Reinhold Environmental Ltd.

2008 APC Round Table & Expo Presentation

July 13-15, 2008, in Savannah, GA

indigo
TECHNOLOGIES

MAPSystem

A Sustainable Emissions Control Solution

2008 APC/PCUG Conference
Savannah, GA
July 13 – 15, 2008

indigo TECHNOLOGIES
creating technology

MAPSystem

- Multi Air Pollutant (Control) System
- Simultaneously controls
  - NOx
  - SOx
  - Hg
  - PM and PM 2.5
  - Opacity
- Target market < 500 MW

indigo TECHNOLOGIES
creating technology

Traditional Technology Limitations

- Ineffective for fine particulate
- Address specific pollutants only
- High capital and operating cost
- Limited ability to retrofit
  - Large size / footprint
  - Limited retrofit space available

indigo TECHNOLOGIES
creating technology

MAPSystem Features

- Simultaneously controls NOx, SOx, Hg and PM in a single consolidated system
- Small footprint
- Low capital and operating costs
- More easily retrofit than a combination of individual pollutant controls
- Installation requires short outage time

indigo TECHNOLOGIES
creating technology

MAPS Development History

- **Acquired technology in 2005**
  - **Tower design**
  - **Specific chemistry**
- **Indigo enhancements through 2007 patents pending**
  - **Hg capture**
  - **Upflow reactor design**

indigo TECHNOLOGIES
creating technology

MAPS Development History

- **Transition and optimization of chemistry in US 2007 - 2008**
  - **Original technology had specific chemistry**
  - **Modify chemistry to be more environmentally friendly**
  - **“Americanize” the design**

indigo TECHNOLOGIES
creating technology

Proven Technology

- **Full scale 70 MW installation in Wroclaw, Poland**
  - **Operated continuously 1990 – 2005**
  - **Progressive modifications and enhancements**
- **Facility acquired by EDF in 2005**
  - **Emissions controls not currently required**

indigo TECHNOLOGIES
creating technology

MAPS Facts

- Novel not new
- Nearly 20 years under development
- 15 years in continuous operation
- A consolidation of proven technologies
- Established emissions control performance

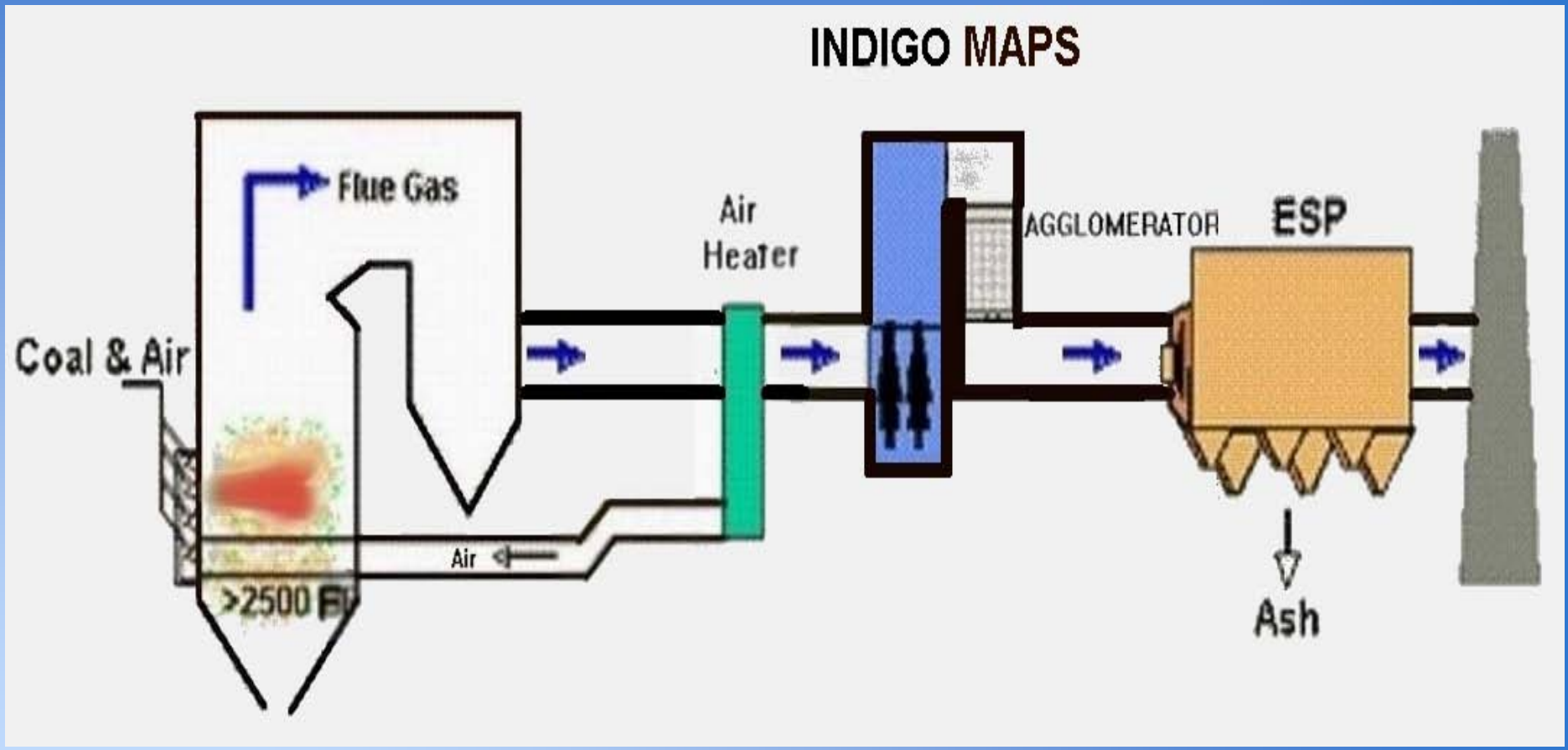
indigo TECHNOLOGIES
creating technology

MAPS Process

- **Two main components**
  - **Reaction tower**
  - **Fine Particulate Control System (FPCS) – formerly referred to as the Agglomerator**
- **Chemical injection**
  - **Water**
  - **Reagent**
  - **Sorbent**

