POWER-GEN NATURAL GAS

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AUGUST 18-20, 2015
GREATER COLUMBUS CONVENTION CENTER
COLUMBUS, OHIO

Performance Improvement In Simple Cycle and Combined Cycle Plants

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Question before we start:

What‘s your present employment field;
What do you expect from this session?

- Gas Turbine Operators
- Maintenance Managers
- Station Managers
- Sales Managers
- Technical Department Managers

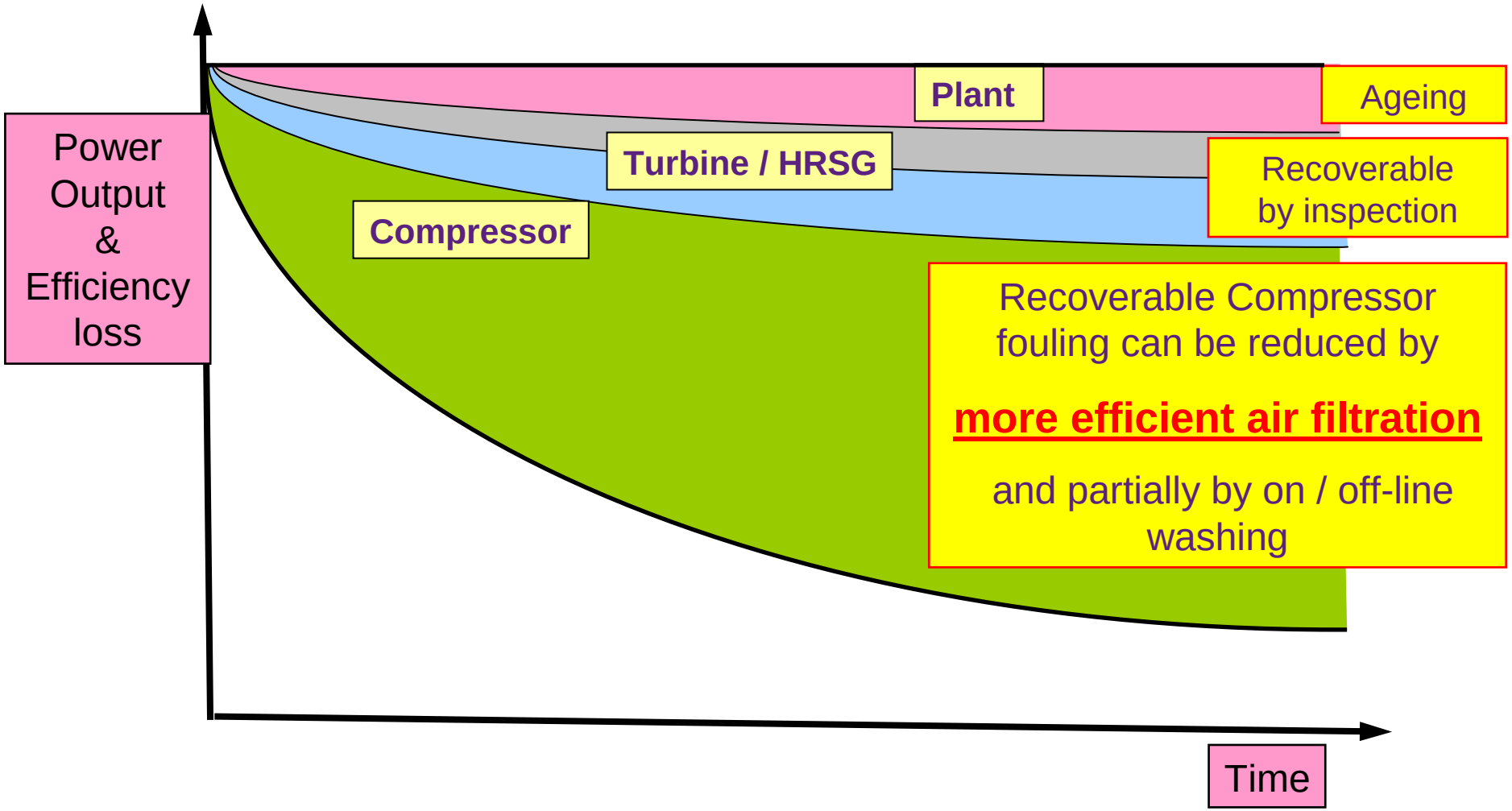
Have you ever seen the Air Flow of a Gas Turbine during Opertion?

