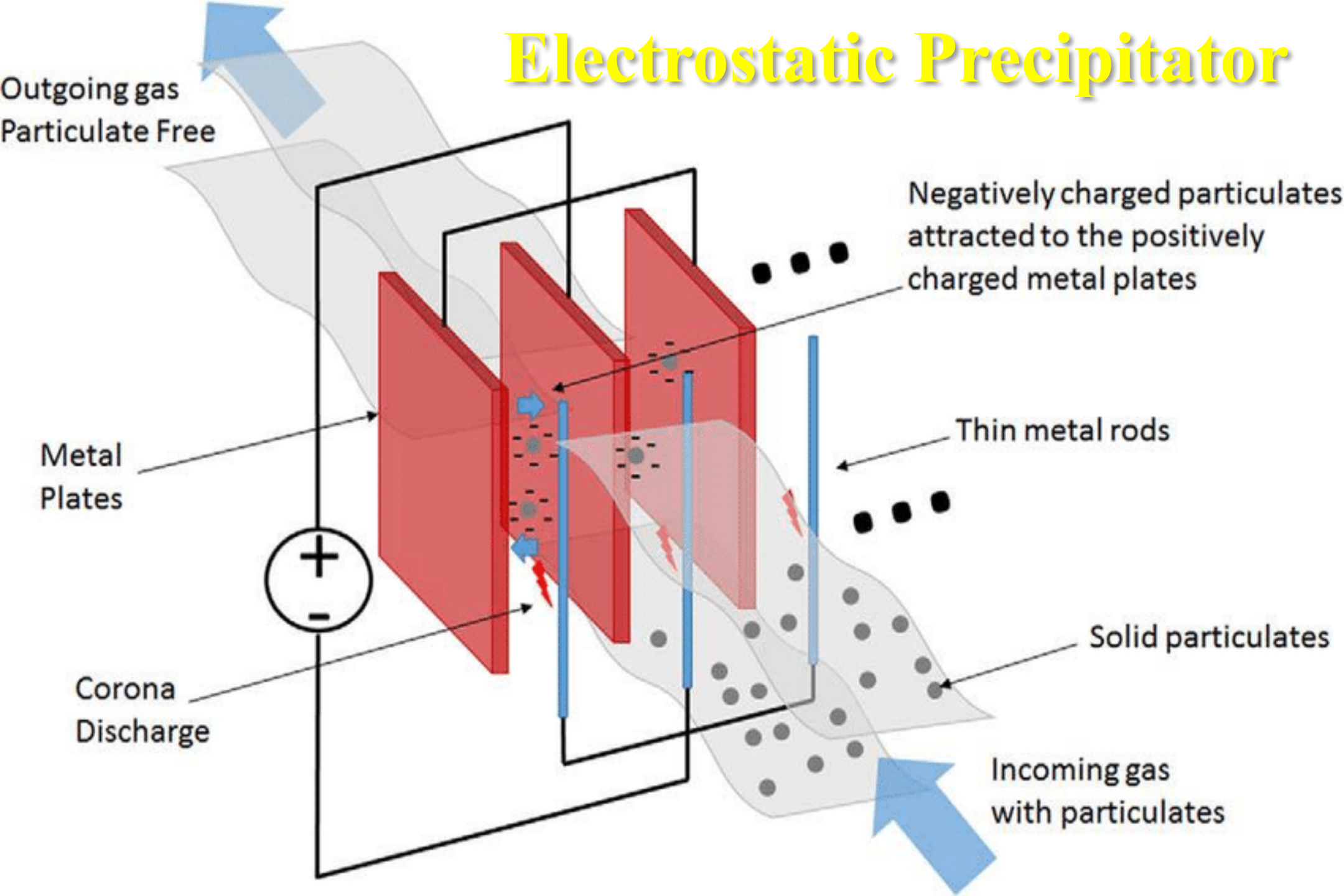

Exhaust Gas Flow
Liquor Flow

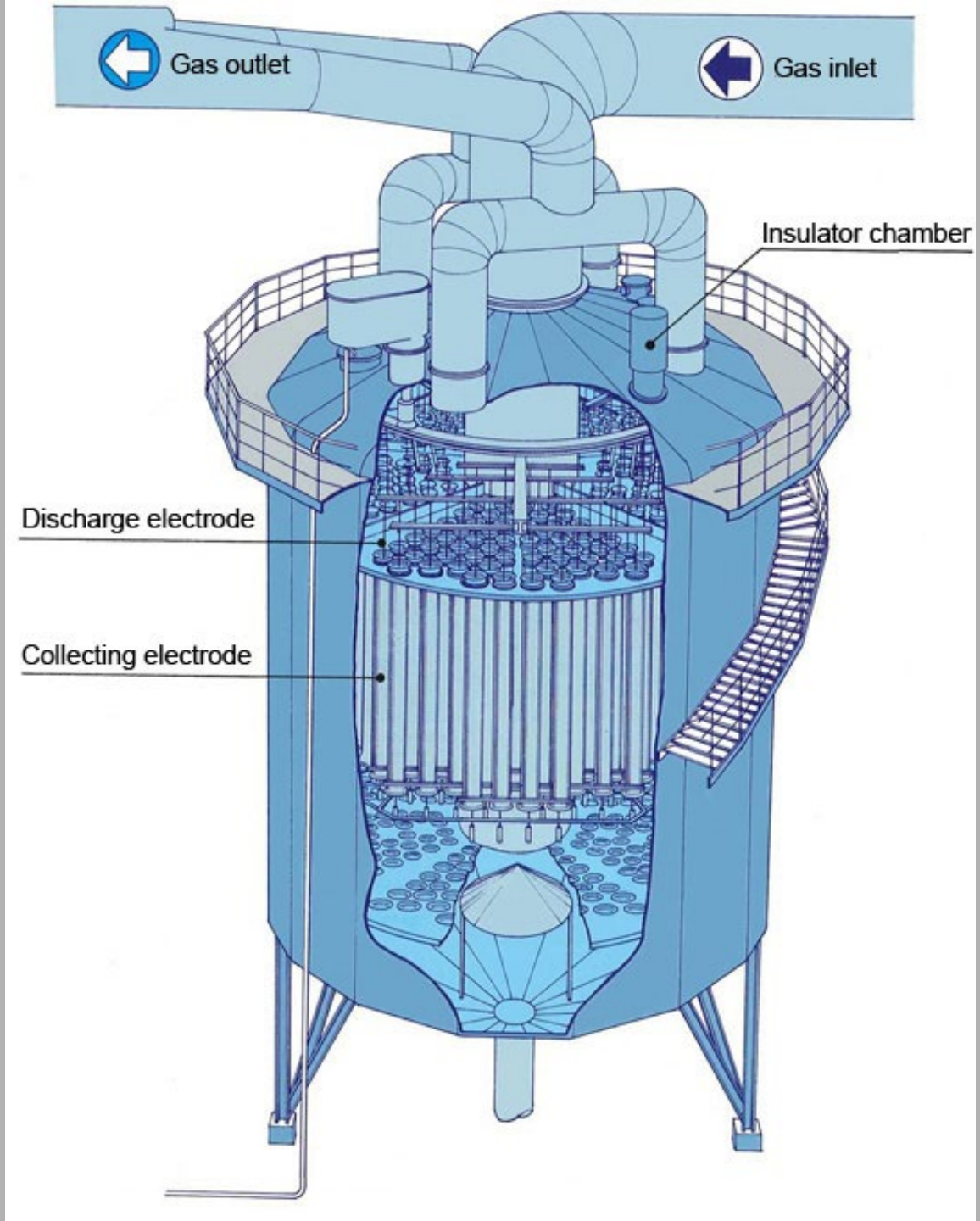
Dry Scrubber / Baghouse

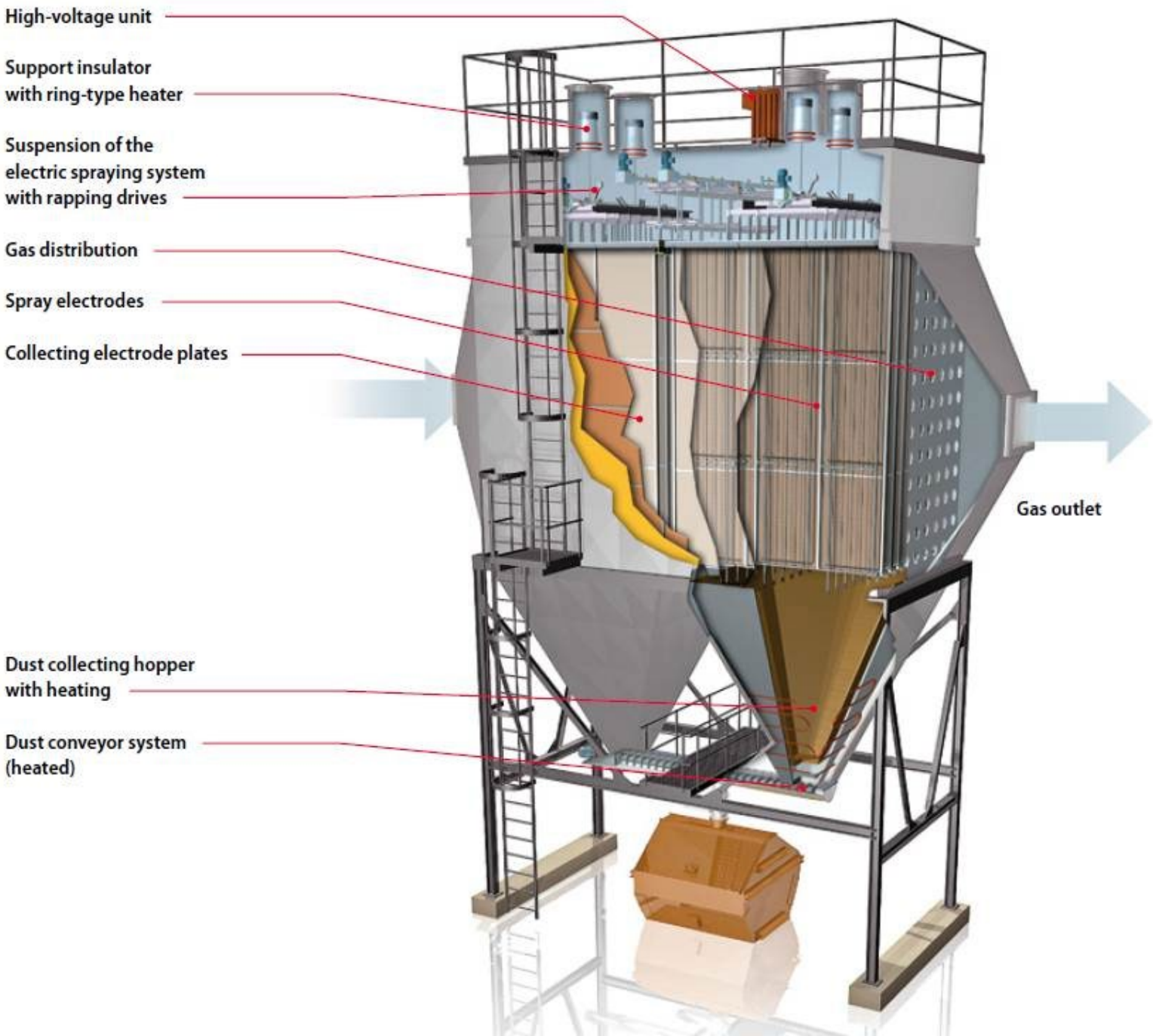



BAG HOUSE
STACK
CIRCULATING
DRY SCRUBBER
LIME
STORAGE
SILO
WATER
TANK
I.D. FAN
AIR SLIDE
BYPRODUCT SILO
CLEAN GAS
RECIRCULATION DUCT