indigo TECHNOLOGIES
creating technology

Multi-Pollutant Removal Using The Indigo Maps Technology



indigo TECHNOLOGIES
creating technology

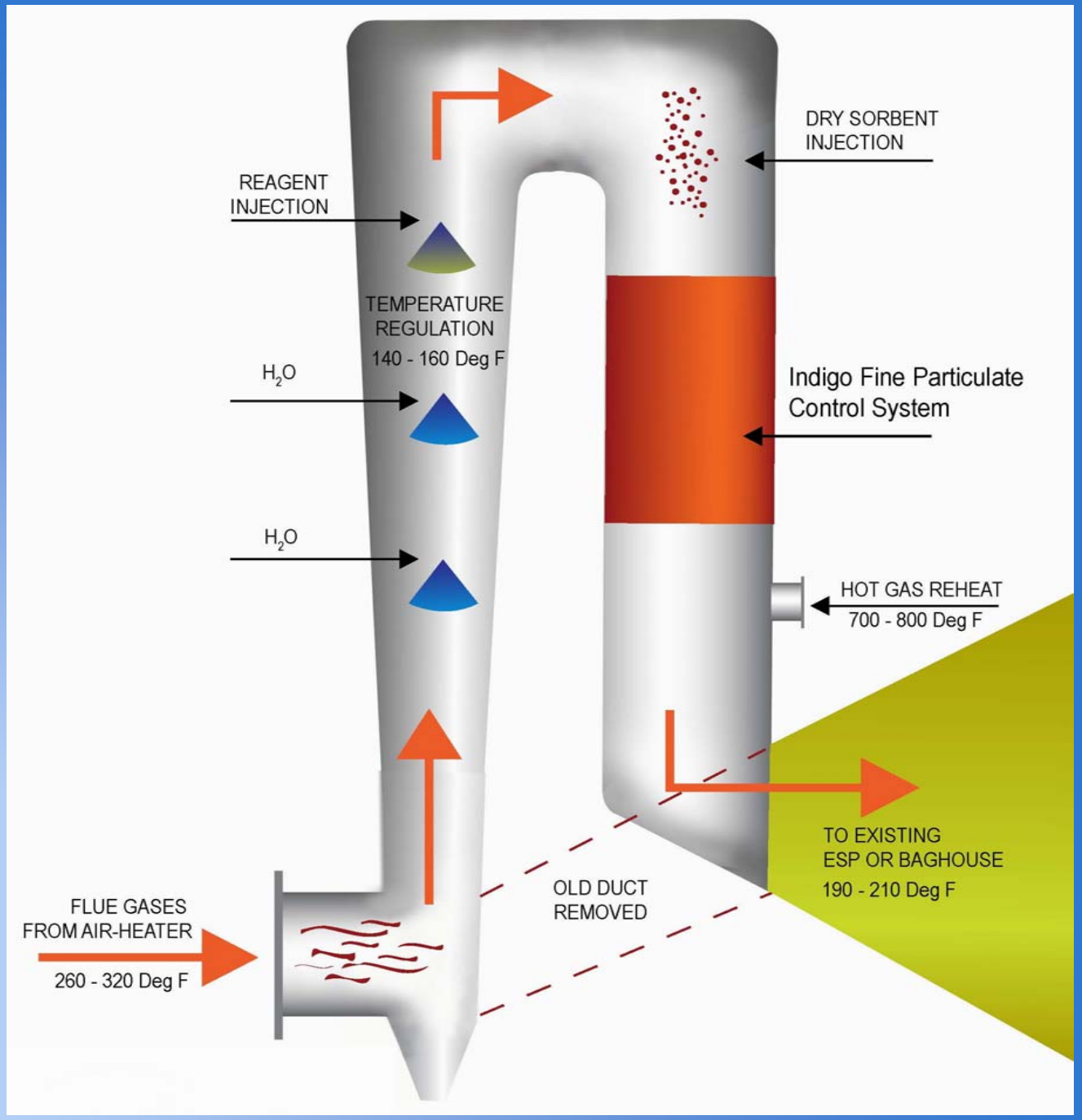
Simultaneously Removes PM2.5, NOx, SOx and Hg