Agenda

- Introduction
- Air Flow and Degradation Effects
- Airborn Dust and Particle Measurement (PM10 / PM2,5)
- Filter dp-Evaluation and Efficiency Test of used Filters
- Air Filter System Efficiency Calculation Tool
- Degradation Cost Calculation Tool
- Questions & Answers

Gas Turbine and CCPP Degradation

Performance Improvement means Minimizing of Degradation/Losses



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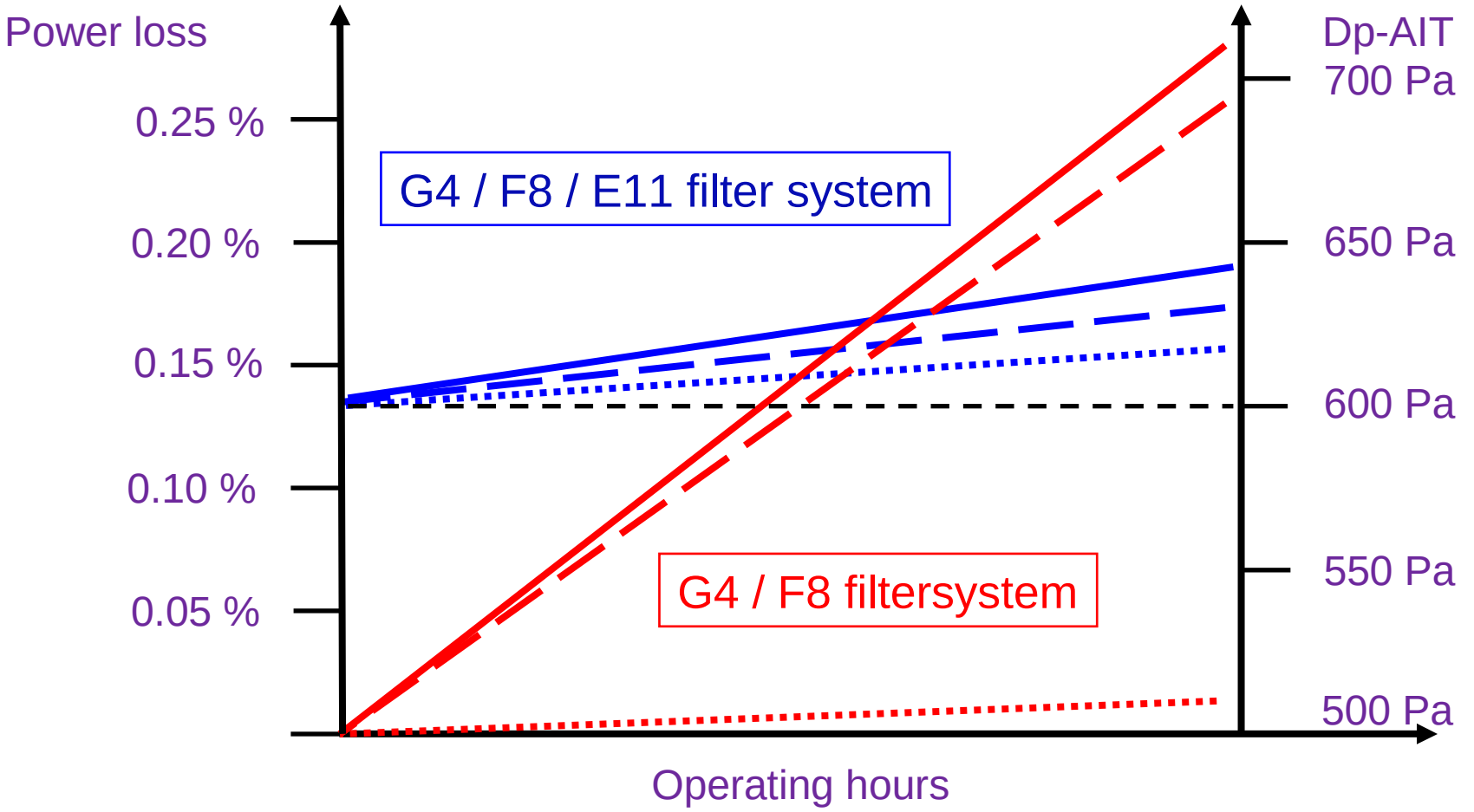
Degradation Effects – dp-increase/compressor blade fouling

Performance of gas turbines degrade over time (power output; efficiency; heat rate)