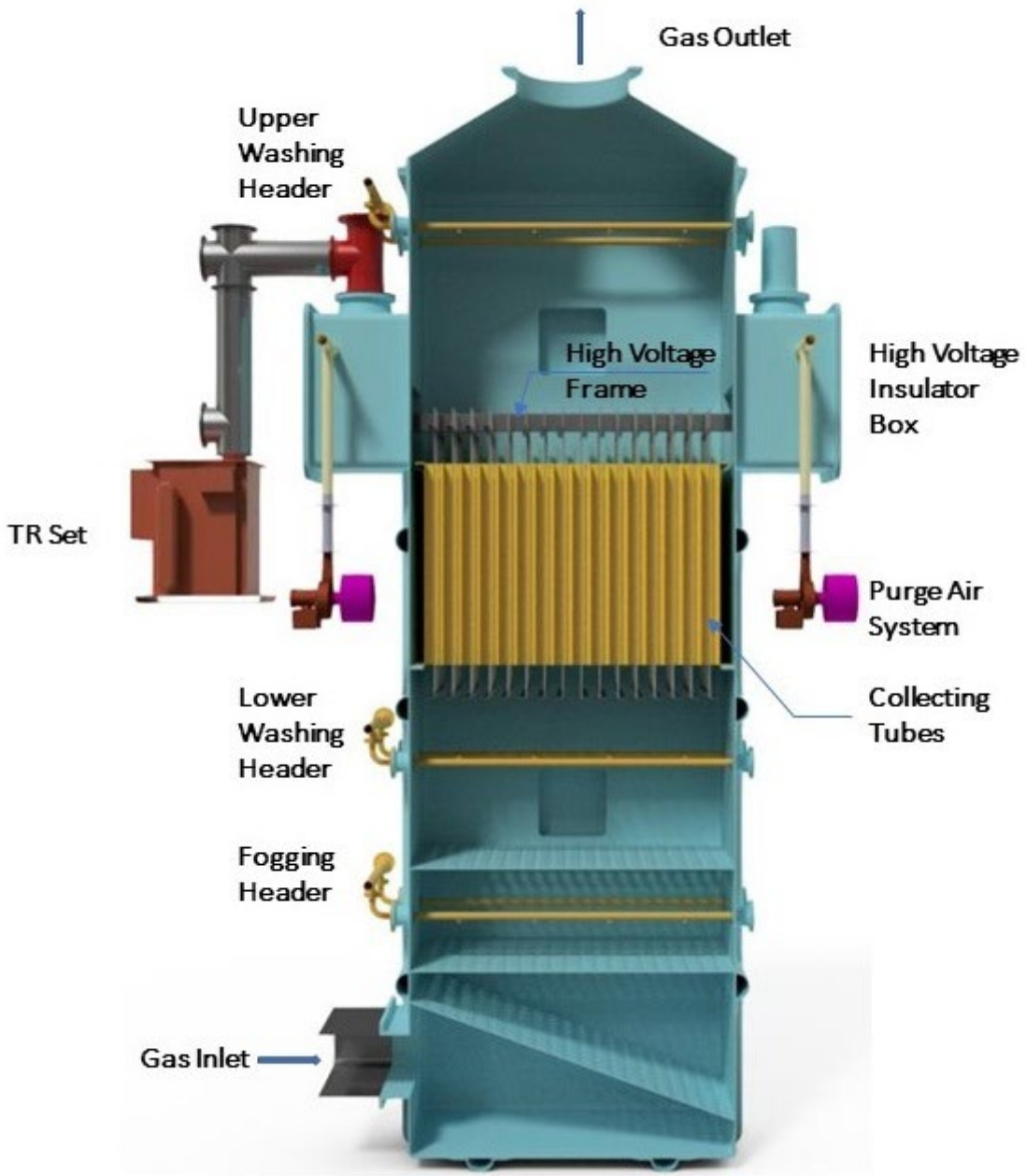
Electrostatic Precipitator

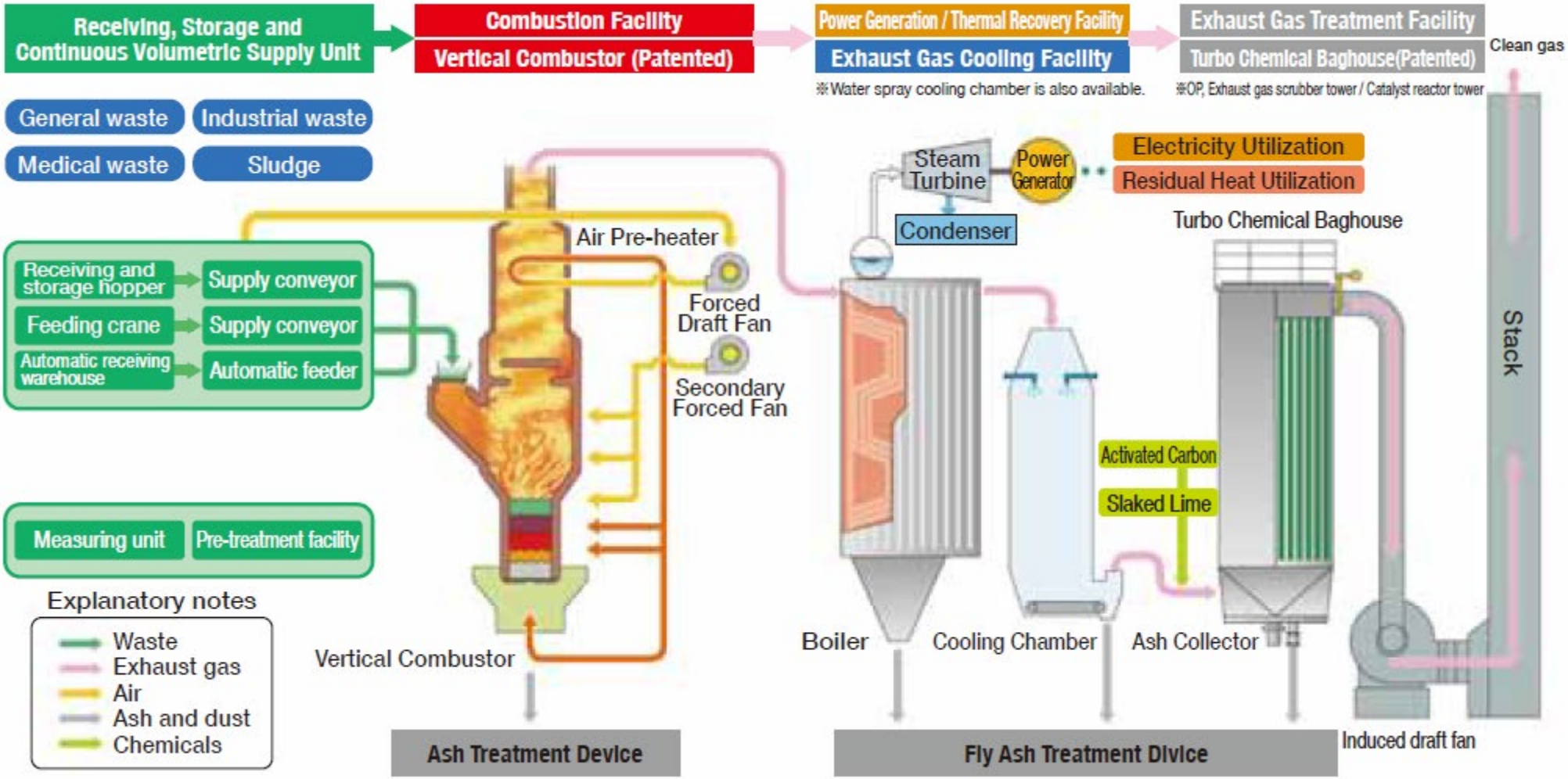


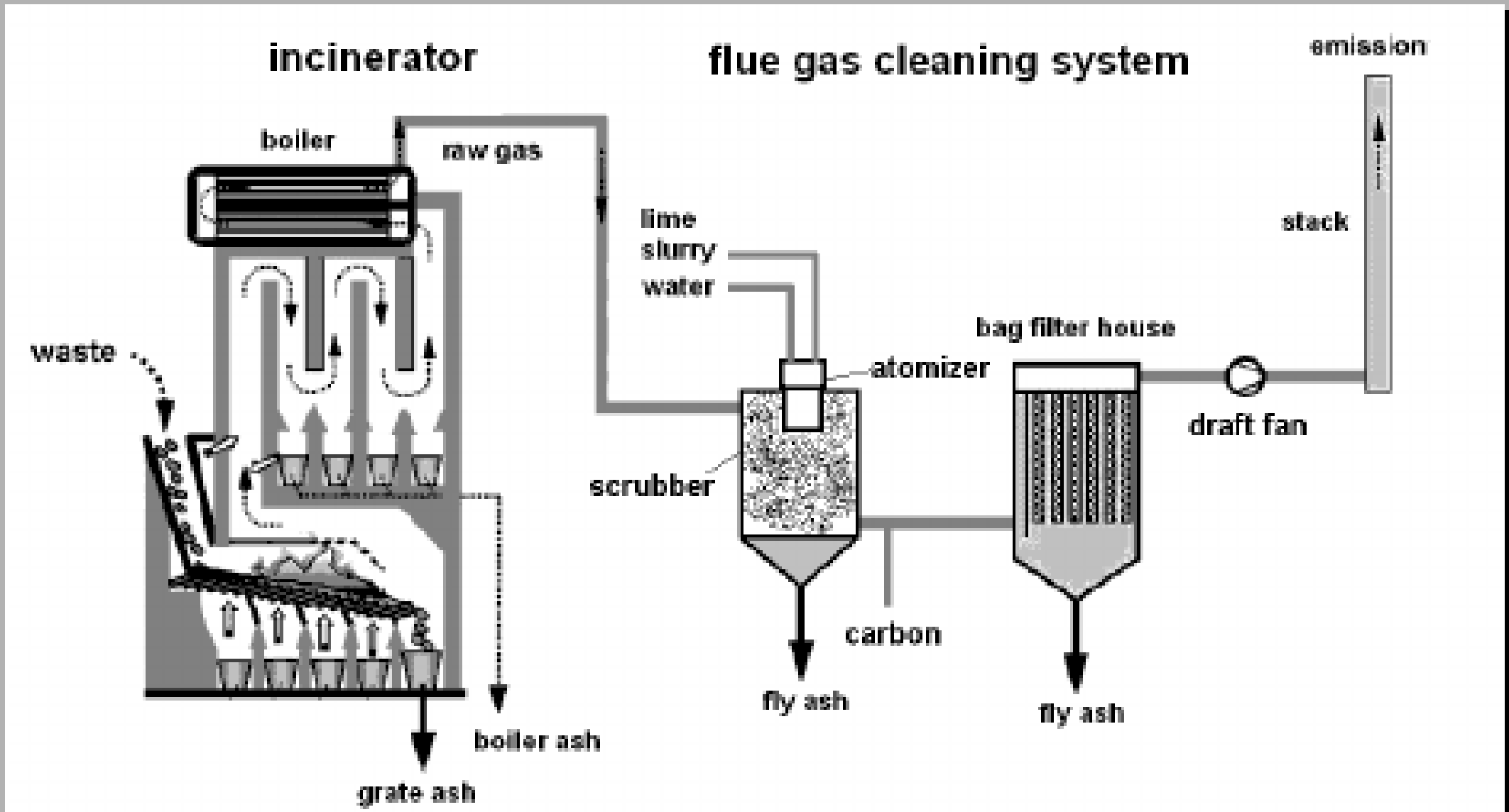

Gas outlet
Gas inlet
Insulator chamber
Discharge electrode
Collecting electrode

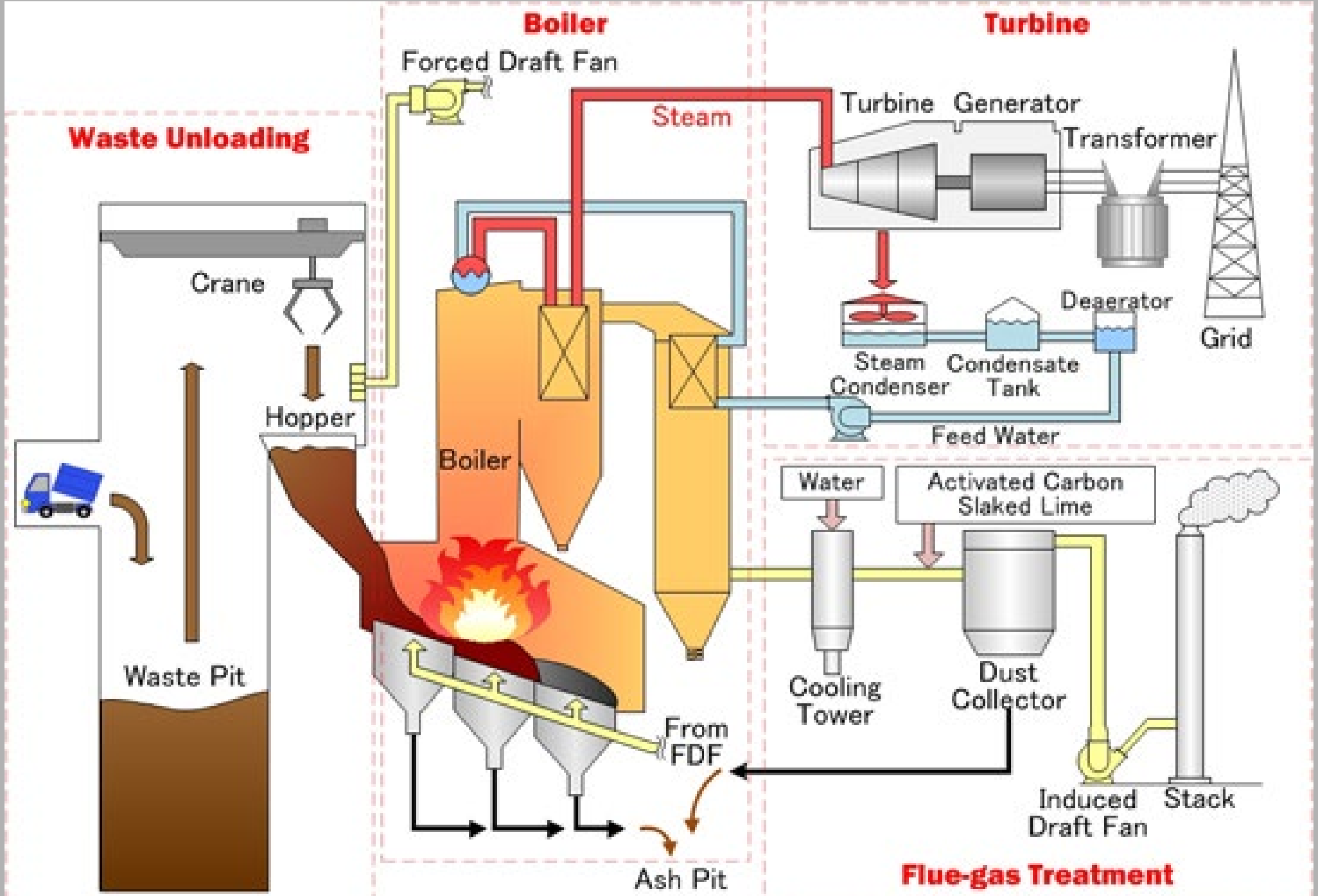

High-voltage unit
Support insulator with ring-type heater
Suspension of the electric spraying system with rapping drives
Gas distribution
Spray electrodes
Collecting electrode plates
Gas outlet
Dust collecting hopper with heating
Dust conveyor system (heated)

