Overview of Poultry Litter Energy Systems

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IPEP Review Meeting

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Objectives

- Combust poultry litter with reliable operation and good environmental performance
  - Continuous operation
  - Low emissions
- Use the heat to produce process steam and/or electricity.
- Export the nutrient rich ash to existing fertilizer granulation plants to incorporate ash into existing fertilizer products
- Export phosphorous rich ash to existing feed mills

Background

- Mixed success with commercial systems for burning litter and manures
  - Agglomeration, fouling, corrosion in fluidized beds
  - Slag in secondary combustors of gasifiers
  - Fouling in spreader stoker convection passes
  - Excess carbon in ash
- Commercial success of four plants burning poultry litter and recovering ash for fertilizer in UK.
- Good emissions and ash quality from pilot fluidized bed combustion of poultry litter
  - Enriched P recovery in boiler ash
  - Enriched K recovery in baghouse ash
  - Clean ash, good carbon burnout

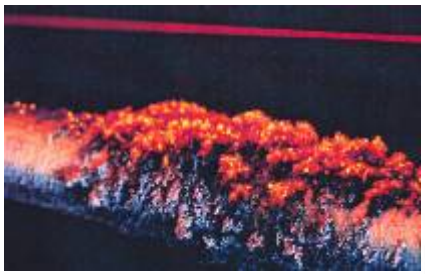
Poultry Litter Contains High Ash and Chlorine

	Poultry Litter	Corn	Wood Waste (Urban)
Carbon, dry wt %	37.87	48.21	48.64
Hydrogen, dry wt %	5.14	6.84	5.64
Nitrogen, dry wt %	3.59	1.79	1.37
Sulfur, dry wt %	0.45	0.14	0.08
Ash, dry wt %	19.24	1.47	9.86
Chlorine, dry wt %	0.91	0.03	0.11
Oxygen, dry wt %	33.69	41.15	34.41
Moisture, % (as delivered)	20-35	12	10-20
Dry HHV, Btu/lb	6,479	8,091	7,811

Poultry Litter Has Abundant Potassium and Phosphorous

	Poultry Litter	Corn	Wood
SiO2	7.60	3.98	55.68
Al2O3	1.60	2.27	7.25
TiO2	0.17	0.08	1.81
FeO2	1.00	1.21	7.22
CaO	16.50	0.72	14.50
MgO	5.50	13.70	1.55
Na2O	10.60	0.15	2.26
K2O	21.40	29.10	1.90
SO3	6.40	0.26	1.46
P2O5	25.00	52.03	0.77
Alkali (K20+Na20) lb/MMBtu	9.50	0.53	0.53

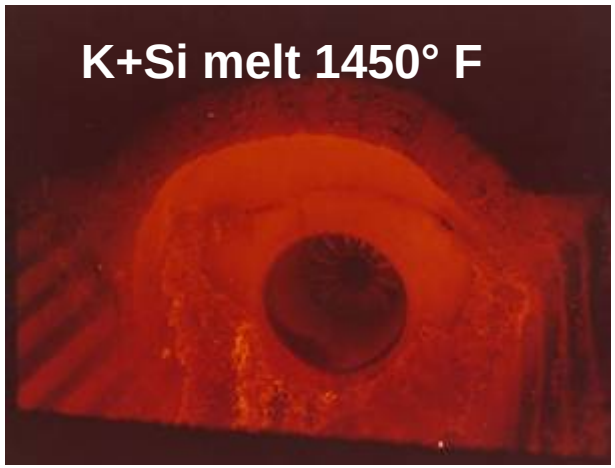
Phosphorous and Potassium Volatilize and Condense in the Boiler