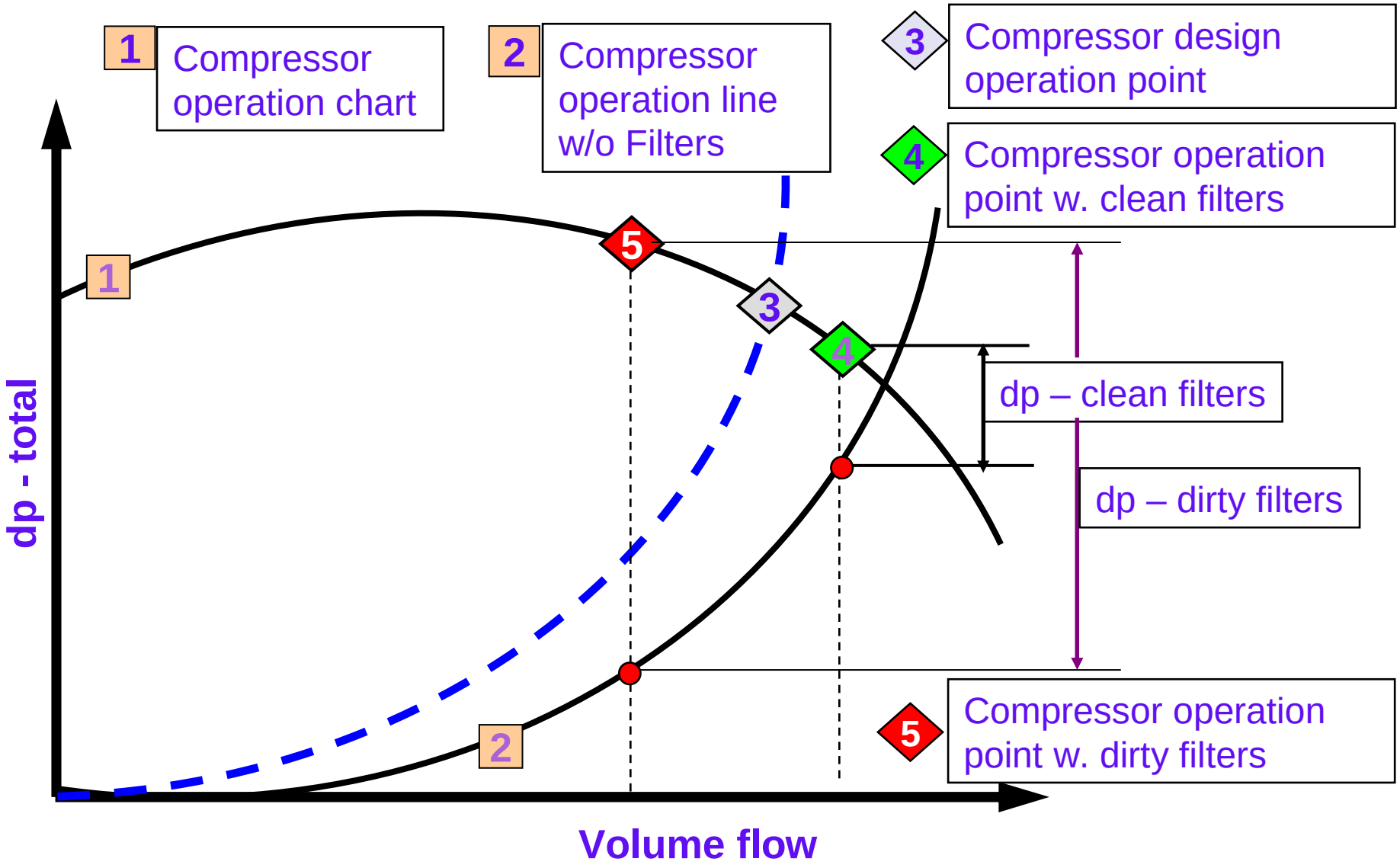
There are two important factors responsible for the degradation rate of a gas turbine:

- Pressure loss over the air intake system
- Fouling of the compressor blades by the local contaminants/deposits which penetrated through the installed air filters

Effect of different Filters



Compressor design and operation



Specific Load of Gas Turbines

	Volume flow [m³/s]	GPO [MW]	Specific load [kW/m³ air]
Alstom			
GT11N2	312	113	361
GT24	331	173	523
GE			
7HA.01	453	275	607
7HA.02	544	330	607
Mitsubushi			
M501	364	189	519
Siemens			
V64.3A	150	65	433
SGT6-5000F	354	187	528
SGT6-8000H	472	274	581