MAPS

INSTALLATION

MODIFICATIONS

TO EXISTING DUCT



indigo TECHNOLOGIES
creating technology

Full-Scale Installation

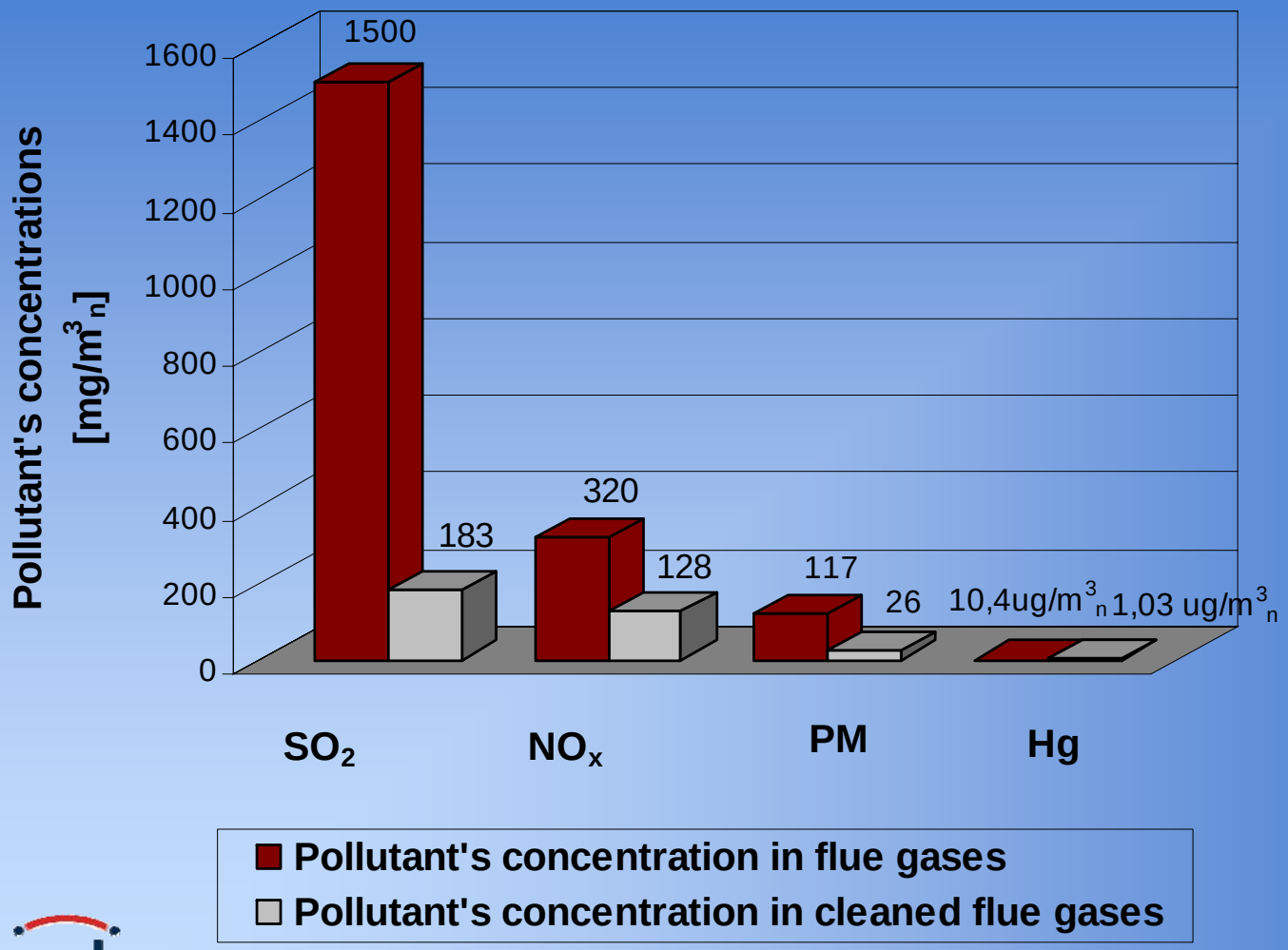
- 70 MW
- Flue gas 200,000 acfm @ 270^0F
- ~ 3% sulfur in coal
- SO_2 concentration: 2000PPM
- NO concentration: 400PPM
- Hg concentration: 10-11 µg / m^3_n

indigo TECHNOLOGIES
creating technology

Full Scale Indigo Maps Installation

indigo
TECHNOLOGIES
creating technology

Emissions Reduction Efficiencies



Reduction

SO_2 – 88%

NO_X – 60%

PM – 78%

Hg – 90%

indigo TECHNOLOGIES creating technology

Established Results

- **Prior to 2005 – 2008 enhancements (with original sorbent and reagent)**
  - **SO2 removal – greater than 80%**
  - **NOx removal – greater that 60%**
  - **Hg removal – greater than 90%**
  - **PM reduction – greater than 70%**

indigo TECHNOLOGIES
creating technology

Gadsden Pilot Objectives

- Employed and modified an existing, non-MAPS pilot
- Sorbent and reagent evaluation
  - Increased chemical utilization
  - Ease of handling / fewer safety issues
  - Lower cost / available in bulk
  - Increase marketability of ash
- Not an evaluation of the MAPSystem components

indigo TECHNOLOGIES
creating technology

Southern Company Gadsden Slipstream Trial Installation

indigo TECHNOLOGIES
creating technology

Gadsden Phase 1

- **December 2007**
  - **Obtained similar results for chemistry from Poland**
  - **Successfully proved alternative reagents and sorbents**
  - **Established criteria for further chemistry testing to enhance utilization**

indigo TECHNOLOGIES
creating technology

Summary Of Removal Efficiency Results Gadsden 1 Trial Installation

- SO2 - >95% - old sorbent at a Molar Ratio of 1.2
  - >95% - new sorbent at a Molar Ratio of 1.2
- Hg - >90% - old reagent
  - >90% - new reagent
- NO - >50% - old reagent
  - >55% - new reagent