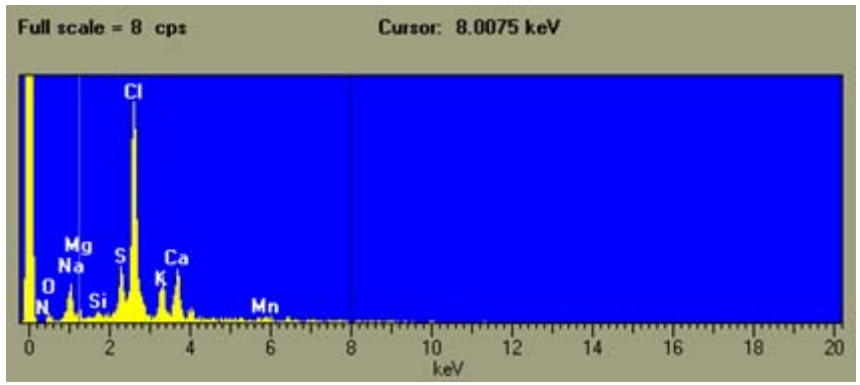


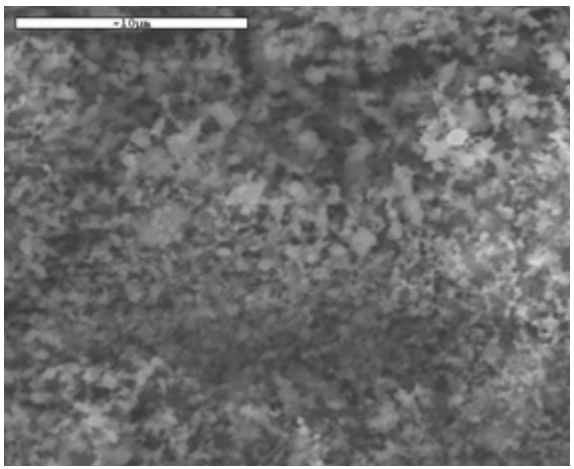
FLYASH

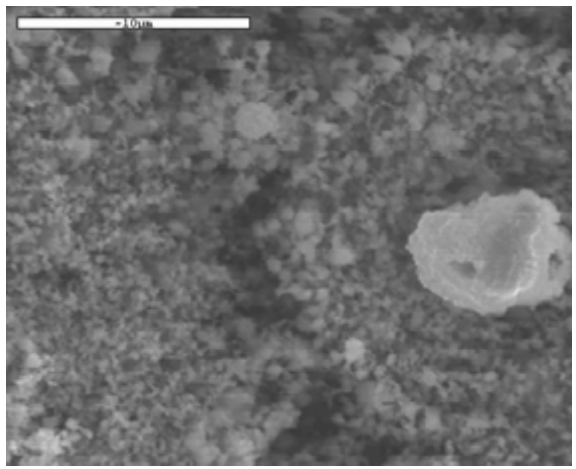
Potassium, Chlorine and Sulfur Vaporize and Condense to Fine Sticky Particles