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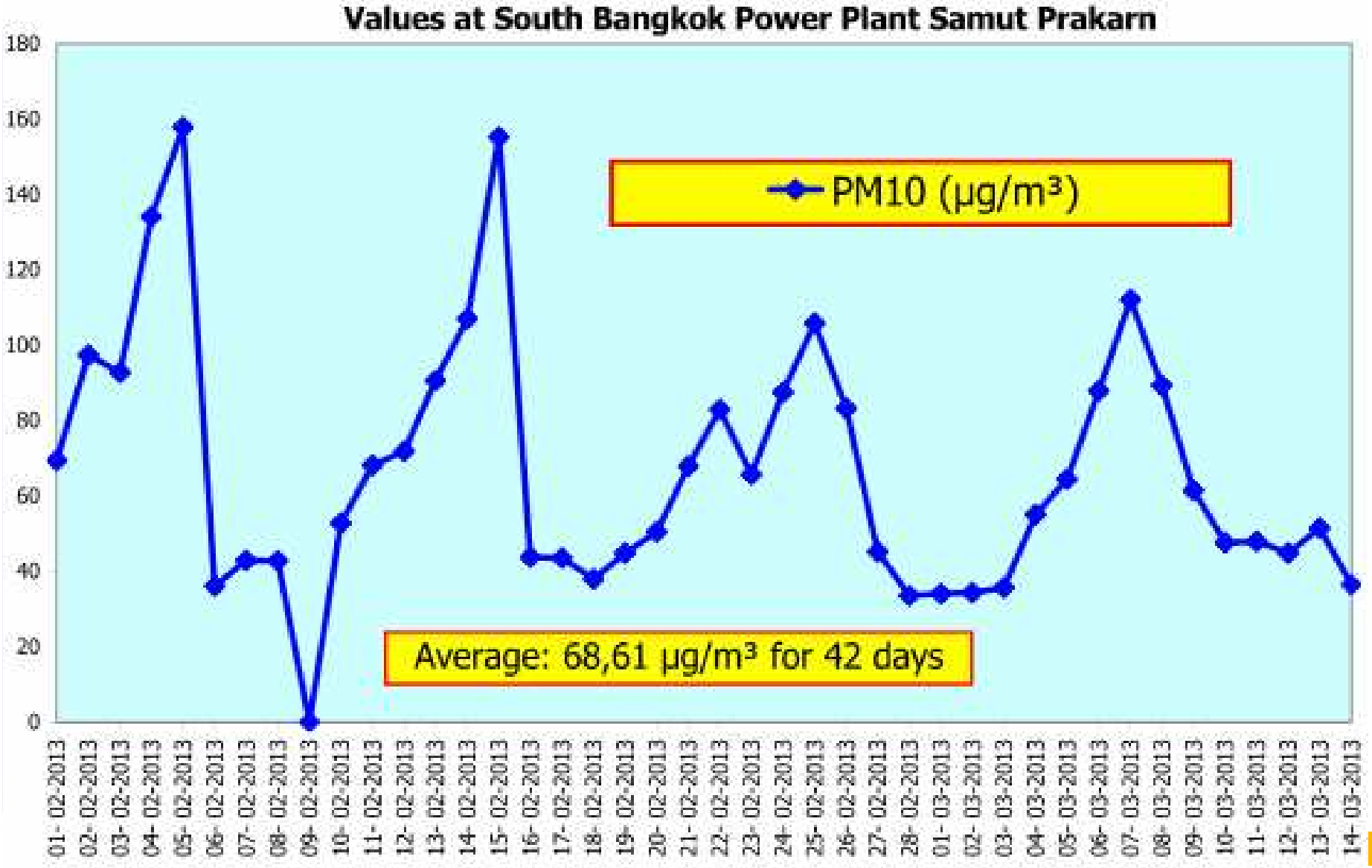
Particles and Dust