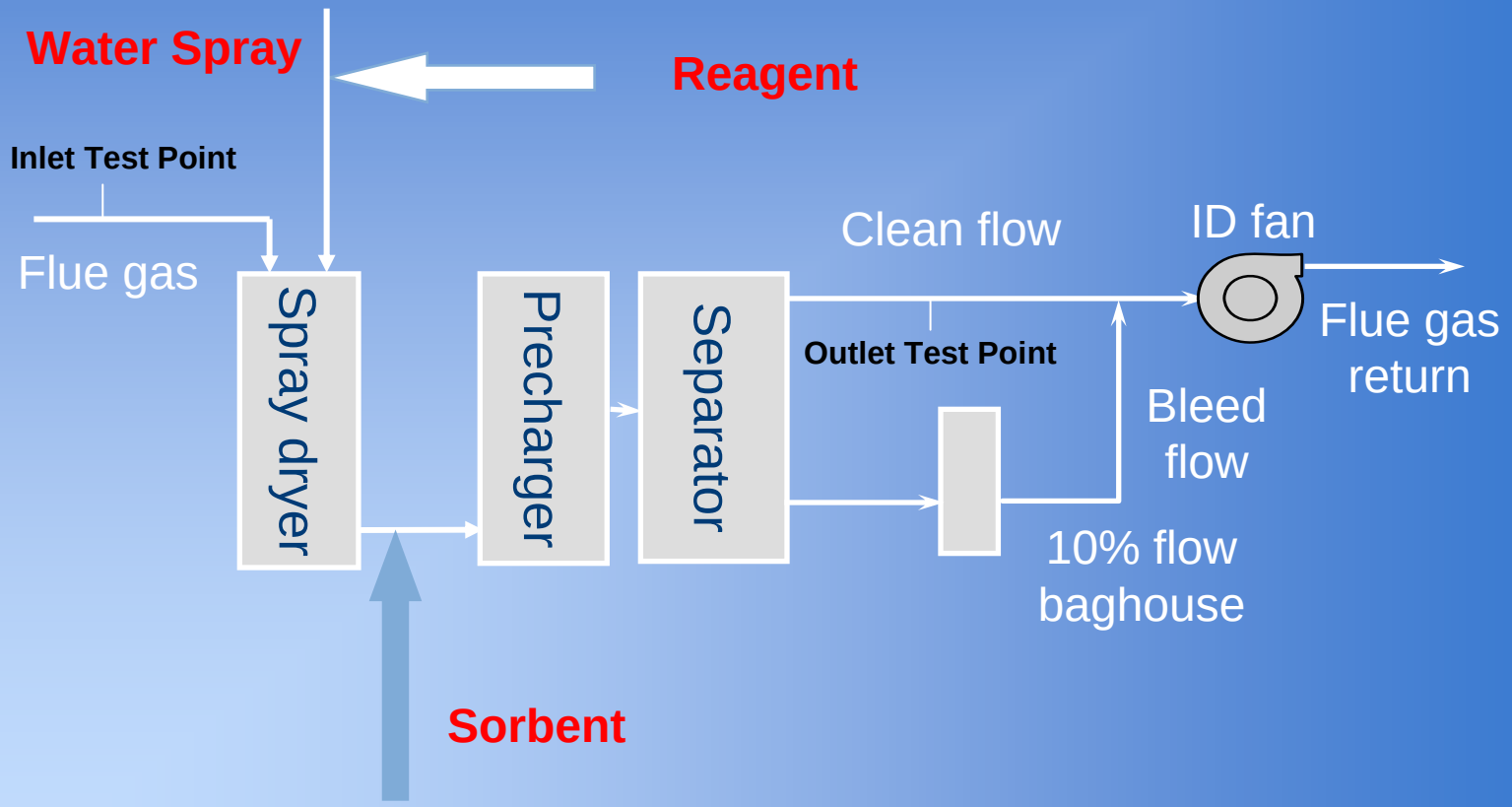
indigo TECHNOLOGIES
creating technology

Gadsden Phase 2

- **August 2008**
  - **Optimize the use of new reagent by modifying the injection location and temperature as replicates MAPS process in Poland**
  - **Perform parametric testing on process variables supportive of future applications**