60% -80% released at 1500F° – 1800F°







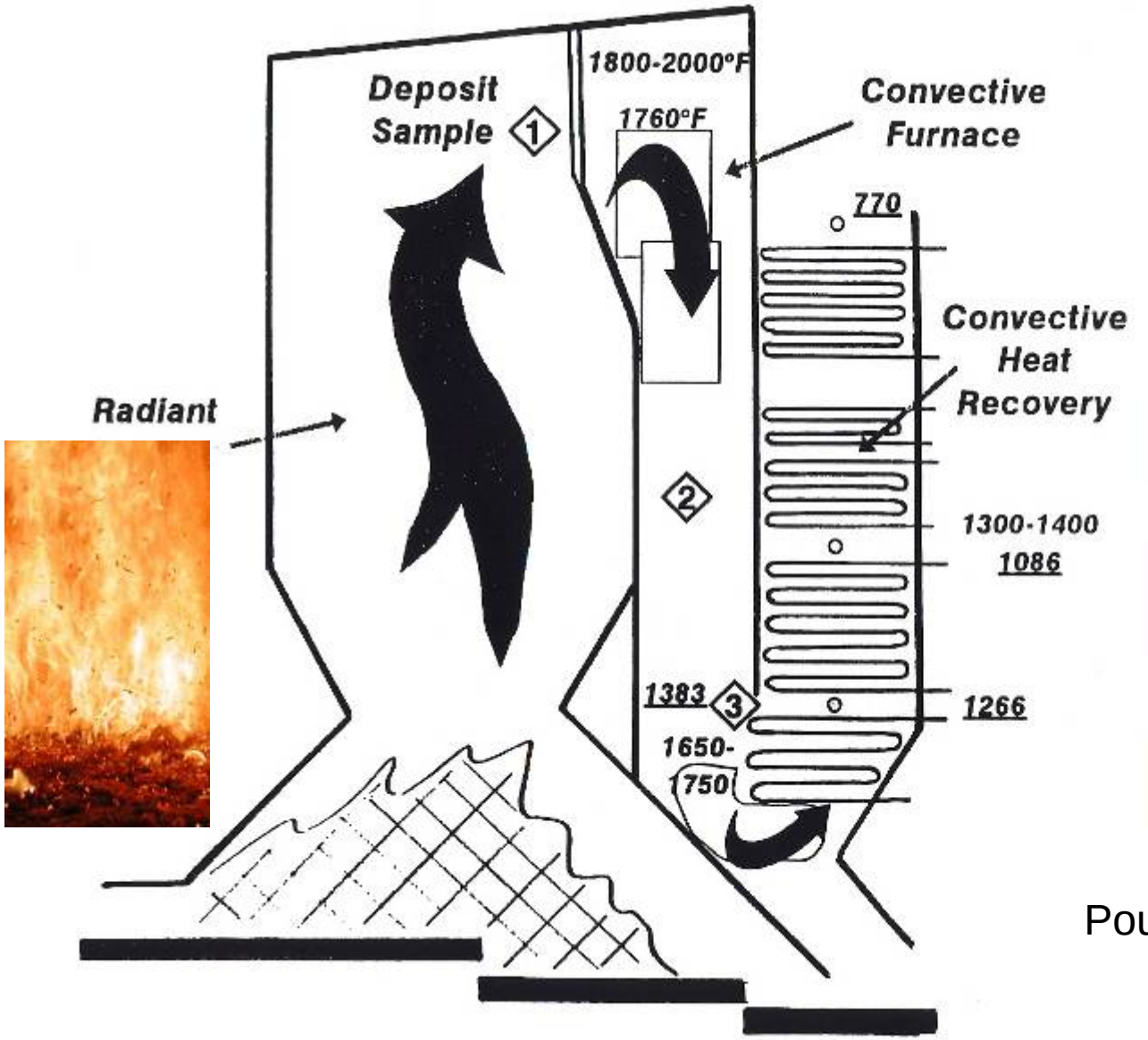


Some Commercial Plants Use A Vibrating Water Cooled Grate for Litter

- Litter is pneumatically distributed onto the grate
- Litter burns as ash is conveyed on the water cooled grate to the ash pit.
- Fine particles and gas are burned above the grate
- Ash is captured on radiant furnace walls and in convection passes
- Bottom ash contains 2% carbon

Detroit Stoker Hydrograte

High Temperatures Cause Excessive Deposits



Fuel Ash Chemistry	
SiO_2	10.7
Al_2O_3	5.8
Fe_2O_3	0.8
CaO	21.4
MgO	6.2
Na_2O	3.8
K_2O	15.1
SO_3	7.0
P_2O_5	30.2
Cl	3000 ppm

Poultry Litter on a Moving Grate (UK)

PL Ash Deposits Formed at Different Gas Temperatures

	Fuel	Radiant Furnace Exit	Lower Convective Furnace	Convective Passes
SiO2	8.4	10.6	0.4	1.3
Al2O3	0.7	2.5	3.0	2.0
TiO2	0.1	0	0	0
FeO2	1.2	1.2	0.1	0.3
CaO	32.3	24.7	4.3	10.3
MgO	4.9	8.5	1.4	2.6
Na2O	3.0	2.8	2.0	1.4
K2O	14.3	15.9	41.4	34.7
SO3	6.4	1.8	40.0	31.9
P2O5	28.7	32.5	7.6	16.4

SO_X Emission Control

--Fuel Ca forms $CaSO_4$ deposited with ash

--Added lime (CaO), if required

Prevention of Ash Fusion due to K, Na, Cl

--Uniform air & fuel dist.