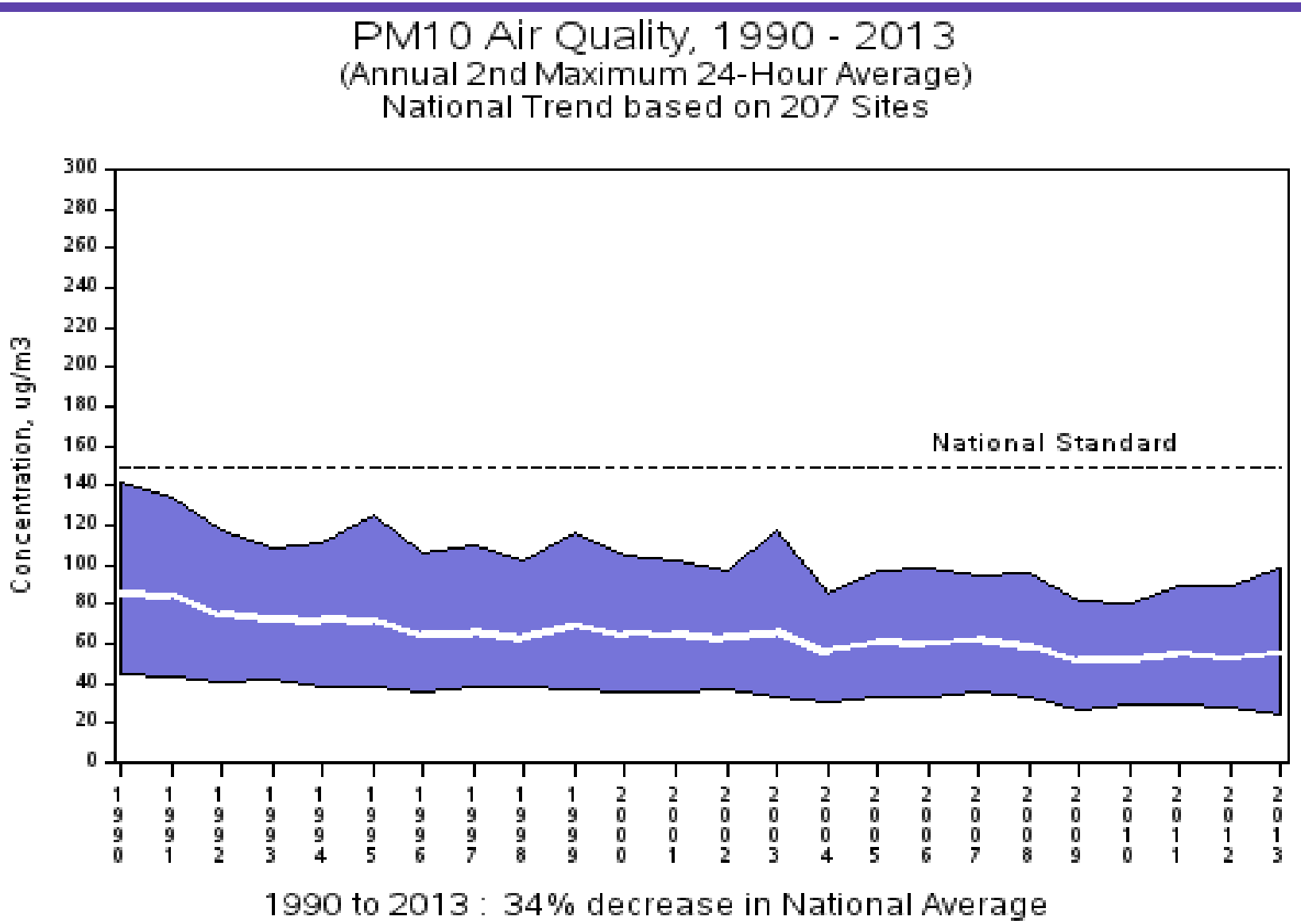
Airborne particles,

the main ingredient of haze, smoke, airborne dust and salt, present serious air quality problems in many areas of the United States and around the world. This particle pollution can occur year-round, will fluctuate according to the local weather conditions and it can cause serious problems to the industry and health problems to humans even at concentrations found in many major cities.