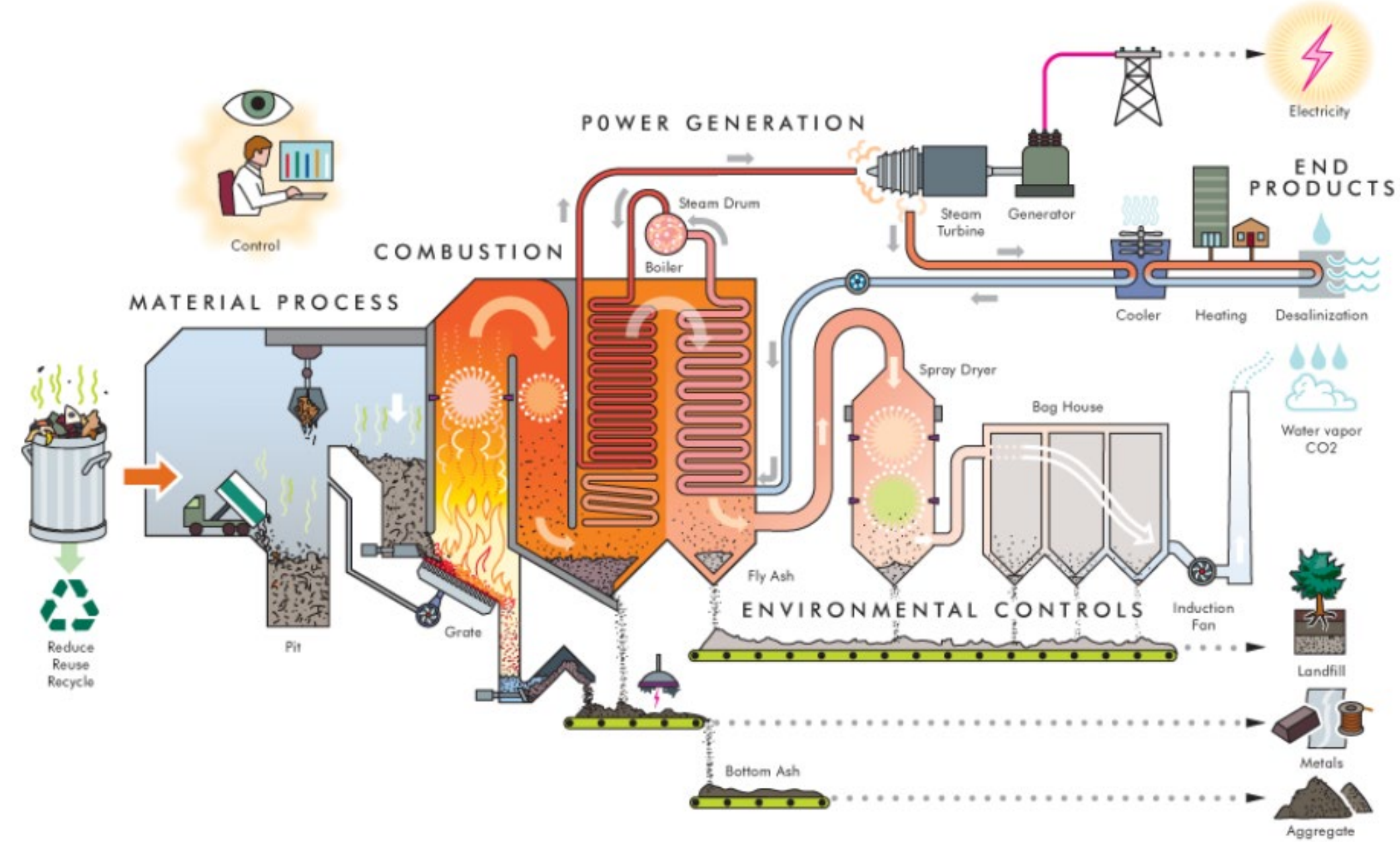
Tubular Electrostatic Precipitator



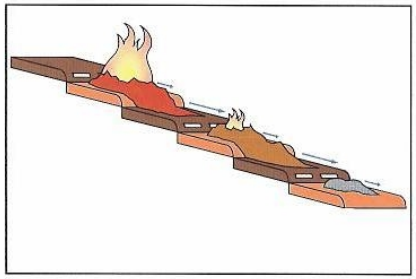

Receiving, Storage and Continuous Volumetric Supply Unit
Combustion Facility
Vertical Combustor (Patented)
Power Generation / Thermal Recovery Facility
Exhaust Gas Cooling Facility
※Water spray cooling chamber is also available.
Exhaust Gas Treatment Facility
Turbo Chemical Baghouse(Patented)
※OP, Exhaust gas scrubber tower / Catalyst reactor tower
Clean gas
General waste
Industrial waste
Medical waste
Sludge
Receiving and storage hopper
Supply conveyor
Feeding crane
Supply conveyor
Automatic receiving warehouse
Automatic feeder
Measuring unit
Pre-treatment facility
Explanatory notes
Waste
Exhaust gas
Air
Ash and dust
Chemicals
Air Pre-heater
Forced Draft Fan
Secondary Forced Fan
Vertical Combustor
Ash Treatment Device
Steam Turbine
Power Generator
Condenser
Electricity Utilization
Residual Heat Utilization
Turbo Chemical Baghouse
Activated Carbon
Slaked Lime
Boiler
Cooling Chamber
Ash Collector
Stack
Induced draft fan
Fly Ash Treatment Divice


incinerator
flue gas cleaning system
emission
boiler
raw gas
lime
slurry
water
stack
waste
bag filter house
atomizer
draft fan
scrubber
carbon
fly ash
fly ash
boiler ash
grate ash


Boiler
Turbine
Forced Draft Fan
Steam
Turbine
Generator
Transformer
Waste Unloading
Crane
Deaerator
Grid
Steam
Condenser
Condensate
Tank
Hopper
Feed Water
Boiler
Water
Activated Carbon
Slaked Lime
Waste Pit
Cooling
Tower
Dust
Collector
From
FDF
Induced
Draft Fan
Stack
Ash Pit
Flue-gas Treatment

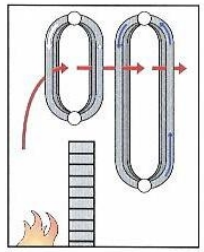

Control
POWER GENERATION
Electricity
END PRODUCTS
Steam Drum
Steam Turbine
Generator
COMBUSTION
Boiler
MATERIAL PROCESS
Cooler
Heating
Desalinization
Spray Dryer
Bag House
Water vapor CO2
Reduce Reuse Recycle
Pit
Grate
Fly Ash
ENVIRONMENTAL CONTROLS
Induction Fan
Landfill
Metals
Bottom Ash
Aggregate

The Waste-to-Energy Process



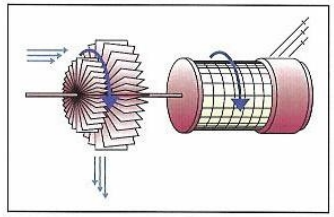
COMBUSTION GRATE

Inclined reciprocating grate systems move the burning waste at specific rates through the furnace, ensuring complete combustion and maximum energy recovery.