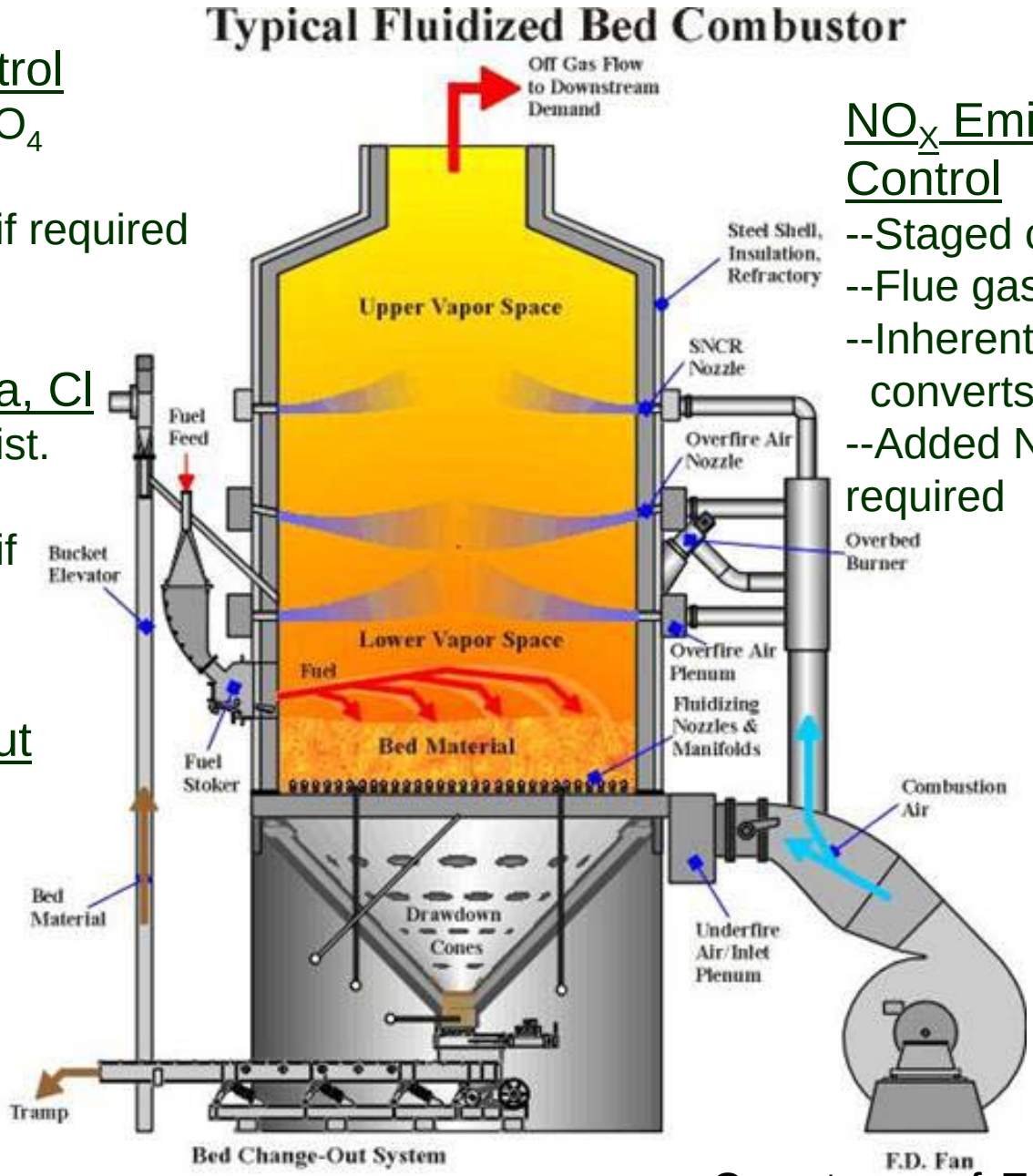
--Low temperatures

--Added lime (CaO), if required

Complete C Burnout

--Bed mixing and fuel/ash abrasion

--Excess air vs. starved air for gasification



NO_X Emission Control

--Staged combustion

--Flue gas recirculation

--Inherent fuel NH_3 converts NO_X to N_2

--Added NH_3, if required

Fluidized Beds Permit Low Combustion Temperatures and Low Emissions

Vapor temp	1400 °F max 1800 °F
Min Bed temp	1300 °F to 1400 °F
O2	6%-12%
CO	25 ppm dv
NOX w/FGR	10-50 ppm
SOx	0- 25 ppm

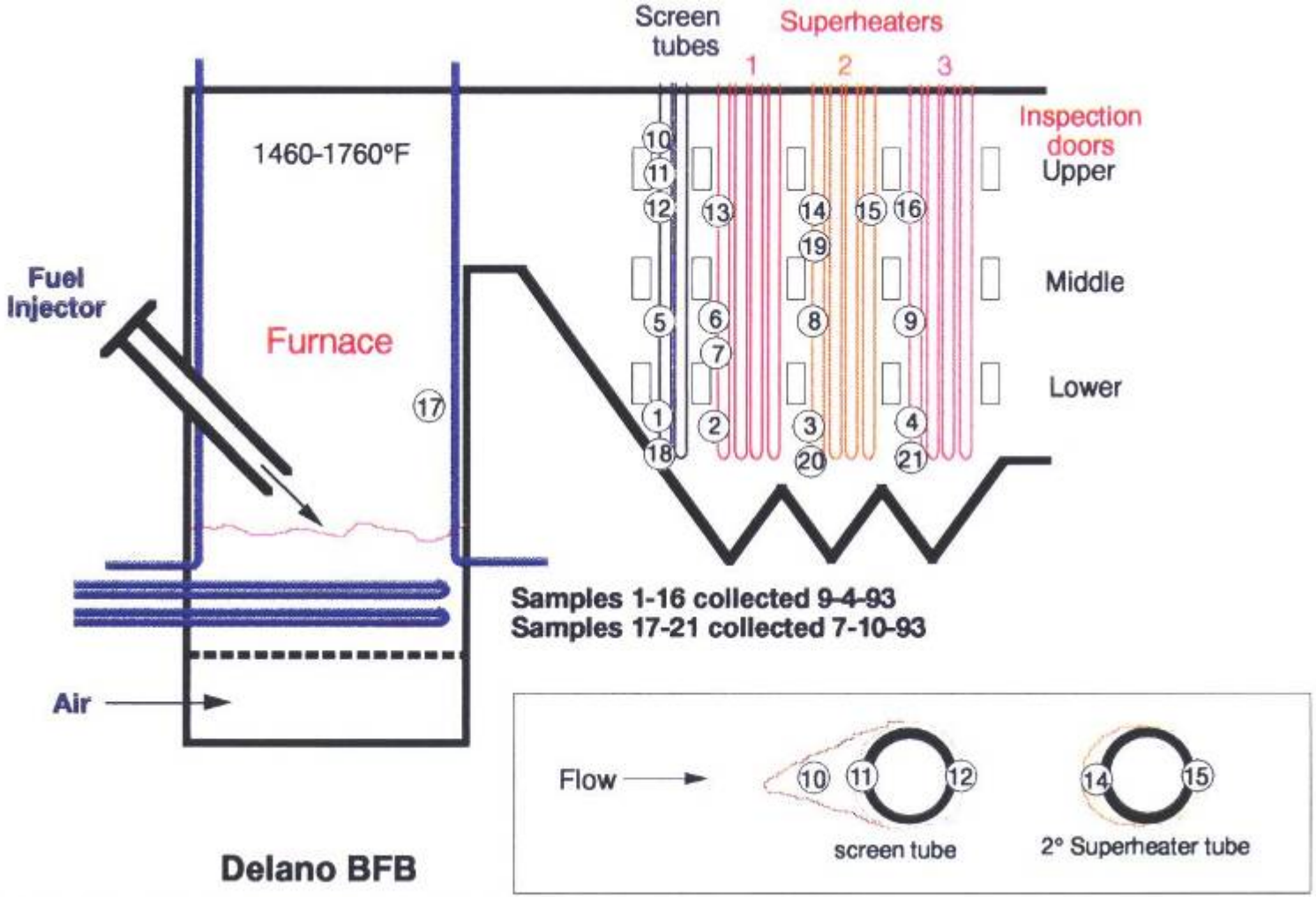
FB Combustor and Boiler for Agricultural Residues