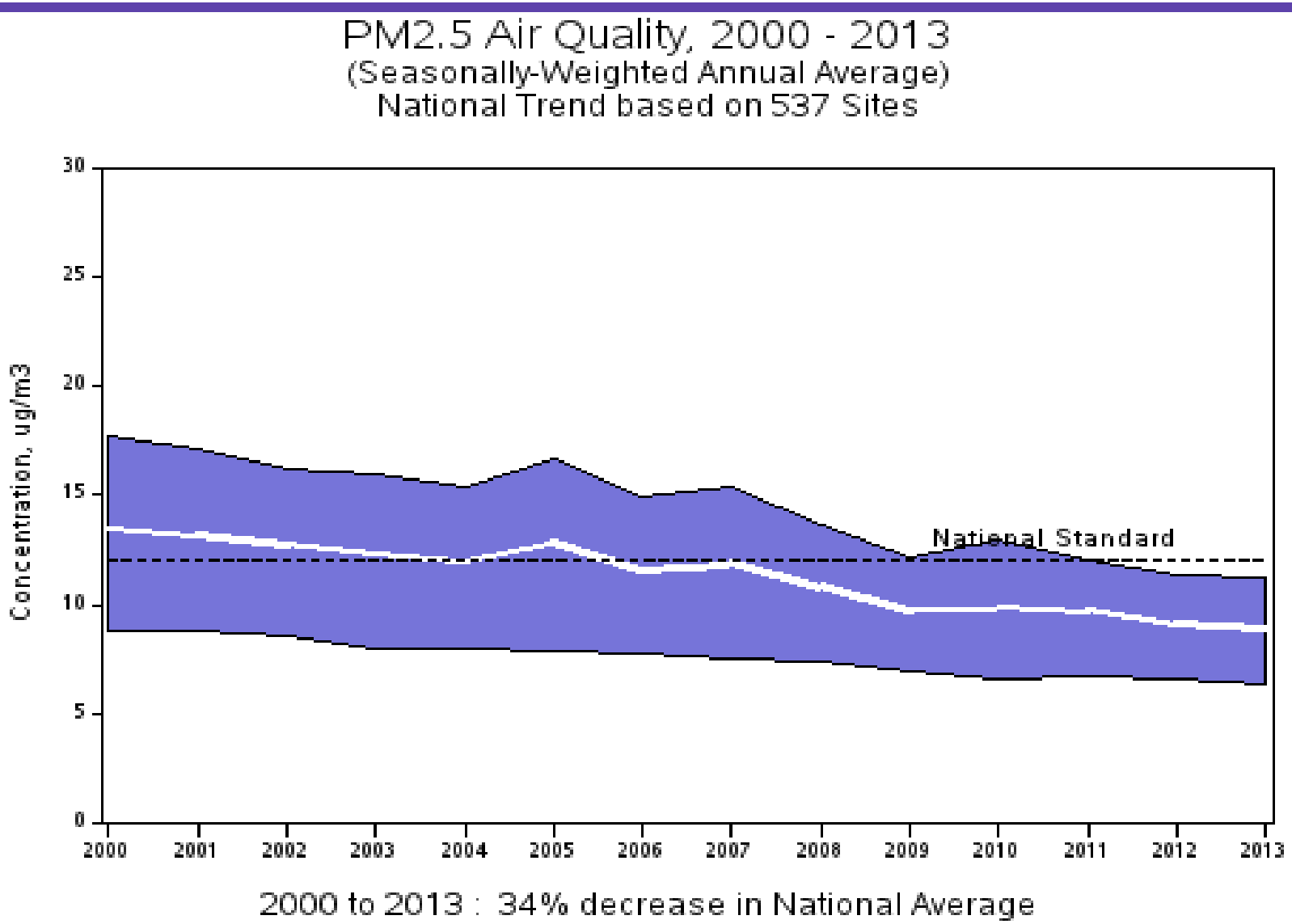
PM10 Dust load measurements



PM10 Air Quality USA [µg/m³]



PM2,5 Air Quality USA [µg/m³]

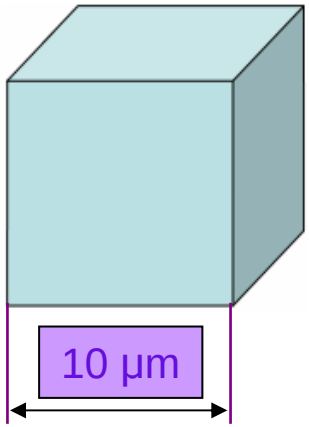


Environmental Impact Summary

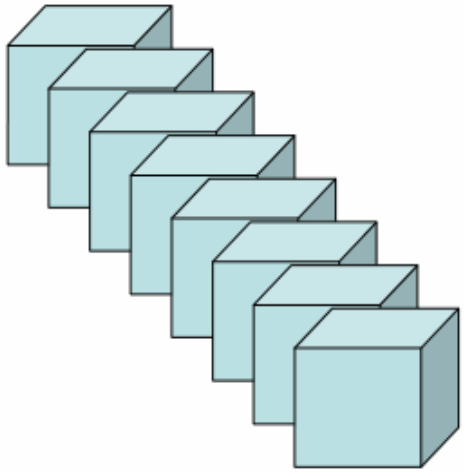
- Environmental dust concentrations are strongly fluctuating with place, time, season, “events”.
- Local deviations from “normal” particle size distributions can be detected.
- The number of coarse particles in air is reduced while number of submicron particles increase.
- Following the trend to smaller particle emissions, EPA- filtration will become more important.

