



Cinergy ESP/FF In-House Seminar

Cinergy West - PSI Corporate Headquarters

Plainfield, Indiana

November 15-17, 2005

Gas Flow Modeling of Precipitator Installations

By

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November 17, 2005

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Objectives:

The objectives of conducting an air flow model study of a precipitator installation are as follows:

- Optimize the velocity distribution within the charged zones within the precipitator which will thus optimize the particulate collection efficiency.
- Minimize the re-entrainment of collected dust from areas outside the charged zones within the precipitator.
- Minimize the system pressure loss.



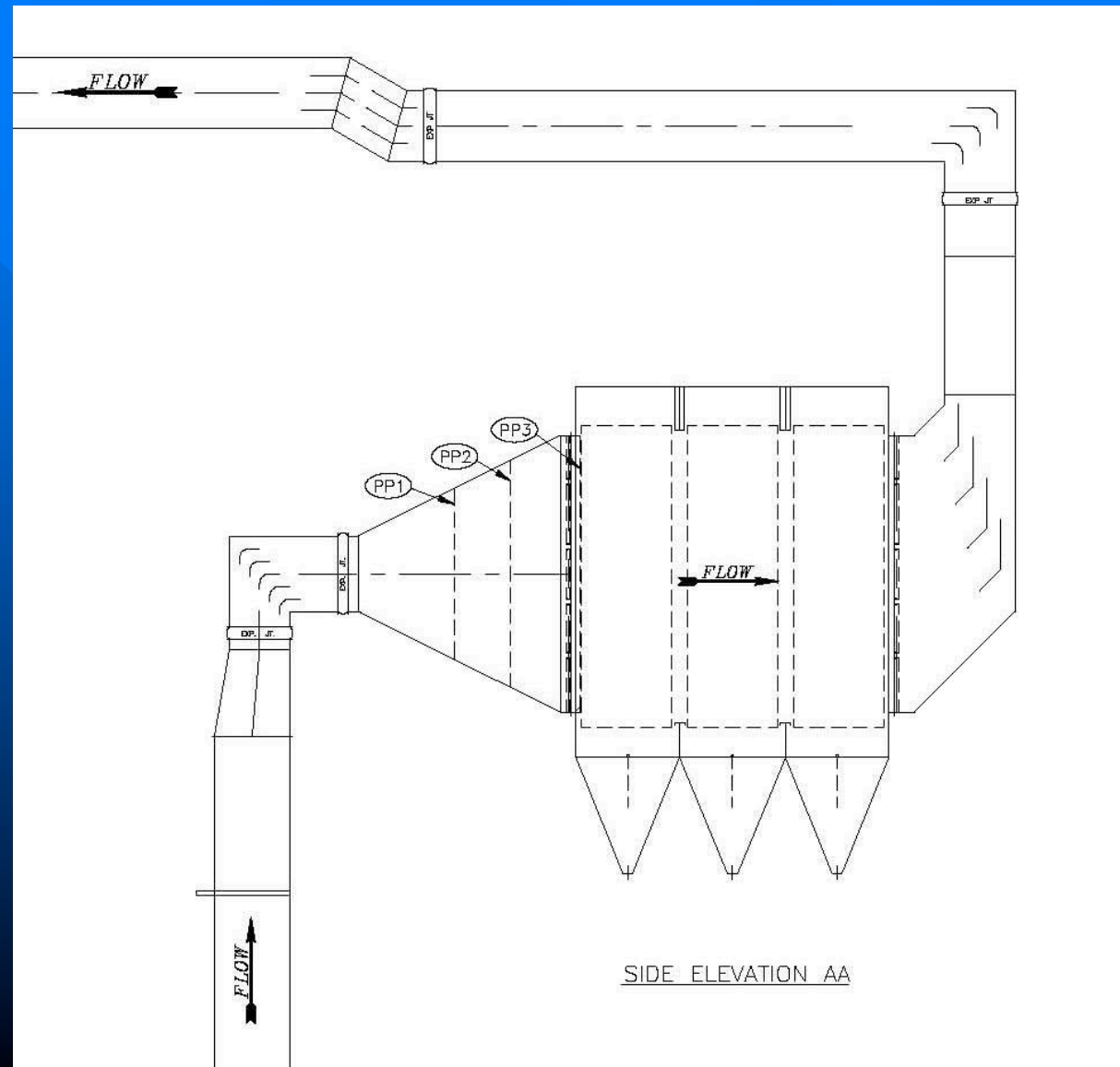
Objectives:

- Minimize dust deposits within the precipitator and associated ductwork.
- Optimize the flow and velocity distributions at the I.D. fan inlet.
- Optimize the velocity distribution and mixing at the flue gas conditioning system, if applicable.



A typical precipitator is as detailed below.

For a typical example Beckjord Unit No. 1 has been used.



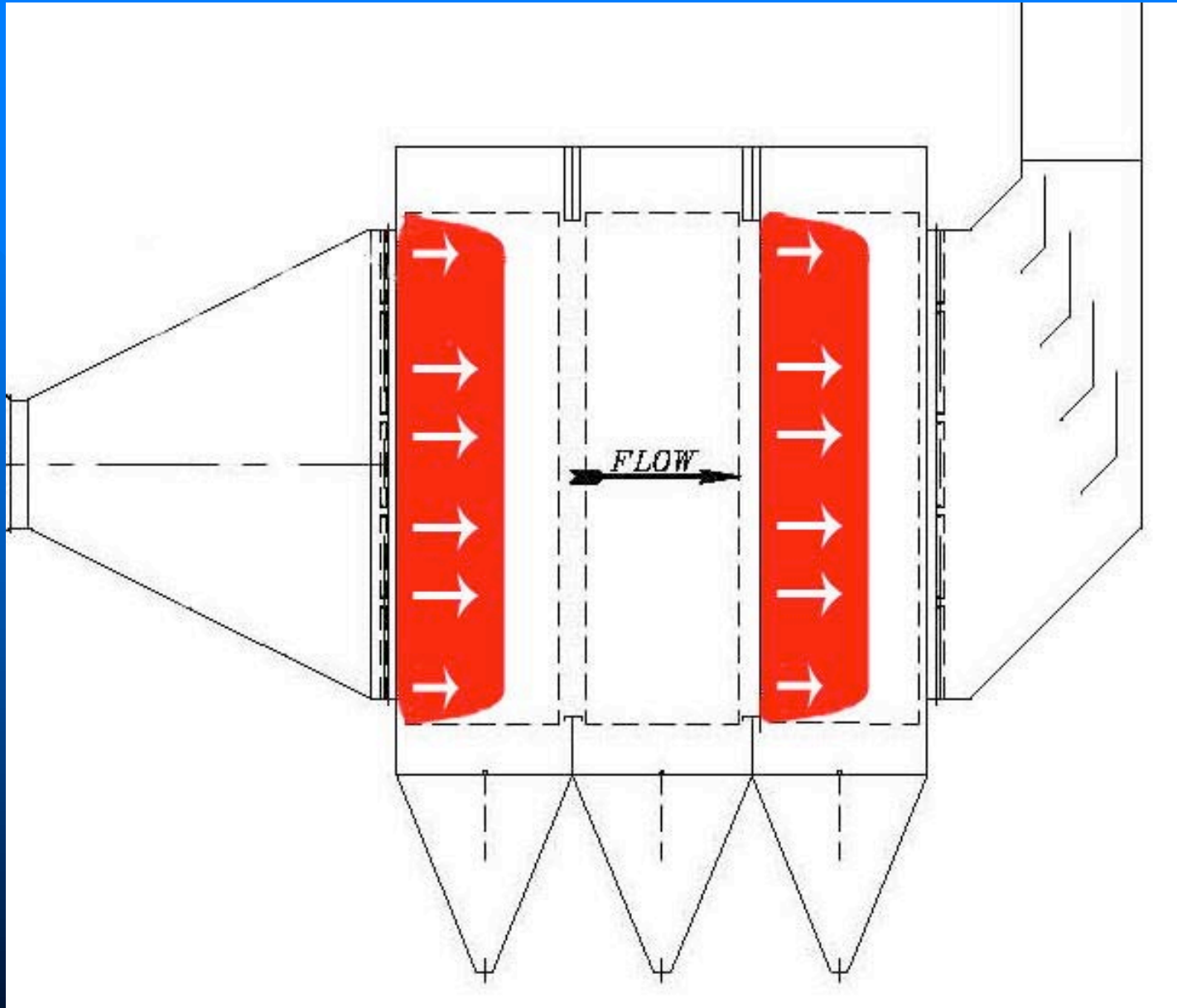


Current criteria in use for the velocity distribution within the precipitator are as follows:

A. ICAC (Institute of Clean Air Companies)

Publication EP-7, which states:

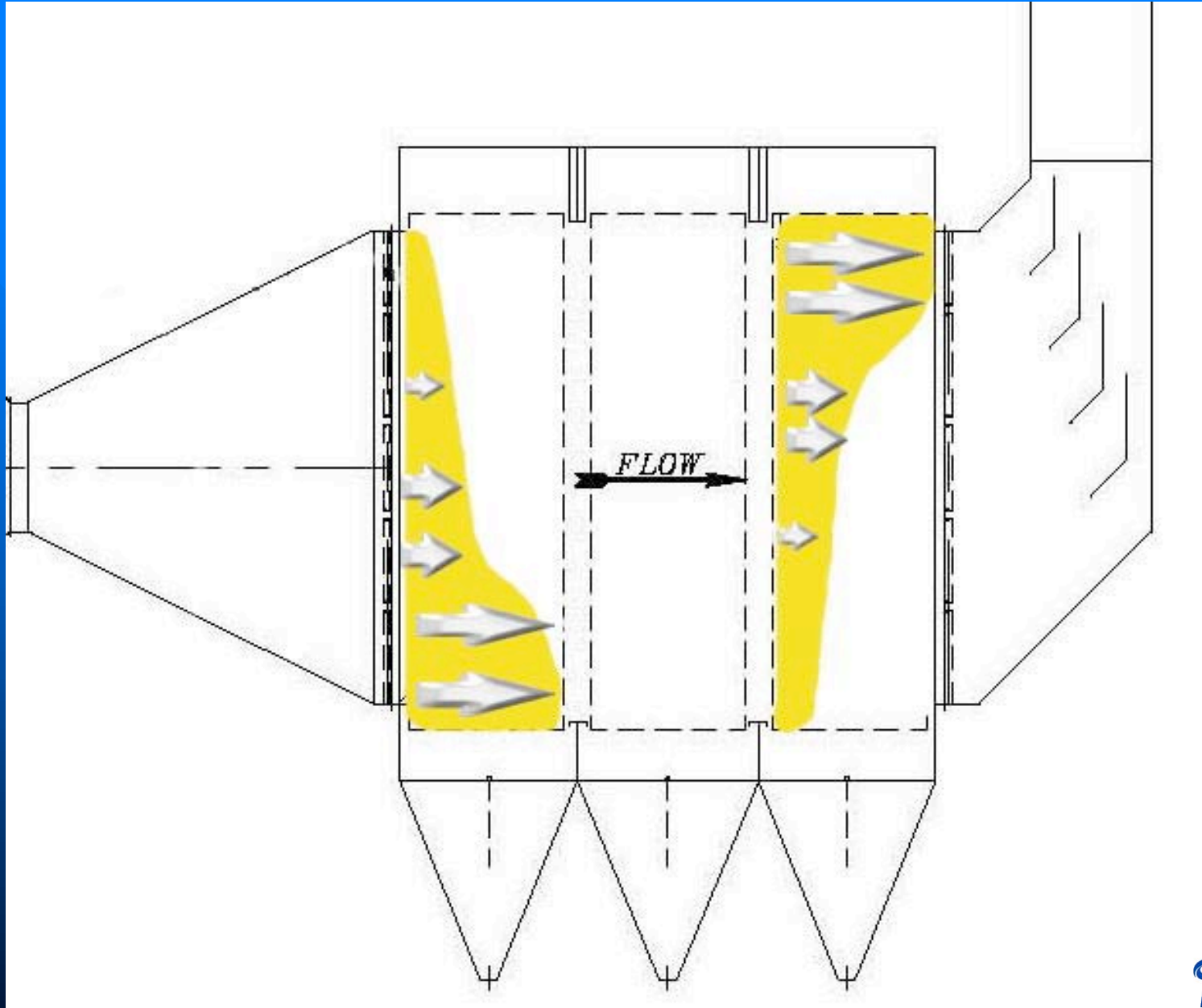
- 85% of the velocities measured at the outlet of the first and last fields of collecting curtains be less than 115% of the mean velocity
- 99% of the velocities measured at the outlet of the first and last fields of collecting curtains be less than 140% of the mean velocity which is typically shown as follows:





B. Skewed Gas Flow

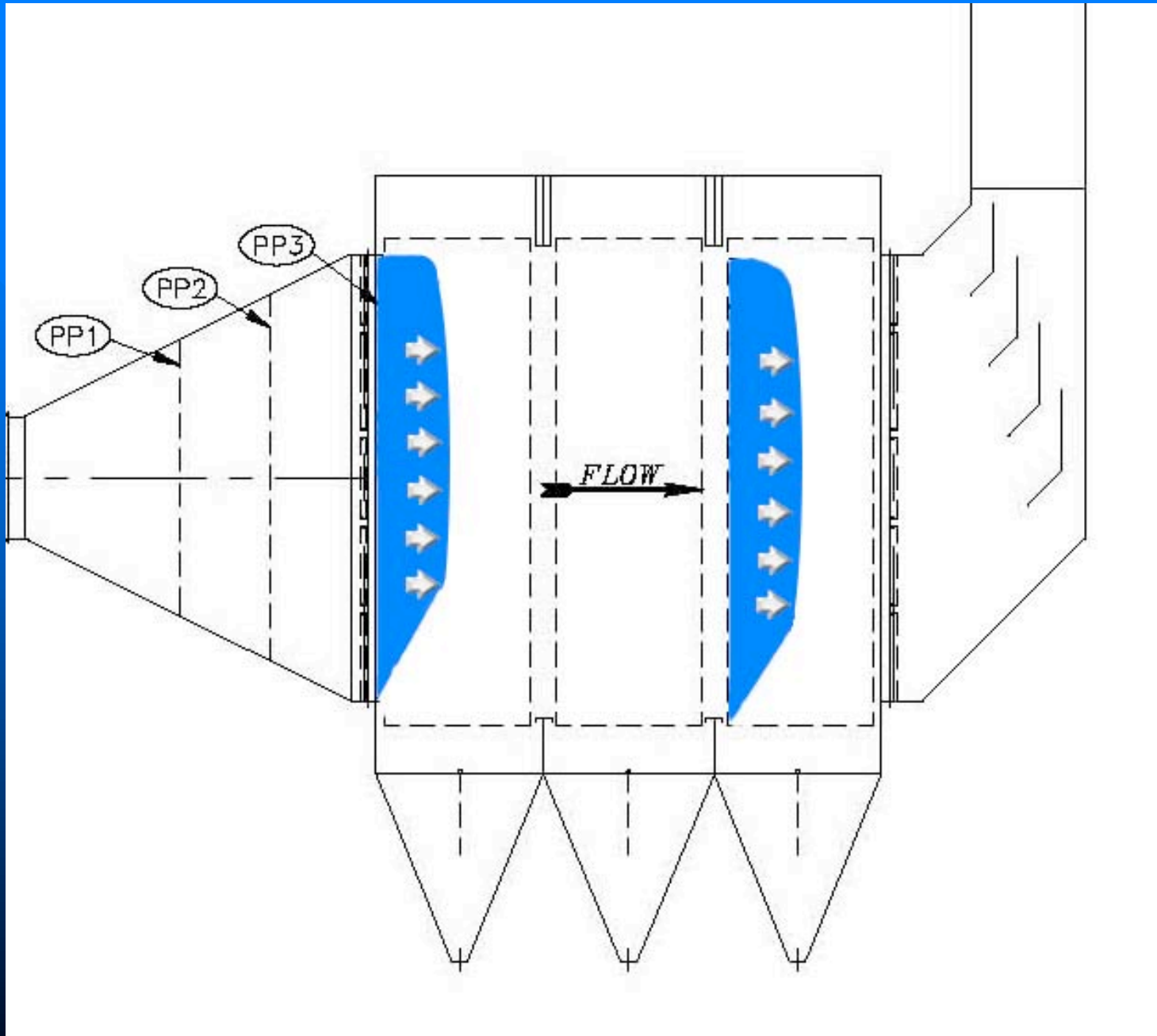
This system developed originally by Art Hein defines that the gas flow through the precipitator should be higher at the bottom of the inlet and at the top of the outlet as shown next:





C. NELS Modification

NELS approach is to minimize the velocity distribution through the charged zones within the precipitator while minimizing the flow through the hoppers, as shown next:





This essentially makes the precipitator smaller while claiming to reduce the outlet emissions.

Consequently this is difficult for the majority of precipitator experts to accept.

However, the first time we implemented this approach was on an 850 MW unit operating with 18% opacity and an SCA of 147 and ammonia gas conditioning.

The modification, which when implemented based on this technology resulted in the unit operating at 900 MW with a 10% opacity and reduced ammonia gas conditioning.



Typical Upgrade Program

In order to complete the optimization of a typical precipitator the following program would be conducted.

However, taking Beckjord Unit 1 as a typical example there were a few additional phases.

- 100 MW unit currently operating at 90 MW to maintain a mean opacity of 20% with SO₃ gas conditioning and updated Neundorfer controls and ash handling system.
- Panic meeting at site to review a possible upgrade program and conduct an internal inspection.



We suggested adding a blockage to the outlet perforated screen as shown here:





This was completed by the plant maintenance crew in less than 24 hours.

- Operating MW increased to 100 MW while maintaining the 20% mean opacity with the same SO₃ gas conditioning.
- Field test program conducted to determine the characteristics of the outlet particulate emission.

This primarily concentrated on the distribution of the exiting particulate, LOI and particle size.



- A model study was then conducted.