Feed Conveyor Lime Silo and Fluidized Bed

Radiant Furnace

Convective Boiler

Alkali Volatilization and Deposition in a Commercial Fluidized bed



Energy Products of Idaho

Pilot Facility Used To Recover Ash

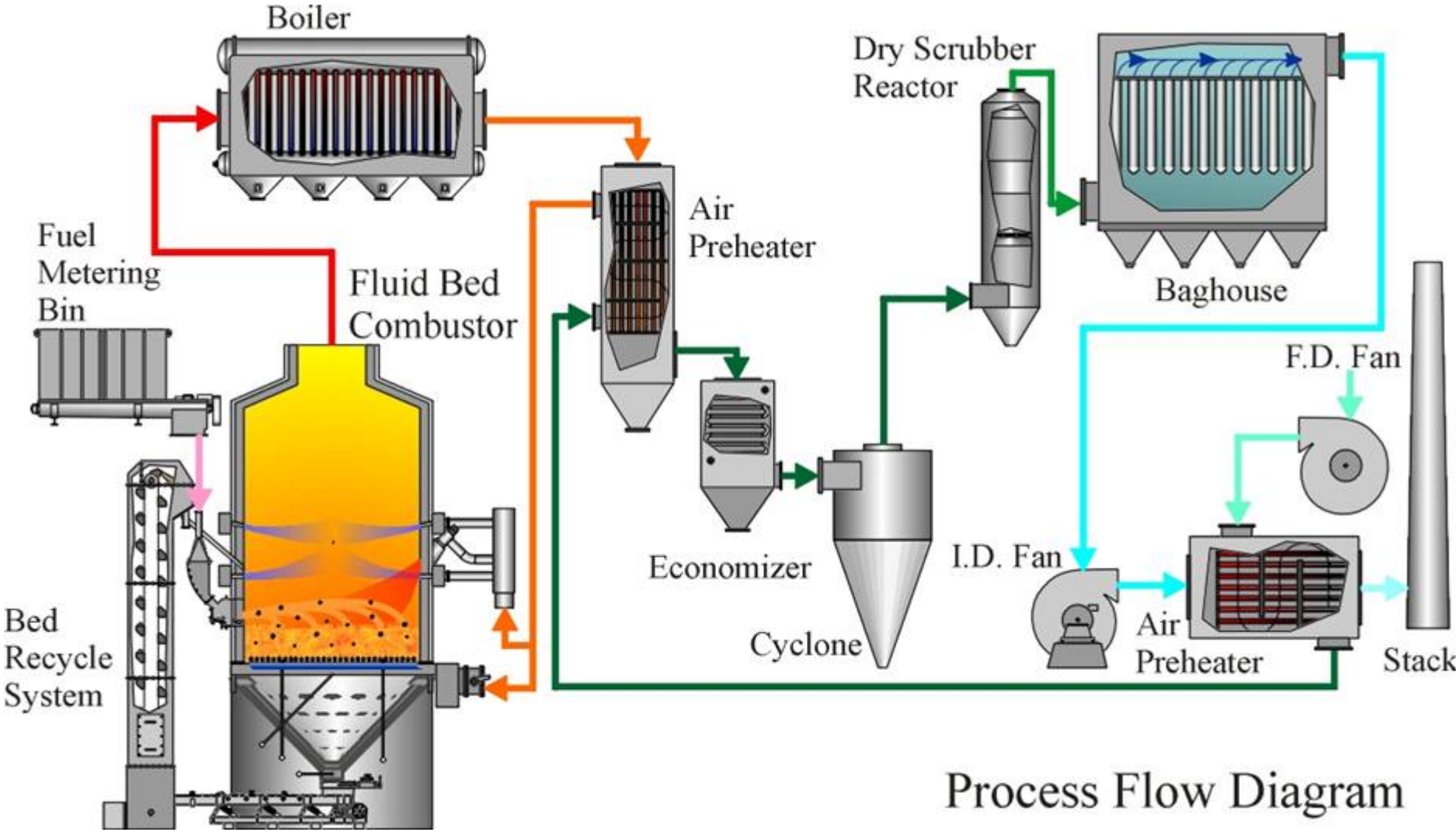
- 3 MMBtuh
- Freeboard 25 ft
- Bed area 8.6 ft2
- Bed Media silica sand 600-800 µm
- 7 sets of OFA w/ FGR or NH3 injection
- Preheat to 800°F
- Aux freeboard burner
- Periodic ash clean/removal
- Analyzers: SO2, NO/NOx, O2, CO