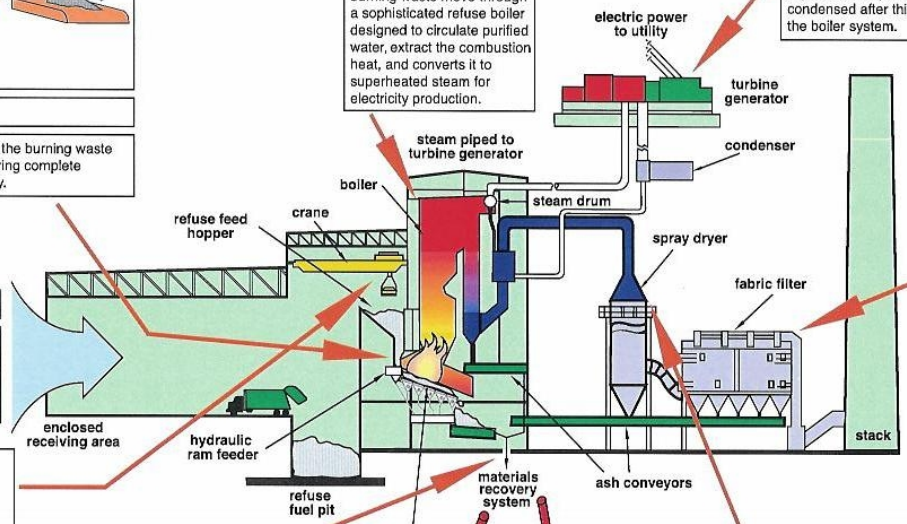
BOILER

Combustion gases from the burning waste move through a sophisticated refuse boiler designed to circulate purified water, extract the combustion heat, and converts it to superheated steam for electricity production.



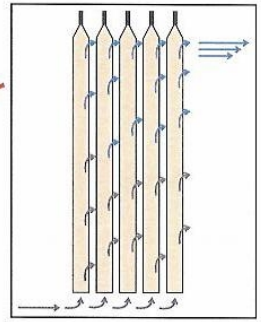
TURBINE-GENERATOR

High-speed precision turbine blades, driven by the high-pressure steam from the boiler, drive a generator to produce electricity. Water condensed after this process is recirculated to the boiler system.



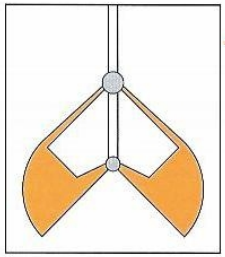
NEGATIVE AIR PRESURE

The plant's combustion air is drawn from the enclosed receiving area and refuse fuel pit, maintaining a negative air pressure that controls the release of dust and odors.



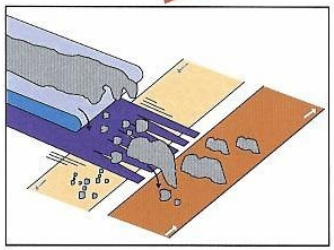
FABRIC FILTER (BAGHOUSE)

Hundreds of Teflon® fabric tubes filter more than 99.9% of the particulate material from the combustion flue gases. The filtered ash is recovered and safely disposed.



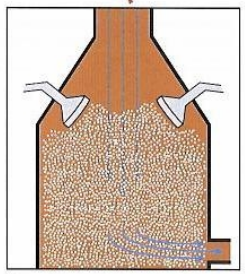
CRANE

Hydraulic refuse cranes mix and load the incoming waste, depositing it into hoppers that feed the plant combustion systems.



MATERIALS RECOVERY

The inert combustion ash residue is size and magnetically separated after combustion, enabling efficient metal recovery for recycling.



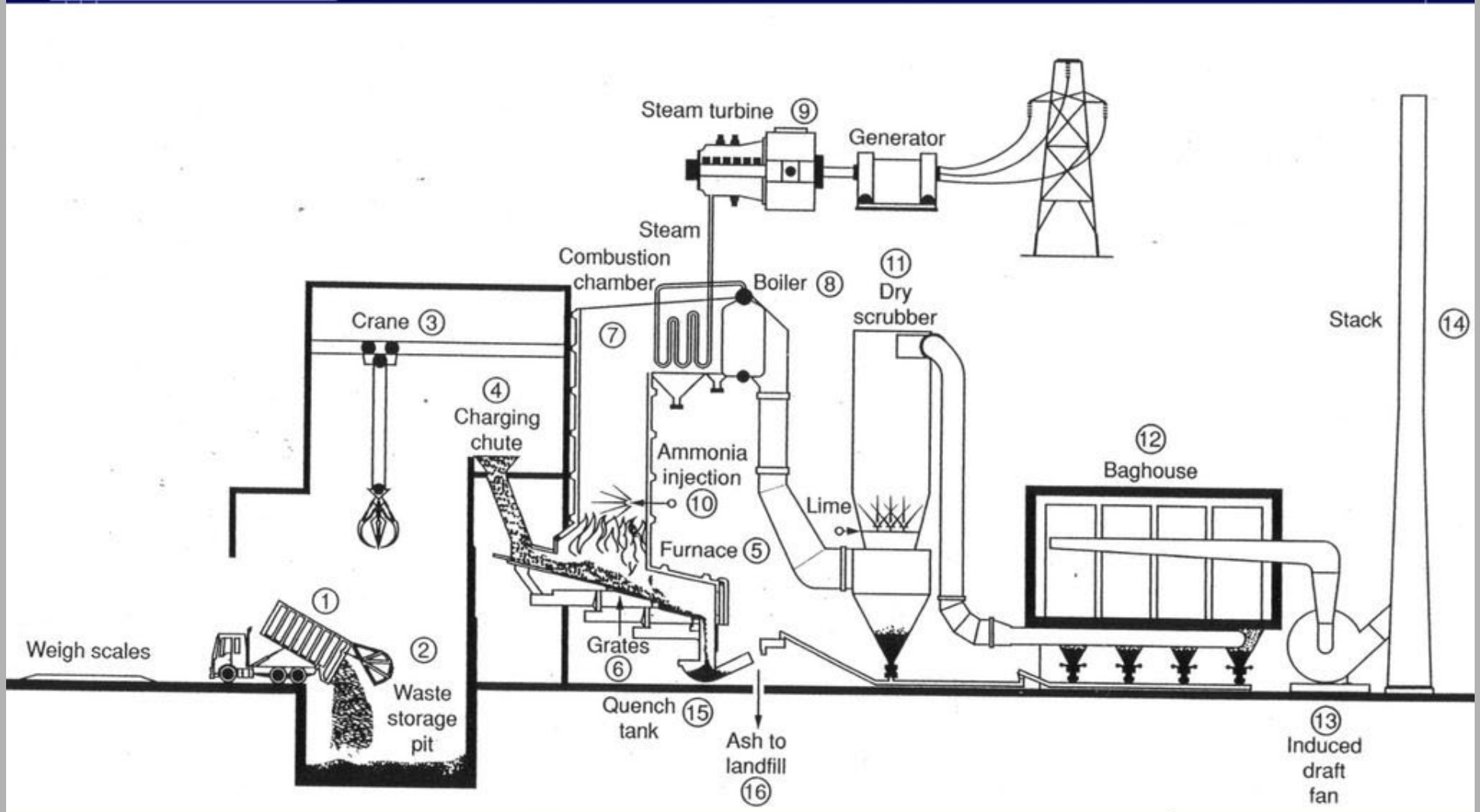
SPRAY DRYER (SCRUBBER)

A precise mixture of lime and water is sprayed into the combustion exhaust gases to remove acid gases, heavy metals, and trace organic emissions.

1 ton of municipal solid waste:
* produces 625 kilowatt-hours of electricity,
* is equivalent to 1.6 barrels (67 gallons of oil)

Wheelabrator Technologies Inc.
A Waste Management Company

How incinerated?



Regulations

State and Local Regulatory Requirements

- General Air Emissions Limitations
  - Visible Emissions
  - Particulate Matter
  - Fugitive Dust
  - Gaseous Emissions
  - Toxic Emissions
- Public Nuisance (Odors, Noise)

State and Local Agency Incinerator Rules

- Crematories
  - Human
  - Animal
- Burn Off Ovens
- Pathological waste, low-level radioactive waste, and/or chemotherapeutic waste
- Acceptable Incinerators
- Regulations more stringent than Federal Regs

Federal Incinerator Rules

- Large Municipal Waste Combustors
- Small Municipal Waste Combustors
- Other Solid Waste Incinerators
- Hospital, Medical, Infectious Waste Incinerators
- Sewage Sludge Incinerators
- Commercial Industrial Solid Waste Incinerators
- Hazardous Waste Incinerators

Large Municipal Waste Combustors

- 40 CFR 60 Subpart E - Construct after 8/17/71
- 40 CFR 60 Subpart Ea – Construct 12/20/89 to 9/20/94
- 40 CFR Subpart Eb - Construct after 9/20/94, Mod or Recon after 6/19/96
- 40 CFR 60 Subpart Cb – EG - Existing on or before 9/20/94
- 40 CFR 62 Subpart FFF – FP - Existing on or before 9/20/94

Subpart Eb

- > 250 tpd MSW
- Siting requirements and Materials separation plan
- Operator training and certification
- Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Opacity, Fugitive ash
- CEMs – O2 or CO2, COM, SO2, NOx, CO
- Initial testing for all contaminants with limits
- Annual testing for PM, Hg, Cd, Pb, HCl, D/F (or CEMS)
- Monitoring, recordkeeping and reporting
- Limits for air curtain incinerators burning yard waste