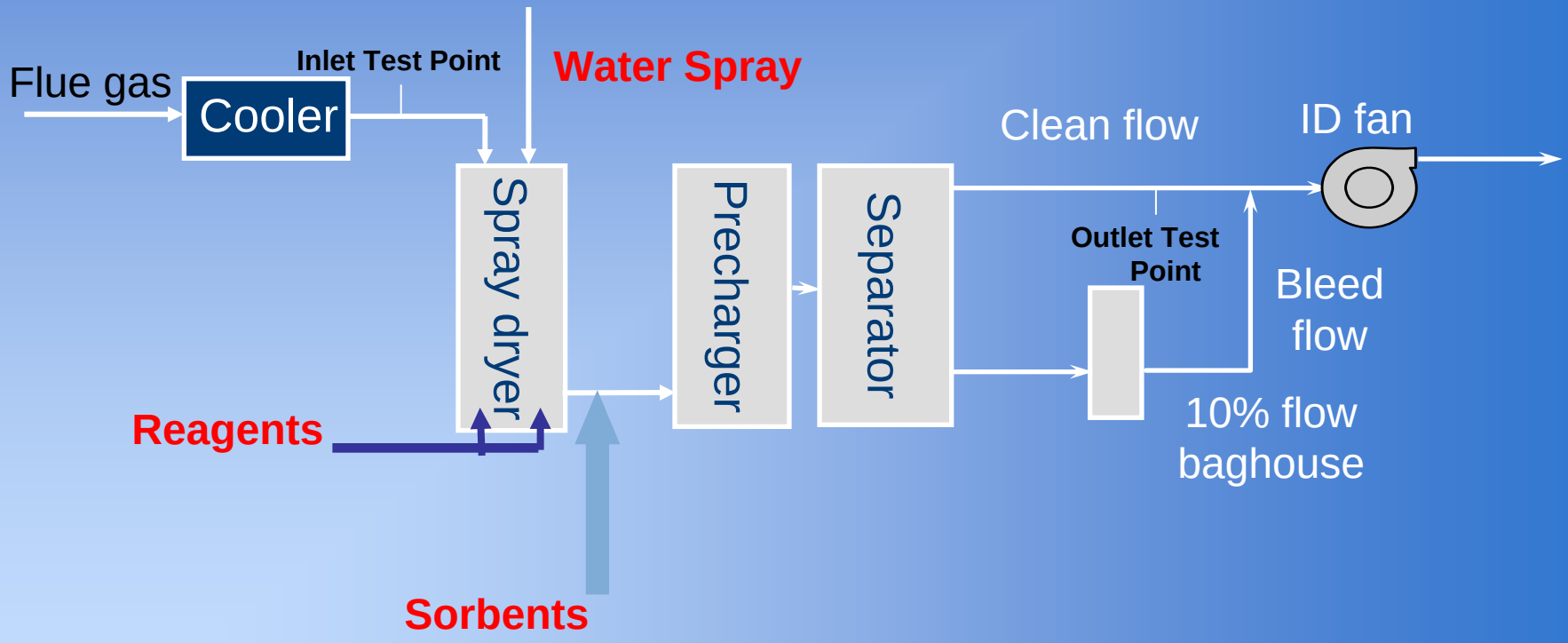
indigo TECHNOLOGIES
creating technology

Peroxide Injection
Process Detail
Gadsden Trial Phase 1 Installation



indigo TECHNOLOGIES
creating technology

Proposed Process Modifications For Stage 2 Testing Gadsden Trial Installation



indigo TECHNOLOGIES
creating technology

Anticipated Reductions

- SO2 OVER 90%
- SO3 OVER 95%
- NOx OVER 60%
- Hg OVER 90%
- TOTAL PM OVER 70%
- OPACITY OVER 80%

indigo TECHNOLOGIES
creating technology

Target Utilization

- SO2 LESS THAN $200/TON
- NOx LESS THAN $1000/TON
- Hg OVER 90% REMOVAL

NO COST

- UP TO 80% IMPROVEMENT

NO COST

- UP TO 80% IMPROVEMENT

NO COST

indigo TECHNOLOGIES
creating technology

Controls	Costs for Additional Controls			
	Installed	Annual Operating		
		Fixed	Variable	Emissions Reduction Cost
SCR, Semi-dry FGD, & Hg Controls Total	FGD $250/kW SCR $110/kW Hg $25/kW $385/kW	$1,800,000 $1,250,000 $ 225,000 $3,275,000 Total Annualized Operating Cost	$6,018,000 $1,325,000 $5,520,000 $12,863,000 $16,138,000	$ 220/ton SO_2 $ 590/ton NO $ 38,300/lbHg $1,915/ton NO incl. 90% Hg removal
Indigo MAPSystem Total	$ 150/kW $ 150/kW	$235,000 $235,000 $470,600 Total Annualized Operating Cost	$7,000,000 $4,380,000 $11,380,000 $11,850,000	$207/ton SO_2 $1053/ton NO incl. 90% Hg removal

indigo TECHNOLOGIES
creating technology

Note: All costs are representative of a 500MW base loaded, Central US region plant burning Appalachian medium sulfur coal (~ 1.3%) with a preexisting ESP. Operating costs assume an annual average load factor of 80%. Analysis provided by Krishnan & Associates, Inc. March 2008.

PM Reduction

- **3 effects result in improved ESP efficiency**
  - **Lower temperature**
  - **Lower resistivity**
  - **Higher moisture**

indigo TECHNOLOGIES
creating technology

Lower Temperature

- Lower gas volume by ratio of absolute temperatures
- 300 °F to 200 ° F reduces gas volume by 15%
- Reduced gas volume results in effectively higher SCA (Specific Collecting Area) by the same ratio
- 200 SCA becomes 230 ft^2 per 1000 acfm
- 300 SCA becomes 345 ft^2 per 1000 acfm

indigo TECHNOLOGIES
creating technology

Lower Temperature

- Higher gas density
- Higher sparkover voltage (KV)
- Higher corona current (MA)
- Higher corona power (KW)
- Higher efficiency
- Lower emissions

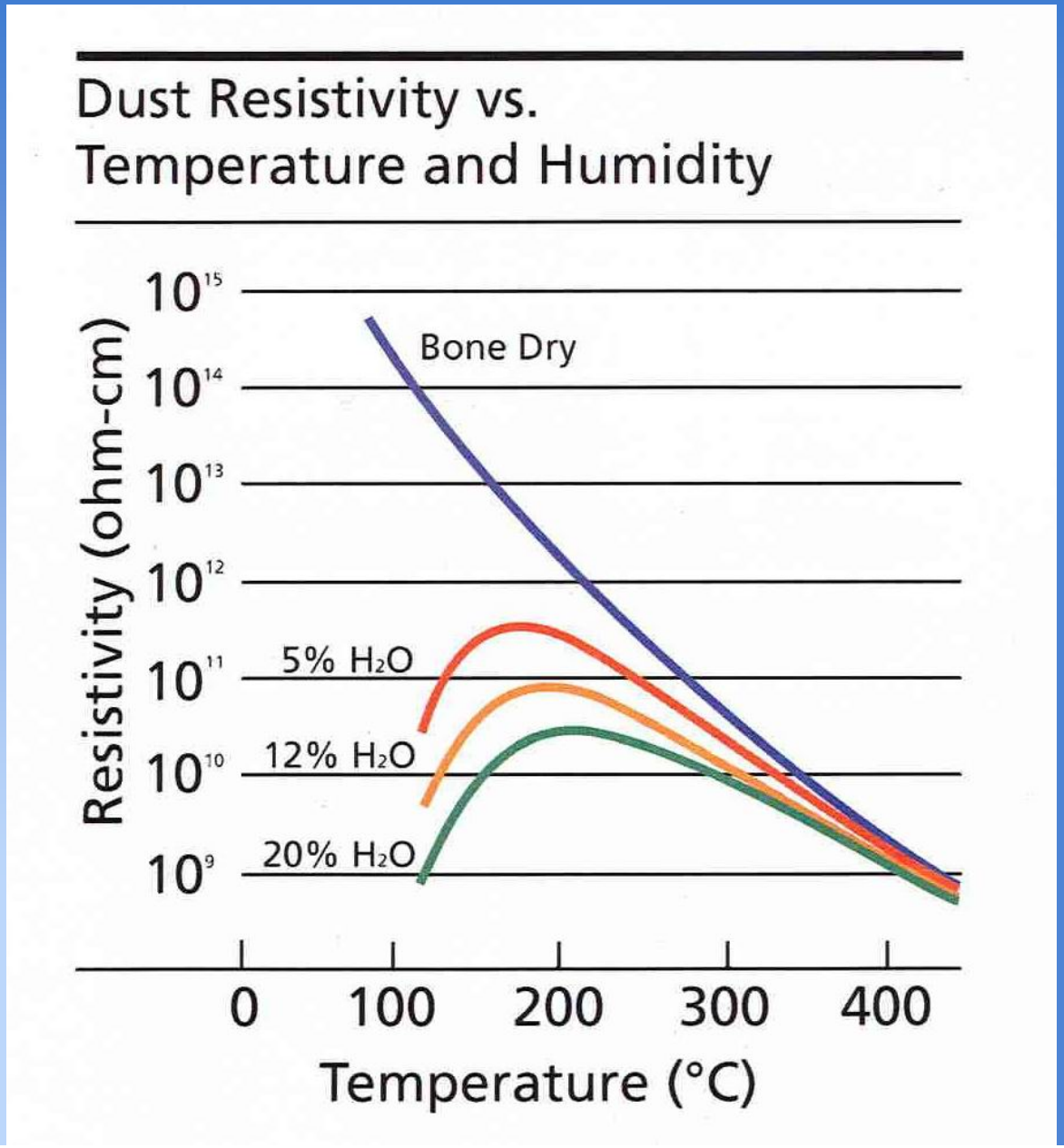
indigo TECHNOLOGIES
creating technology

Lower Resistivity

- Ash resistivity determined by
  - Chemistry
  - SO3
  - Temperature
  - Moisture
- Adding moisture and reducing temperature has dual effect on resistivity