FB and Boiler Separate Ash Constituents

- Boiler/Cyclone ash is coarse and enriched in phosphorous

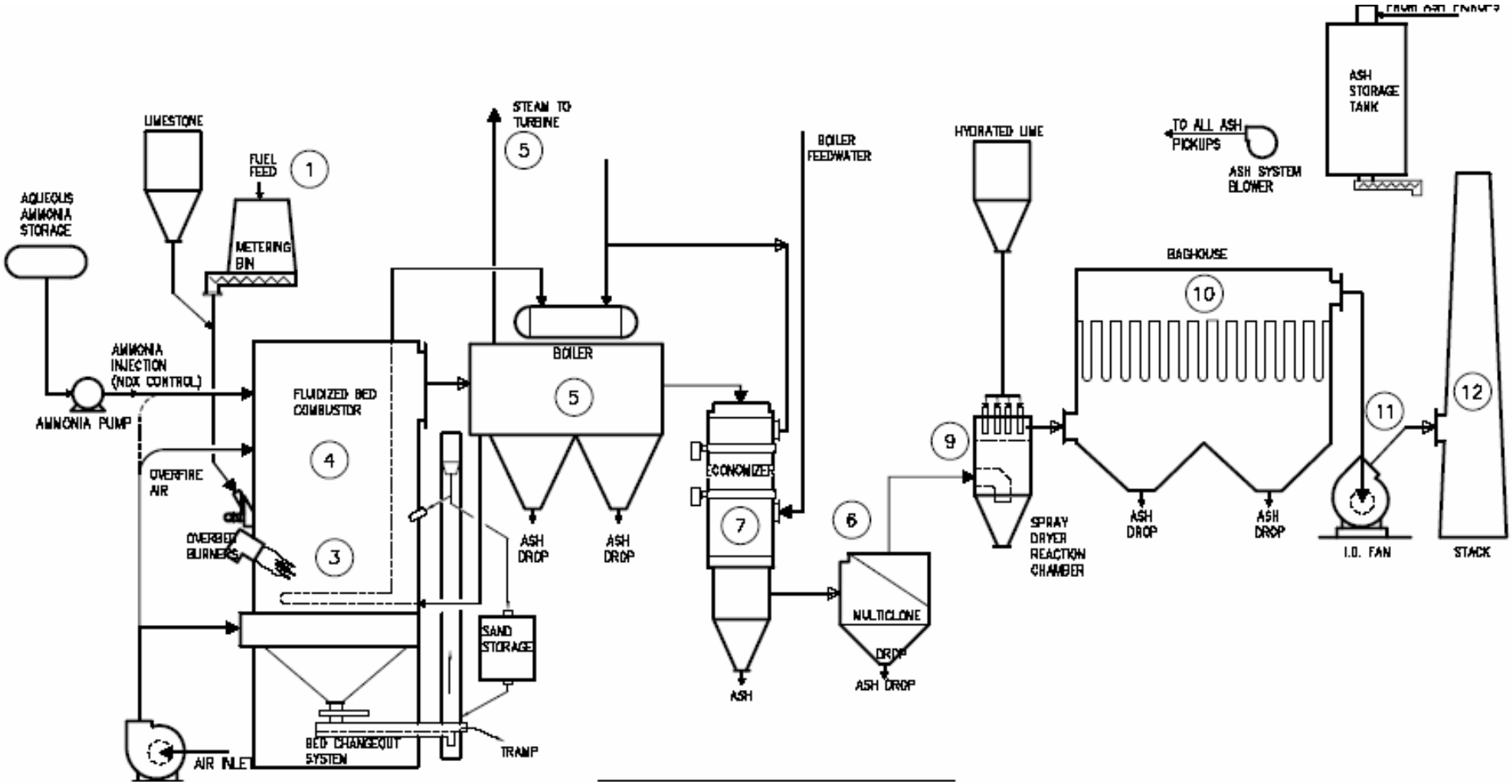
- Baghouse ash is fine and enriched in potassium