Small Municipal Waste Combustors

- **40 CFR 60 Subpart AAAA - Construct after 8/30/99, Mod or Recon after 6/6/01**
- **40 CFR 60 Subpart BBBB – EG - Existing on or before 8/30/99**
- **40 CFR 62 Subpart JJJ – FP - Existing on or before 8/30/99**

Subpart AAAA

- 35-250 tpd MSW
- Siting requirements and Materials separation plan
- Operator training and certification
- Good combustion practices
- Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Opacity, Fugitive ash
- CEMs – O2 or CO2, COM, SO2, CO, NOx for Class 1
- Initial and Annual testing for PM, Hg, Cd, Pb, HCl, D/F
- Class 2 may have less annual testing
- Monitoring, recordkeeping and reporting
- Limits for air curtain incinerators burning yard waste

Other Solid Waste Incinerators

- **40 CFR 60 Subpart EEEE - Construct after 12/9/04, Mod or Recon after 6/16/06**
- **40 CFR 60 Subpart FFFF – EG - Existing on or before 12/9/04**

Subpart EEEE

- <35 tpd MSW and Institutional units
- Siting requirements and waste management plan
- Operator training and qualification
- Good combustion practices
- Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Opacity
- CEMs – O2, CO
- Initial and Annual testing for all pollutants
- Less frequent than annual testing may be allowed
- Monitoring, recordkeeping and reporting
- Limits for air curtain incinerators

Hospital, Medical, and Infectious Waste Incinerators

- **40 CFR 60 Subpart Ec - Construct after 6/20/96 to 12/1/08, Mod after 3/16/98 to 4/6/10, Construct after 12/1/08, Mod after 4/6/10**
- **40 CFR 60 Subpart Ce – EG – Construct on or before 6/20/96, Mod on or before 3/16/98, Construct after 6/20/96 to 12/1/08, Mod after 3/16/98 to 4/6/10**
- **40 CFR 62 HHH - FP**

Subpart Ec

- Siting requirements and waste management plan
- Operator training and qualification
- Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Opacity, Fugitive ash
- Various emission limits for different dates and size of units
- CEMs – CO
- Initial and Annual testing for all pollutants (or CEMs)
- Monitoring, recordkeeping and reporting

Sewage Sludge Incinerators

- **40 CFR 60 Subpart O - Construct after 6/11/73**
- **40 CFR 60 Subpart LLLL – Construct after 10/14/10, Mod after 9/21/11**
- **40 CFR 60 Subpart MMMM – EG – Construct before 10/14/10**
- **40 CFR 62 LLL – FP - Construct before 10/14/10**

Subpart LLLL

- Siting requirements
- Operator training and qualification
- Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Fugitive ash
- Various emission limits for different dates and size of units
- CEMs – CO
- Initial and Annual testing for all pollutants (or CEMs)
- Monitoring, recordkeeping and reporting

Commercial and Industrial Solid Waste Incinerators

- **40 CFR 60 Subpart CCCC - Construct after 6/4/10, Mod or Recon after 8/7/13**
- **40 CFR 60 Subpart DDDD – EG – Construct on or before 11/30/99 and not modified or reconstructed after 6/1/01, Construct after 11/30/99 but no later than 6/4/10 or commenced modification or reconstruction after 6/1/01 but no later than 8/7/13, Construct on or before 6/4/10 or commenced modification or reconstruction after 6/4/10 but no later than 8/7/13**
- **40 CFR 62 III – FP - Construct before 11/30/99**

Subpart CCCC

- **Incinerate solid waste as defined in 40 CFR Part 241**
- **Siting requirements and Waste management plan**
- **Operator training and qualification**
- **Emission limits for PM, Cd, Pb, Hg, SO2, HCl, Dioxin/Furan, NOx, CO, Fugitive ash**
- **Various emission limits based on dates of construction, mod or recon and type of unit**
- **CEMs – required based on unit type, other monitors required based on APC type**
- **Initial and Annual testing for all pollutants (or CEMs)**
- **Monitoring, recordkeeping and reporting**
- **Air curtain incinerator requirements**

Hazardous Waste Incinerators

- **40 CFR 63 Subpart EEE**

Subpart EEE

- HWI, Cement kilns, Lightweight Aggregate kilns, some boilers
- Operator training and qualification
- Emission limits for PM, Cd, Pb, Hg, HCl, Dioxin/Furan, CO, As, Be, Cr, hydrocarbons, Cl gas
- DRE 99.99%. But 99.9999% for dioxin listed hazardous waste
- CEMs – Hydrocarbon, COM, PM
- Extensive unit performance testing
- System interlocks (AWFCO) to stop flow of material
- Initial and Annual testing for all pollutants
- O&M plan
- Monitoring, recordkeeping and reporting

Incinerator Inspection

Inspector Safety Equipment

- Hard Hat
- Safety Glasses or Goggles
- Gloves
- Steel Tipped Safety Shoes
- Ear Protectors
- District Safety Policy

Identify Potential Safety Problems

- **Eye Injuries:**
  - **Watching flames through hatches**
  - **Scrubber liquor**
- **Sharps & Infectious Wastes:**
  - **Avoid Skin contact**
- **Burns:**
  - **Contact with hot equipment**
- **Inhalation Hazards:**
  - **Fugitive leaks, high pressure scrubbers/ducts**
  - **Alkaline reagent storage/mixing equip Stacks or vents**

Common Potential Safety Problems

- Weak or Slippery Walkways/Ladders
- Corroded Ductwork or Control Devices
- High Electrical Voltage, Control Cabinets
- Rotating Equipment: Fans/Fan Belts

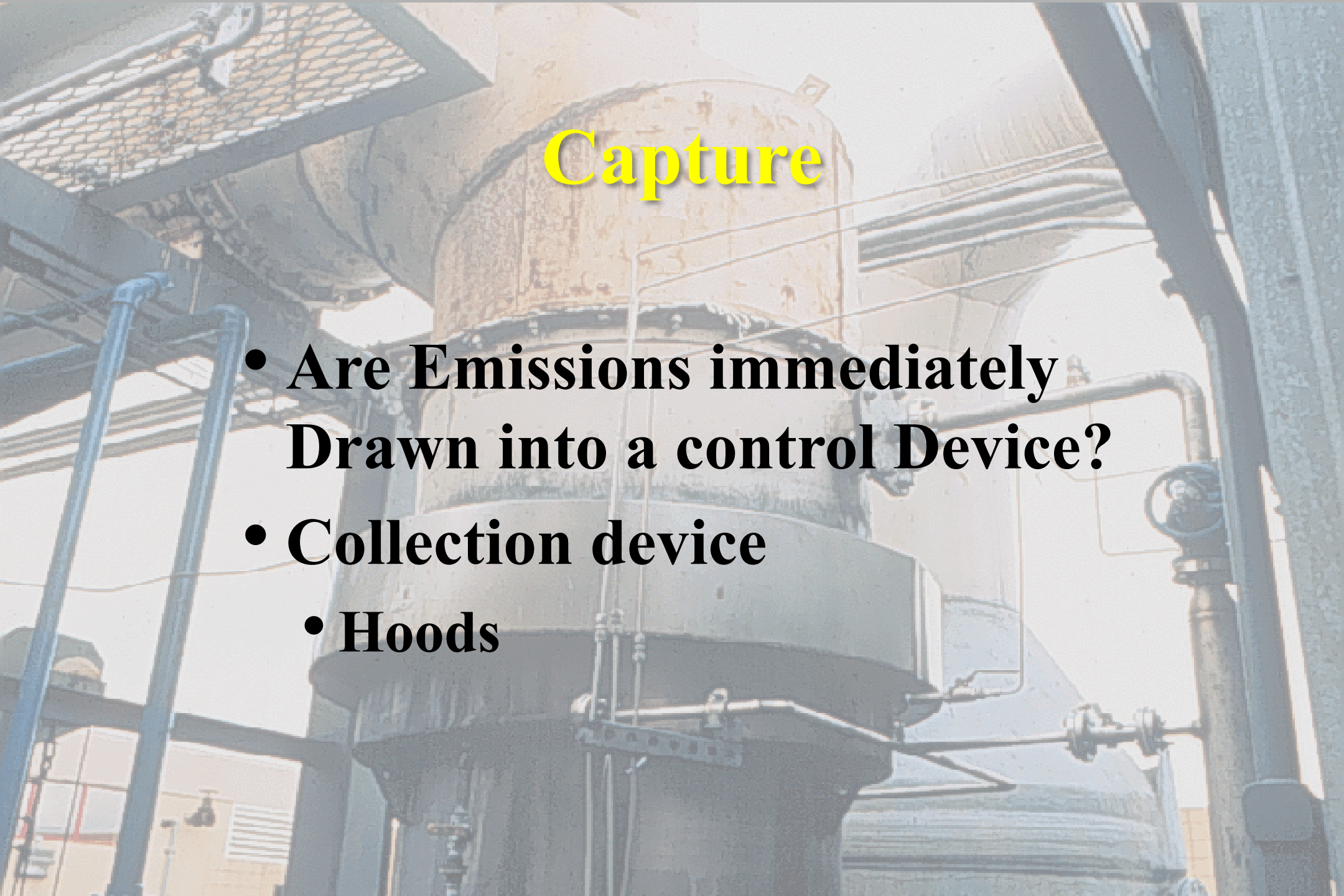

HOT

Compliance with Permit Requirements

- Temperature (preheat and or operating)
- Type of Waste
- Charging Rate
- Hours of Operation
- Monitoring
- Recordkeeping
- Many Others