Particles size and surface

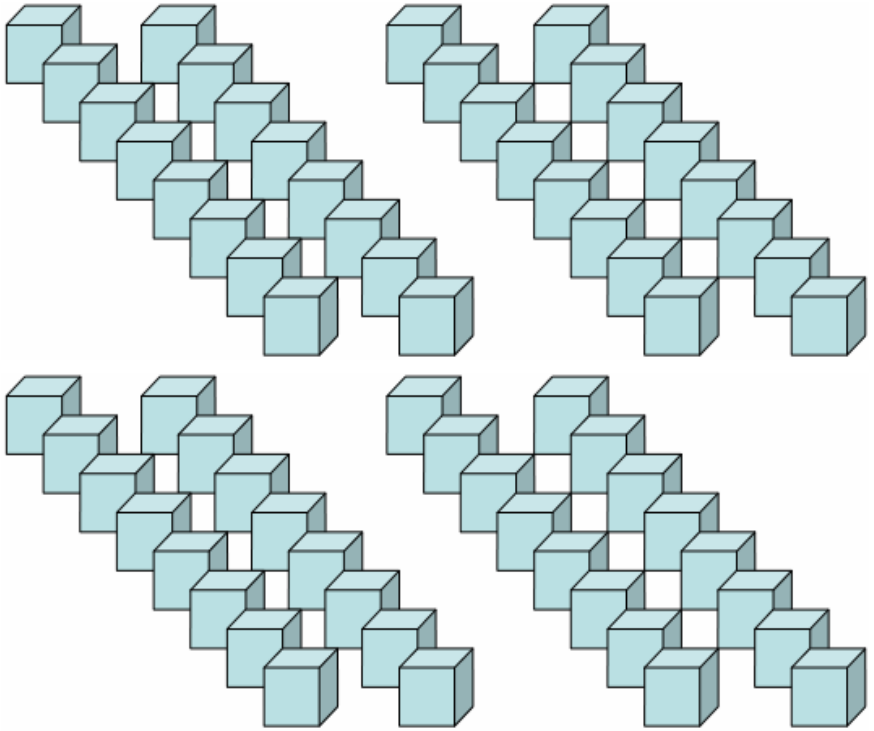
Total volume always: 1000 µm³



Total Surface: 600 µm²

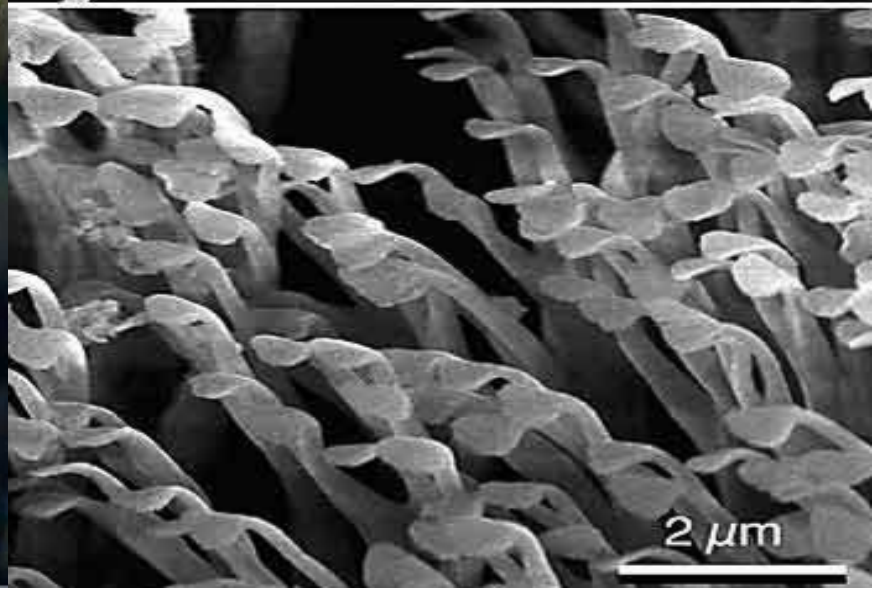


Total Surface: 1200 µm²



Total Surface: 2400 µm²

Van der Waal forces in action



Fine dust settling velocity in Air

The settling velocity in air of some fine dust particles at an air speed of 1 m/s:

➢ 50 µm particles	500 mm/s
➢ 20 µm particles	100 mm/s
➢ 10 µm particles	30 mm/s
➢ 2 µm particles	1 mm/s
➢ 1 µm particles	0.03 mm/s

Air pollution visible

Particles contribute to haze, such as this brown haze over Boston.