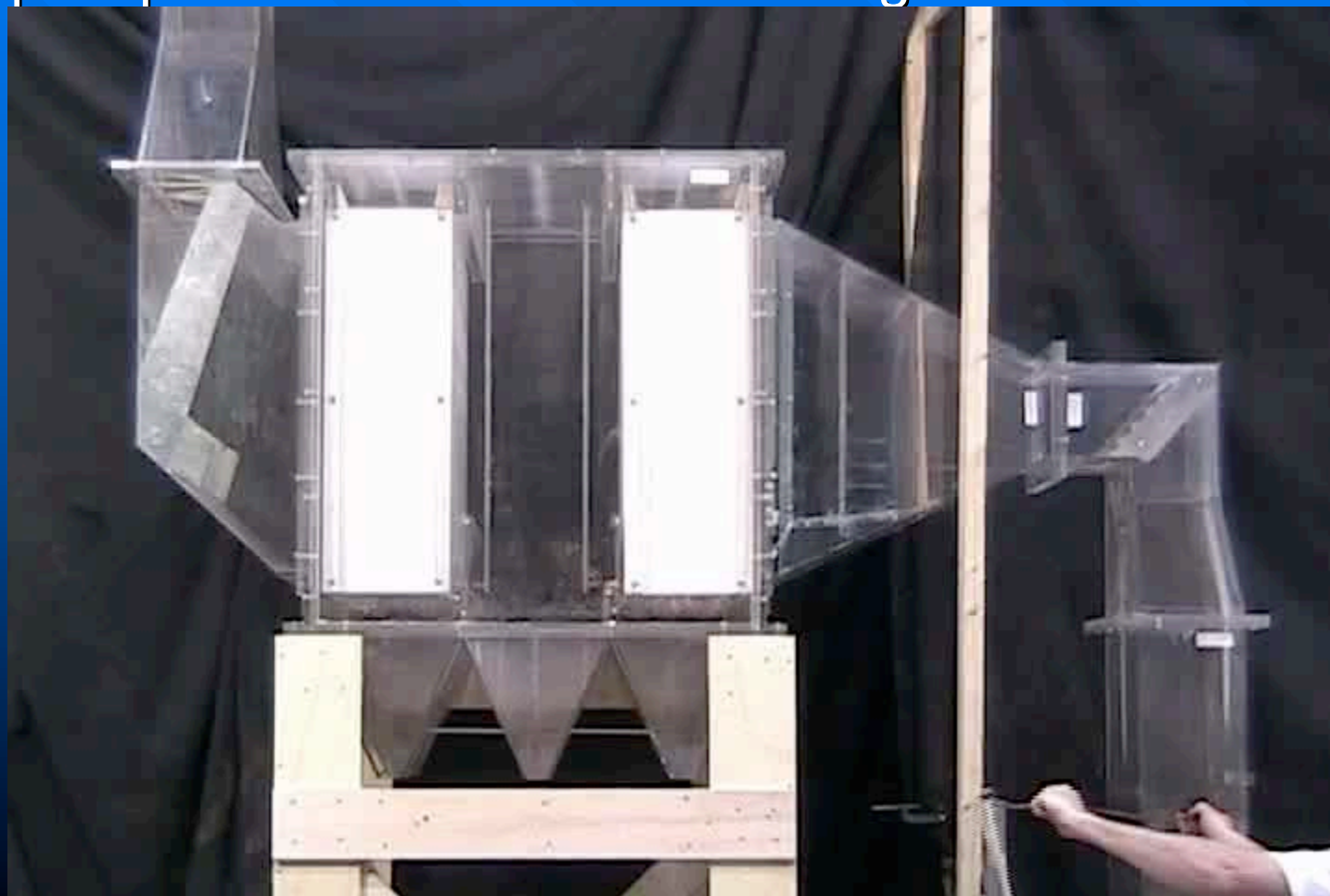


A 1/12-scale physical model of the installation was constructed from clear plastic as shown here.



The model was then tested to determine the modifications required to optimize the particulate collection efficiency.

This reduced the flow through the lower section of the precipitator and unified that through the remainder as





The degree of modification was based on NELS experience.

A physical model study was used rather than a CFD model as based on NELS experience the CFD model does **not** reproduce the detailed velocity distribution to a sufficient degree of accuracy.



- The following modifications were then installed:
 - Inlet swing doors at the bottom of the screen at the precipitator inlet which allows dust to enter the hopper with minimal gas flow.
 - Between field baffle to reduce the flow through the lower section of the precipitator and in the hoppers.
 - Extended blockage at the bottom of the outlet screen.





- The unit now operates at over 100 MW at an opacity of 10% with 30% less SO₃ injection with a lower quality coal.

Since the installation in May/June 2004 the unit has **not** had to reduce load due to opacity concerns.



This is the standard presentation with respect to gas flow modeling for precipitator installations.

This together with all the other subjects addressed during this seminar will all improve the particulate collection efficiency a precipitator installation to varying degrees.

But, all will have minimal benefit if the ash removal system does not operate satisfactorily.

However, the definition of satisfactorily is crucial.

From a maintenance aspect as long as all parts operate and there are no significant and visible leaks – things are satisfactory.



NELS have, over the past 2 years, found that even minor volumes of air leaking between hopper outlets through the ash removal system can create massive changes in the particulate emissions.