indigo TECHNOLOGIES
creating technology

Resistivity Curve



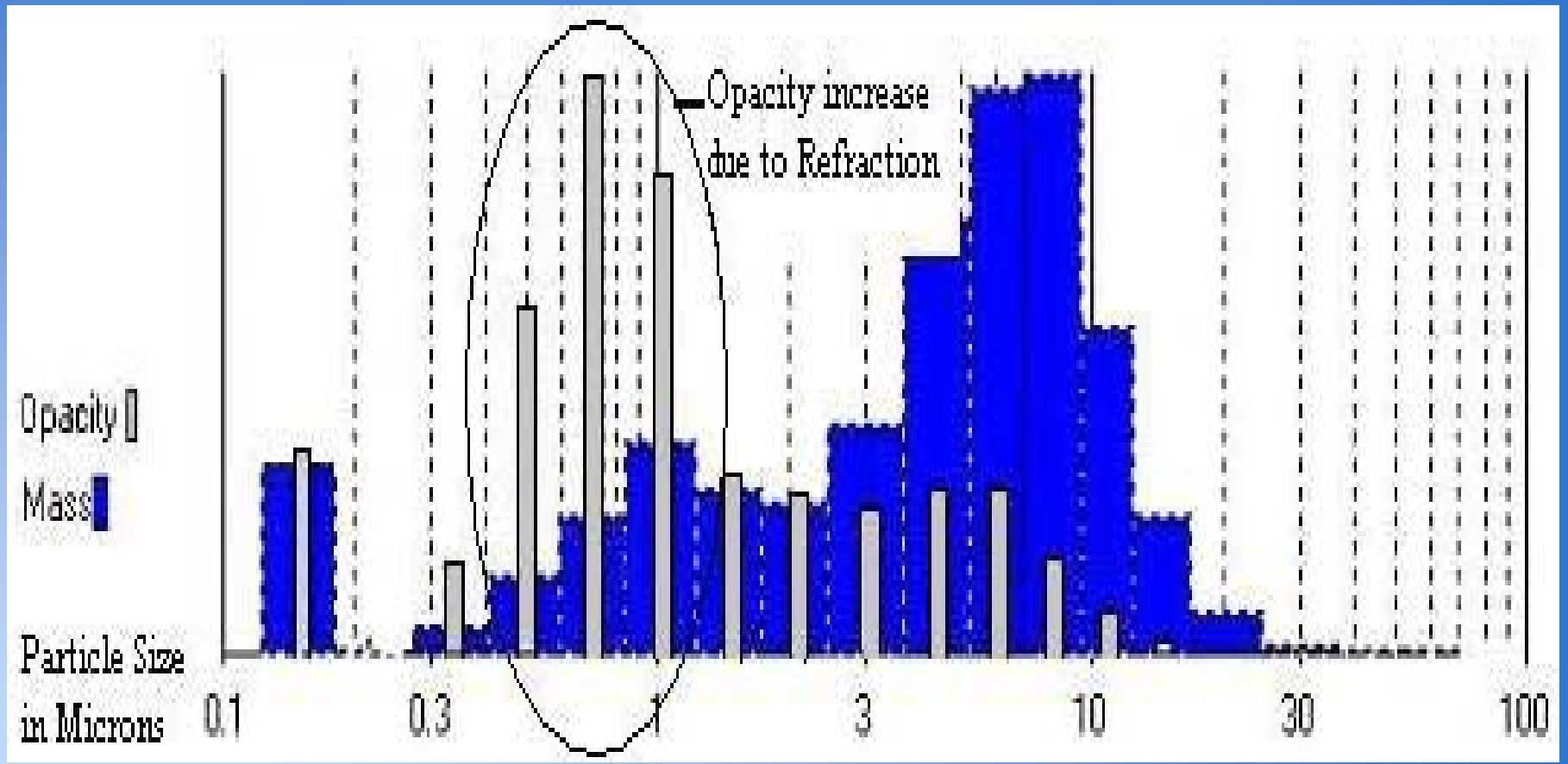
indigo TECHNOLOGIES
creating technology

PM2.5 and Opacity Reduction

- Indigo Fine Particle Control System (FPCS)
- Agglomerates fine particles (PM2.5)
- Fine particles cause high opacity
- Reducing fine particles reduces opacity
- Fine particles limit ESP corona current
- Reducing fine particles reduces “corona quenching” increases ESP power
- Increased ESP power improves efficiency for all particle sizes