Air Pollution Control Points of Inspection

- Capture
- Transport
- Air Mover
- Instrumentation
- Control
- Subsystem

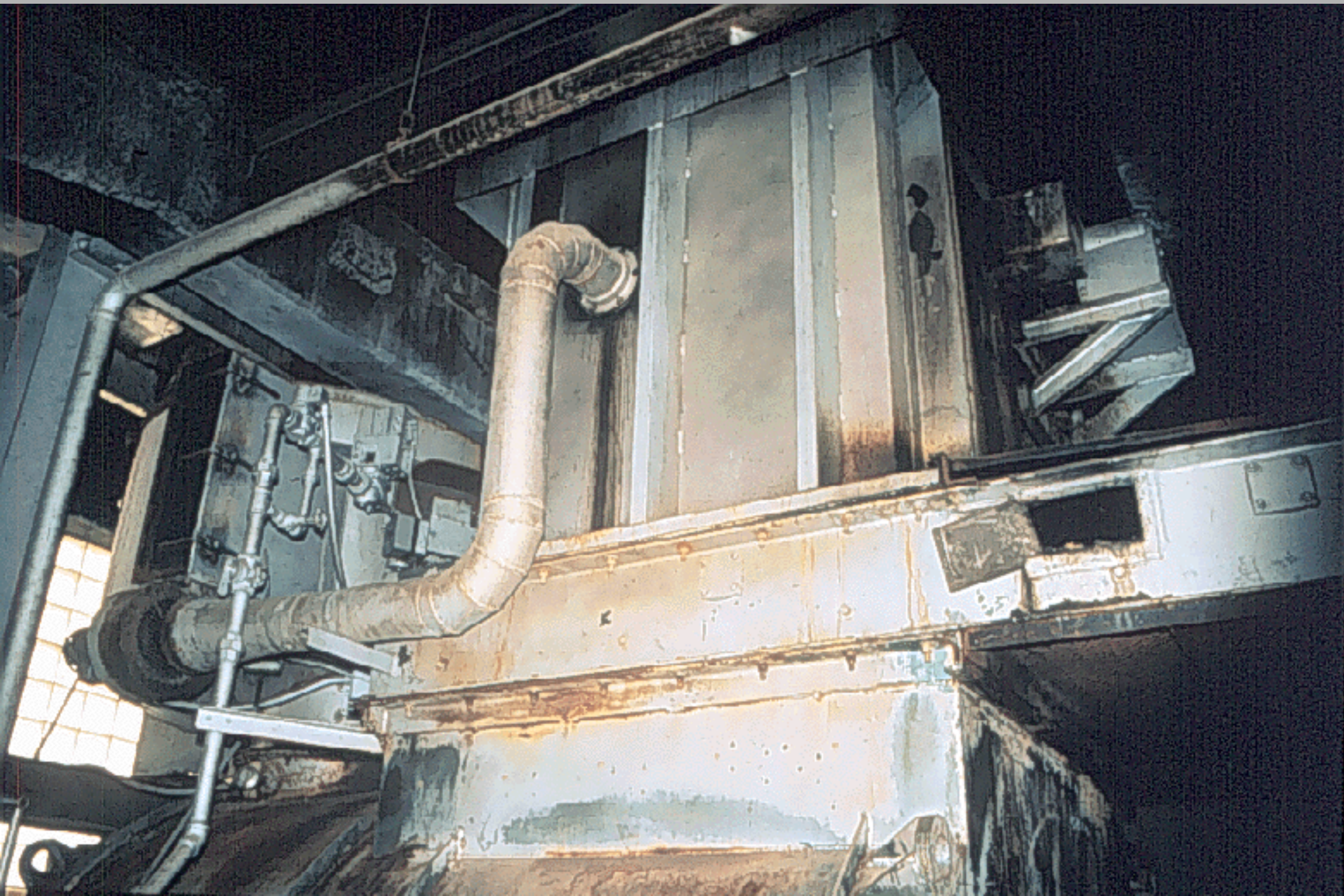


Capture

- Are Emissions immediately Drawn into a control Device?
- Collection device
  - Hoods

Transport

- **Are Emissions Moved to the Control Device Without Loss**
- **Are There any Leaks**