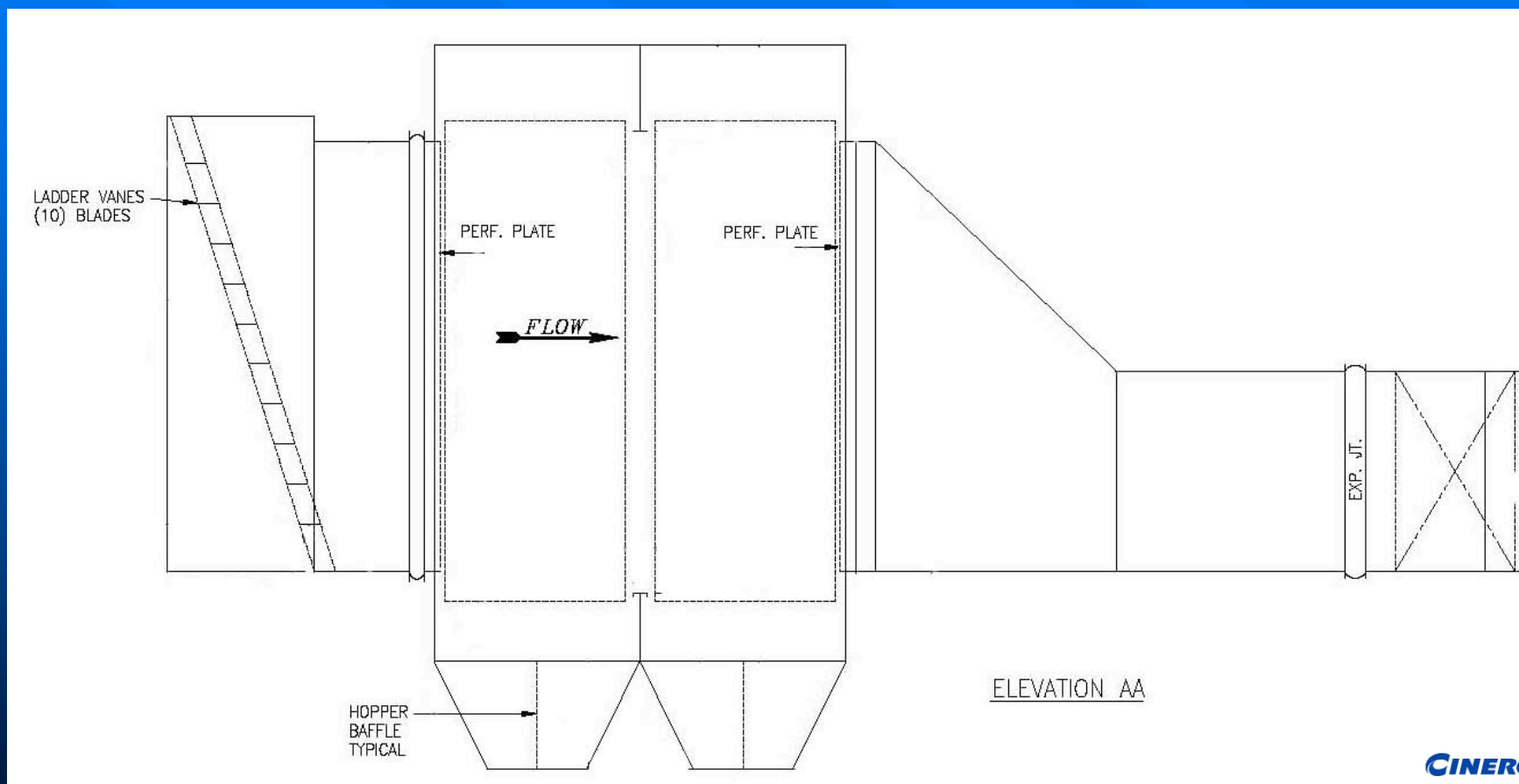
These are all internal problems which cannot be identified by a visual inspection of the installation.

Currently NELS is developing a series of tests to evaluate these systems and a data base to allow the operation to be evaluated and thus recommend an upgrade program, if necessary.



Kodak Unit #41

We have just completed a similar program for the precipitator for Boiler 41 at Trigen-Cinergy Kodak in Rochester, as shown here.





Kodak Model Study





Kodak Field Installation



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In this case the SCA was approximately 107 with the LOI and mean particulate in the ash exiting the precipitator of 50% and 150 micron.

This requires the installation of a channel screen which had been developed by NELS for boiler outlet and hot and cold side precipitators.

This unit started up in Mid-October, 2005 and apparently is collecting large quantities of ash based on hopper loading information.



A further upgrade to these channels is currently being optimized to make this system even more effective in other similar installations.

Don't forget, no precipitator is too small. This unit has a SCA of 107 compared with most other precipitators which are about 300.

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