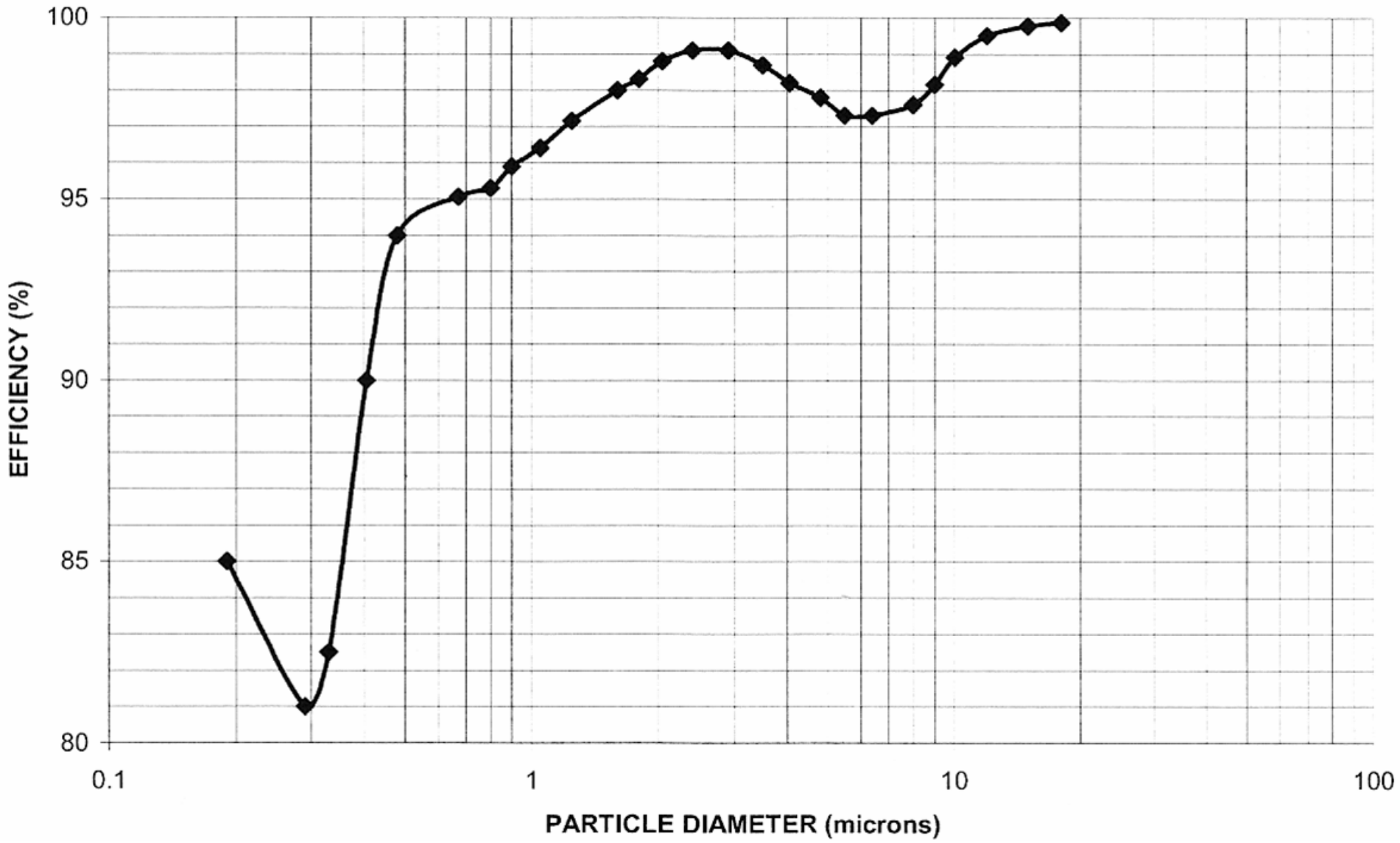
indigo TECHNOLOGIES
creating technology

Typical Mass And Opacity Versus Particle Size At ESP Outlet

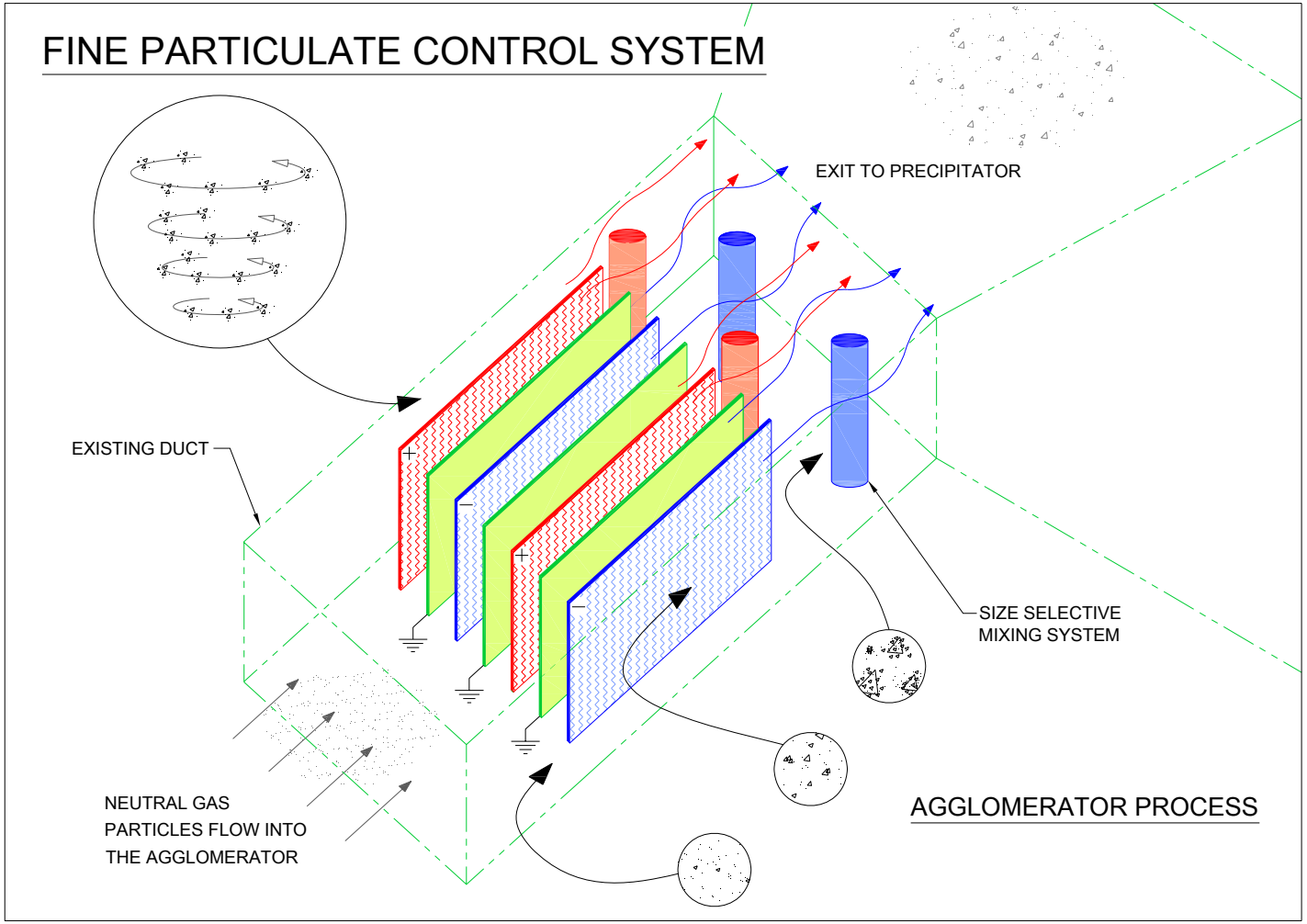


indigo TECHNOLOGIES
creating technology

Measured Efficiency (EPRI)