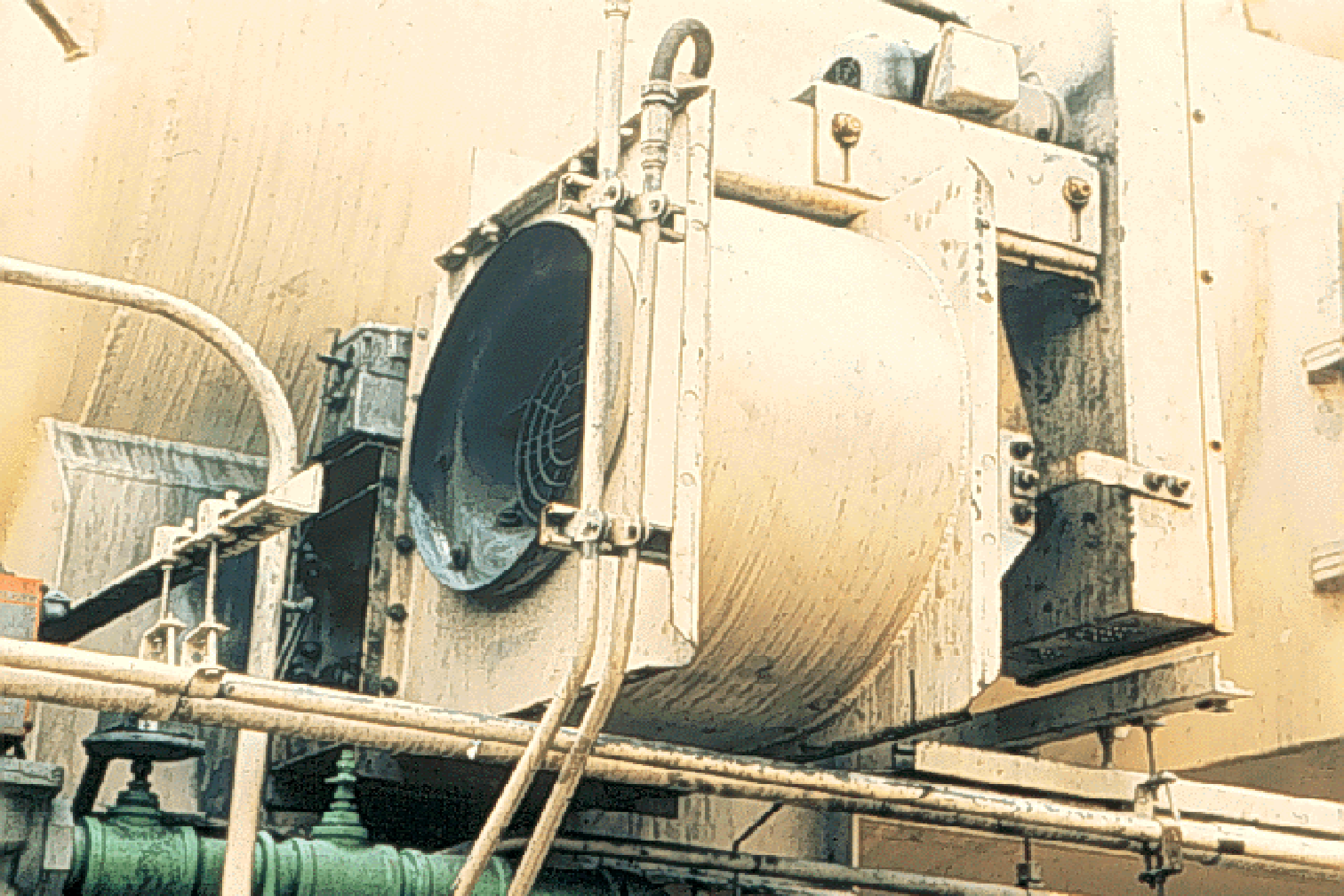



HOT
HOT

Air Mover

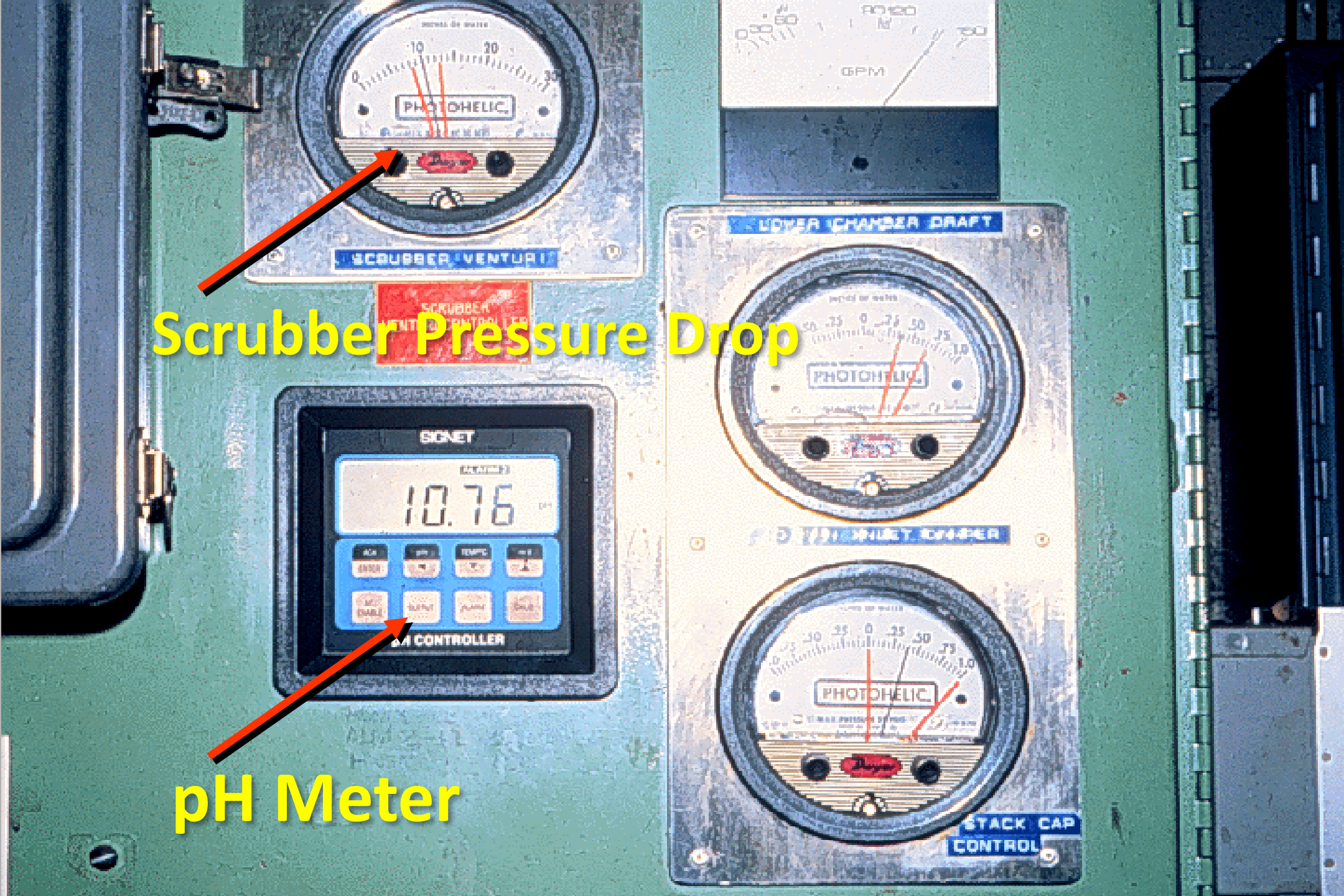
- **Is the fan big enough for the Job?**
- **Is it Operating as Designed and Permitted?**


Horsepower ?



Instrumentation

- Are the proper instruments present?
- Do these instruments appear to be functioning?
- Are the instruments showing the appropriate units?


Scrubber Pressure Drop
pH Meter
PHOTOHELIC
SCRUBBER VENTURI
SCRUBBER
SIGNET
10.76
CONTROLLER
LOWER CHAMBER DRAFT
PHOTOHELIC
PHOTOHELIC
STACK CAP
CONTROL

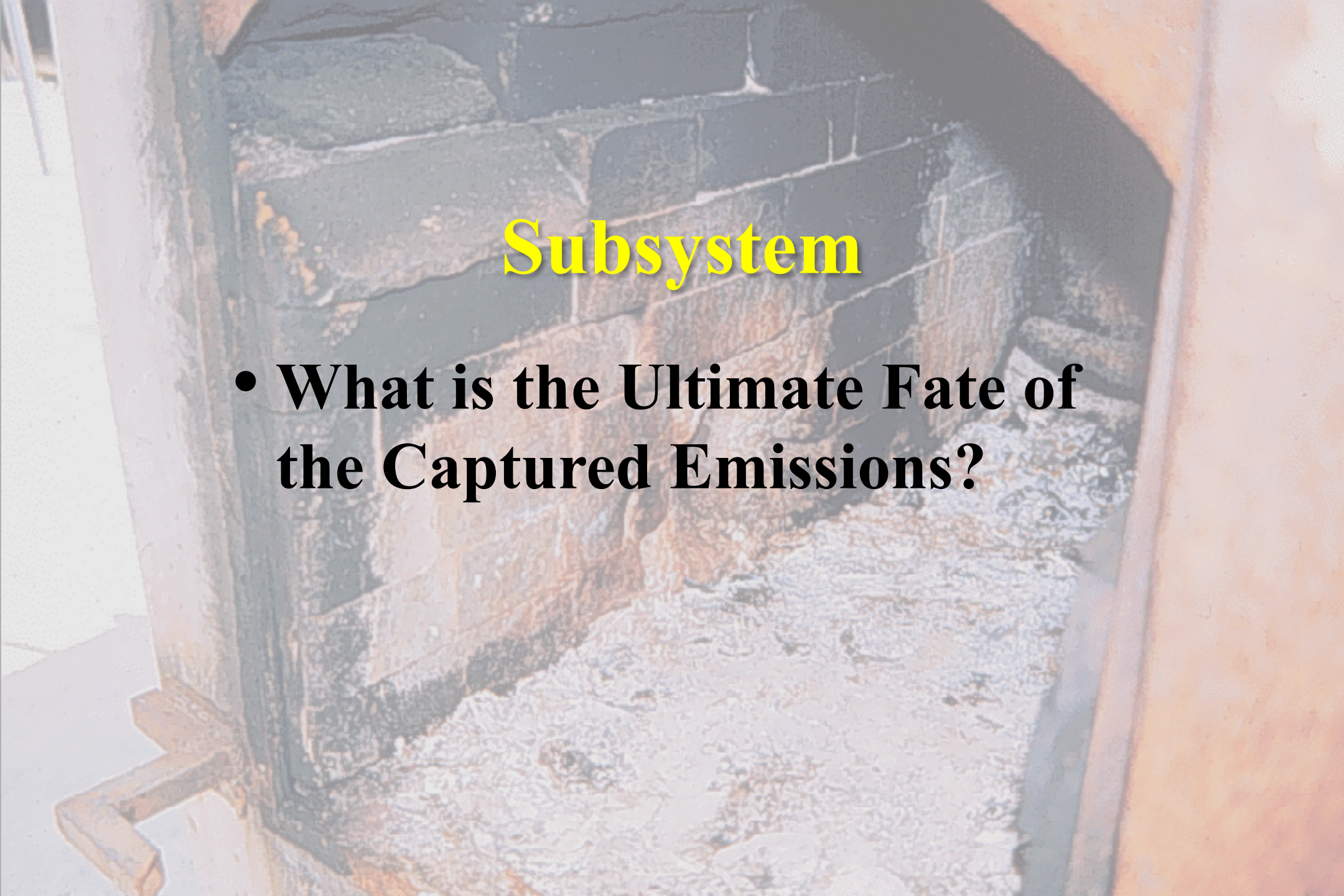

MONITOR LABS INC.
CO ANALYZER MODEL 8830

Control Device

- Is it On?
- Visible Emissions?


CAUSTIC


HOT



Subsystem

- What is the Ultimate Fate of the Captured Emissions?

What about Violations?

- Notice To Comply (NTC)
  - Minor Deficiency
  - Non-Emissions Related
  - Non-Recurring

What about Violations?

- Notice Of Violation (NOV)
  - Emissions Related
  - Same Problem At Last Inspection

Four Options After A NOV

- Continue to Operate in Violation
- Cease the Non-compliant Activity (shut down the operation)
- Correct the Problem
- Apply for a Variance