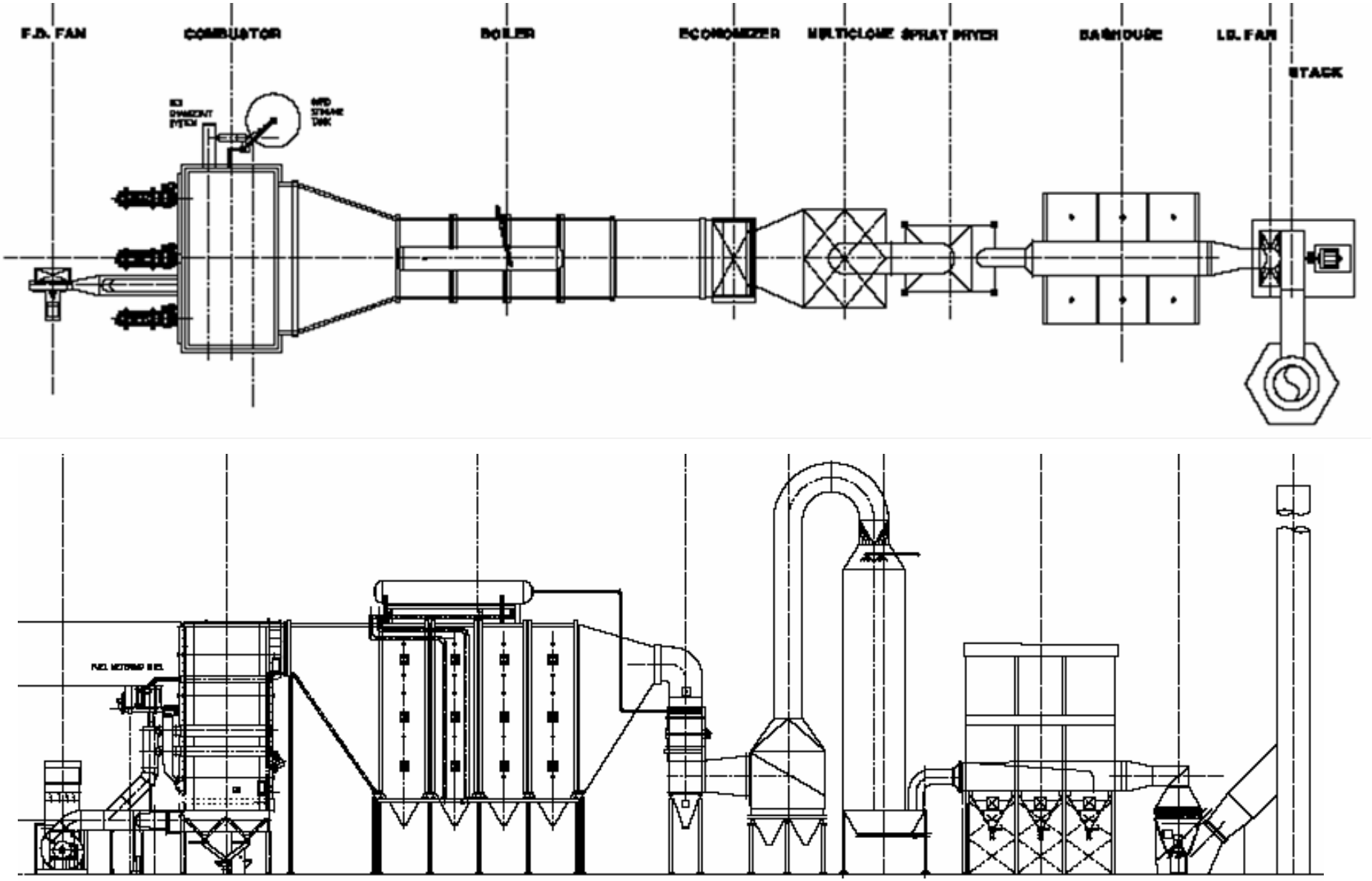
Elements of a Commercial FB System for Energy and Nutrient Recovery