Indigo FPCS

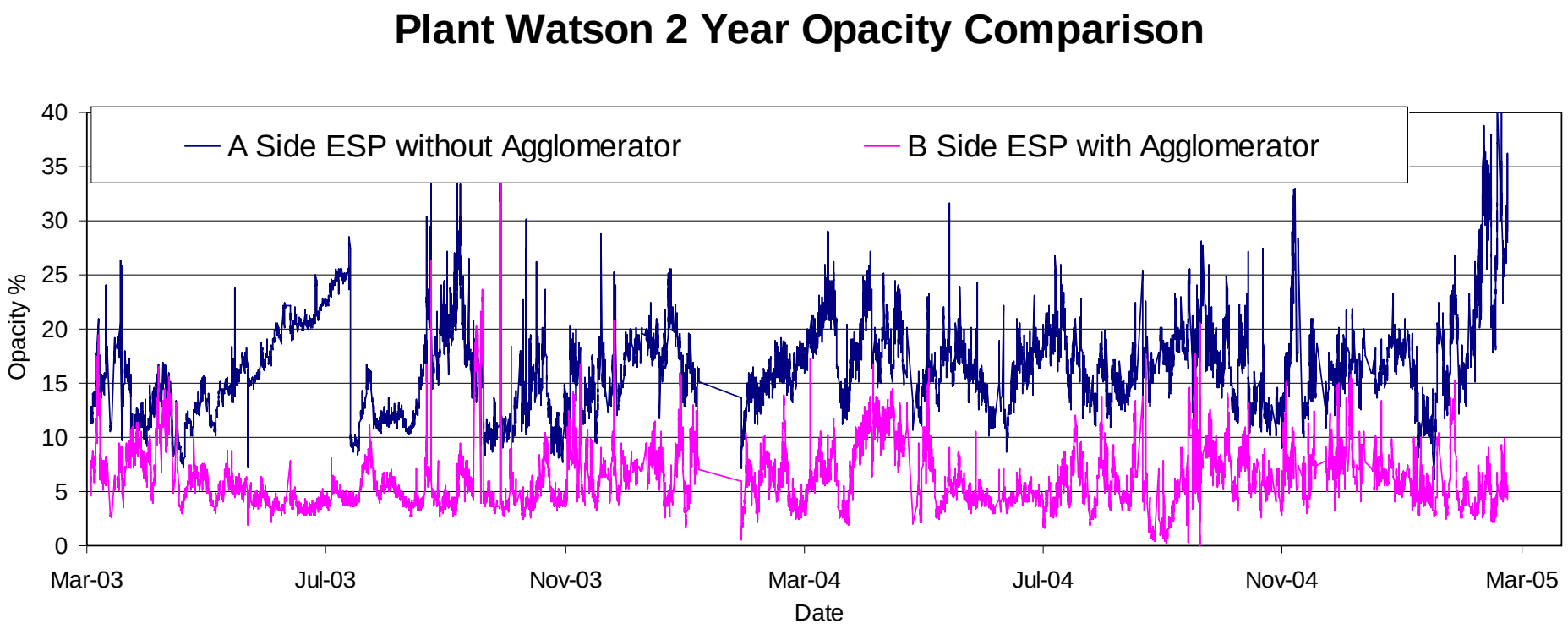

FINE PARTICULATE CONTROL SYSTEM
EXIT TO PRECIPITATOR
EXISTING DUCT
SIZE SELECTIVE
MIXING SYSTEM
NEUTRAL GAS
PARTICLES FLOW INTO
THE AGGLOMERATOR
AGGLOMERATOR PROCESS

Inlet Field Electrical Improvement

	A Precipitator		B Precipitator		
	Voltage (kV)	Current (mA)	Voltage (kV)	Current (mA)	Percentage Increase in Current
Before Agglomerator	52.4	217	52.6	230	5.8%
B Pass with Agglomerator	55.0	230	55.0	330	43.5%
Percentage Increase	5.0%	6.0%	4.6%	43.8%	

indigo TECHNOLOGIES
creating technology

Opacity Trend At Watson Station



indigo TECHNOLOGIES
creating technology

Demonstration Site

- Indigo is looking for full scale demonstration sites for MAPSystem
- Typically < 200MW
  - Full installation to compare before and after
  - Half installation for A:B comparison
- 2009 installation with all testing to be completed by end of 2009

indigo TECHNOLOGIES
creating technology

Summary

- Indigo has acquired a technology that has been in operation for over 15 years in Poland
- Simultaneously controls SOx, NOx, Hg, PM
- Indigo has conducted pilot scale testing in the US to evaluate alternative chemistries
- We have identified cost effective and environmentally friendly alternatives
- Further pilot testing in 2008 to enhance chemical utilization and conduct parametric studies

indigo TECHNOLOGIES
creating technology

Summary

- Target market < 500 MW
- Small footprint
- Cost effective for smaller, older units where the high cost of the combination of traditional, single pollutant controls cannot be justified
- Looking for full scale demonstration sites

indigo TECHNOLOGIES
creating technology

Thank You!

Bob Crynack
Indigo Technologies LLC
1-888-358-0171
www.indigotechnologies-us.com
bob@indigotechnologies-us.com

indigo TECHNOLOGIES
creating technology