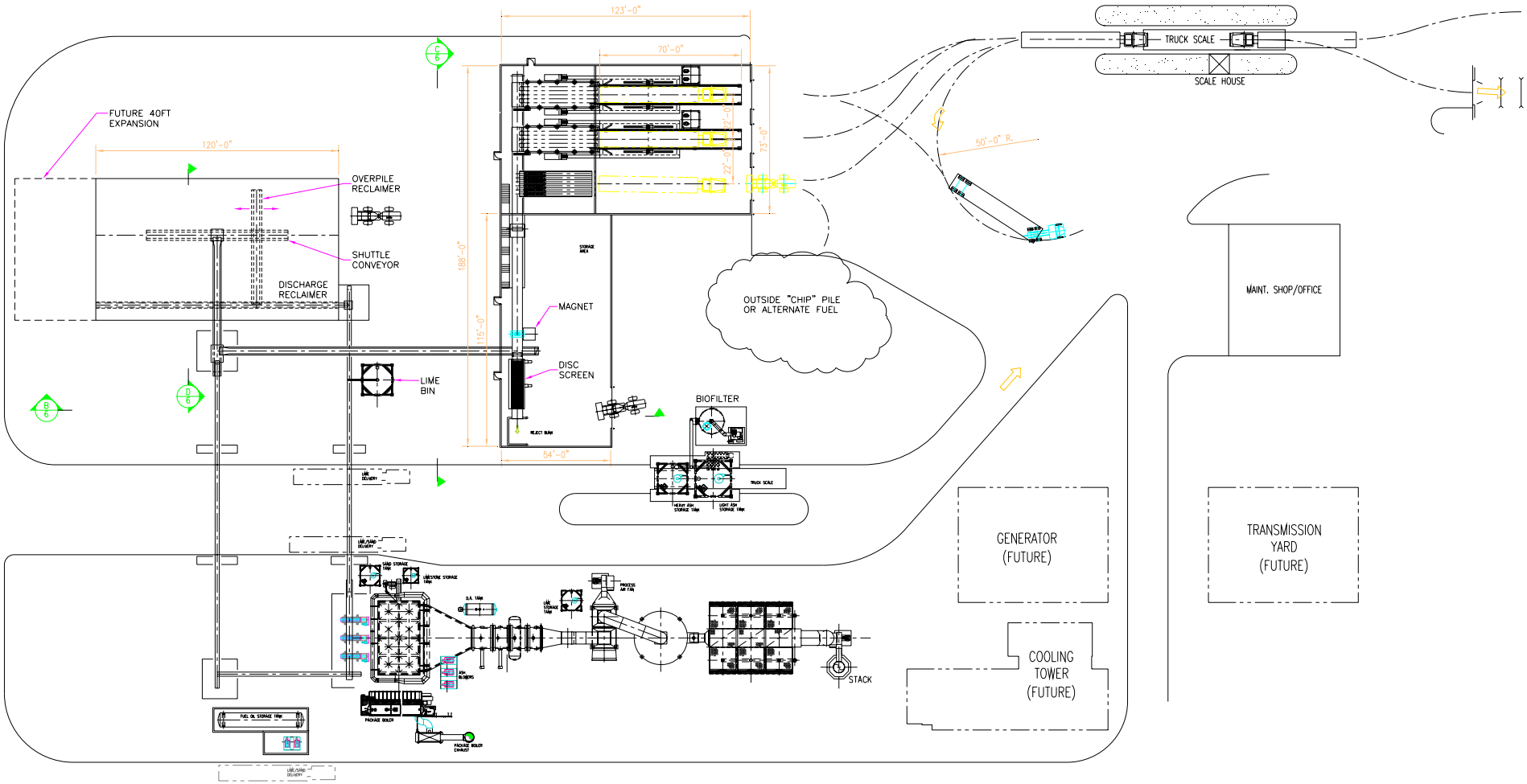
Courtesy Energy Products of Idaho

Energy Products of Idaho Proposal for IPEP

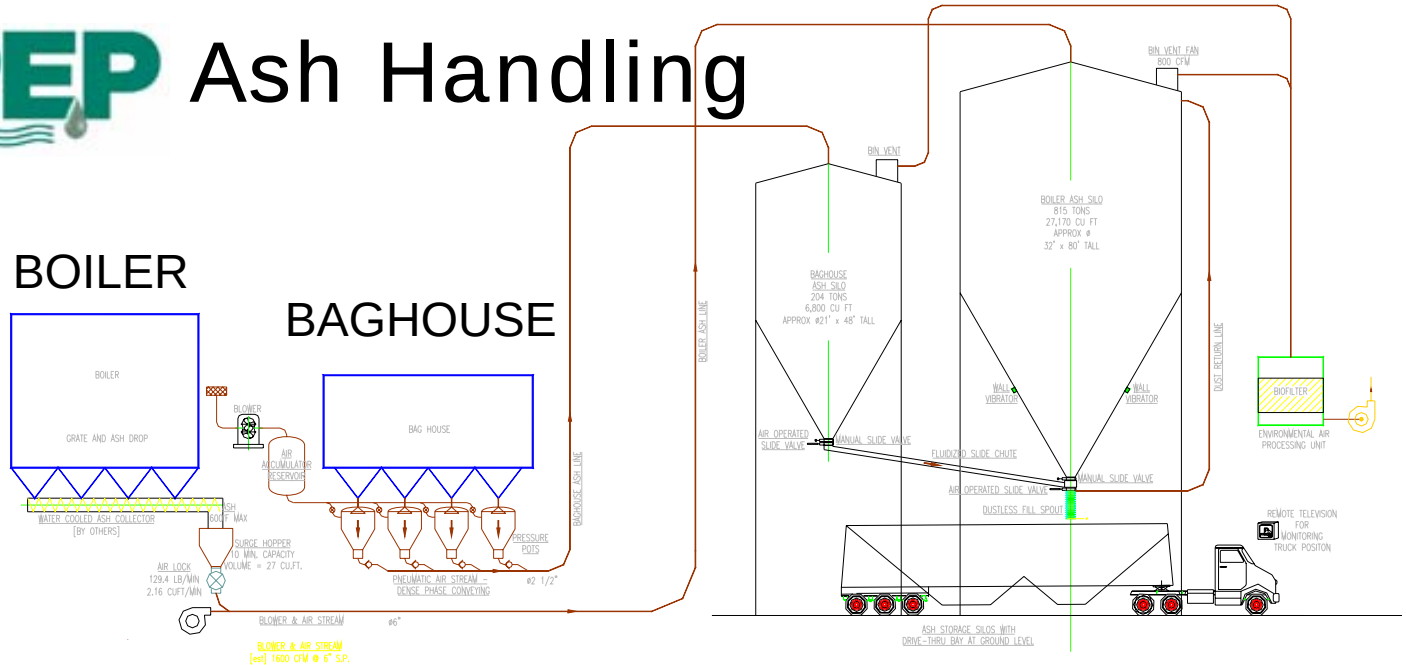



F.D. FAN
COMBUSTOR
BOILER
ECONOMIZER
MULTICLONE
SPRAY DRYER
BAGHOUSE
I.D. FAN
STACK

BOILER LAYOUT WITH RECEIVING AND STORAGE



Ash Handling



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