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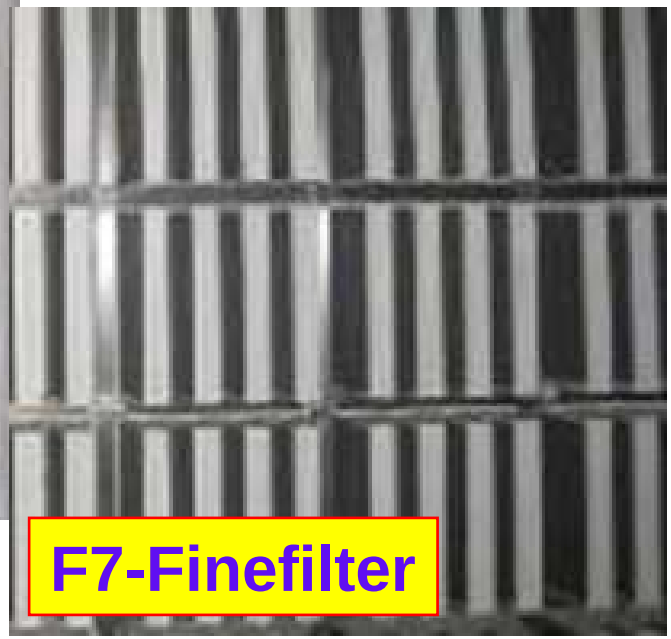
Original Air Filter Installation



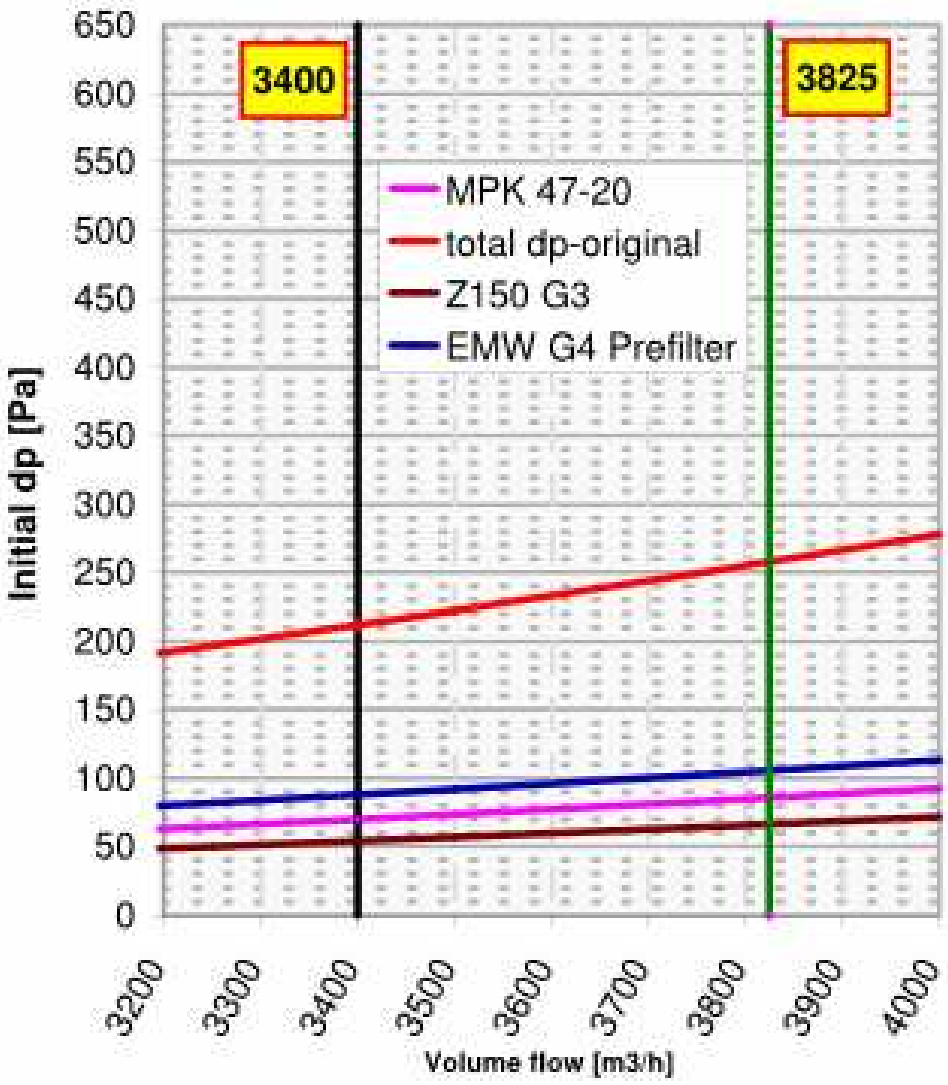
Before Upgrade:
Power Output loss - 3.07%
Heat Rate loss + 1.36%

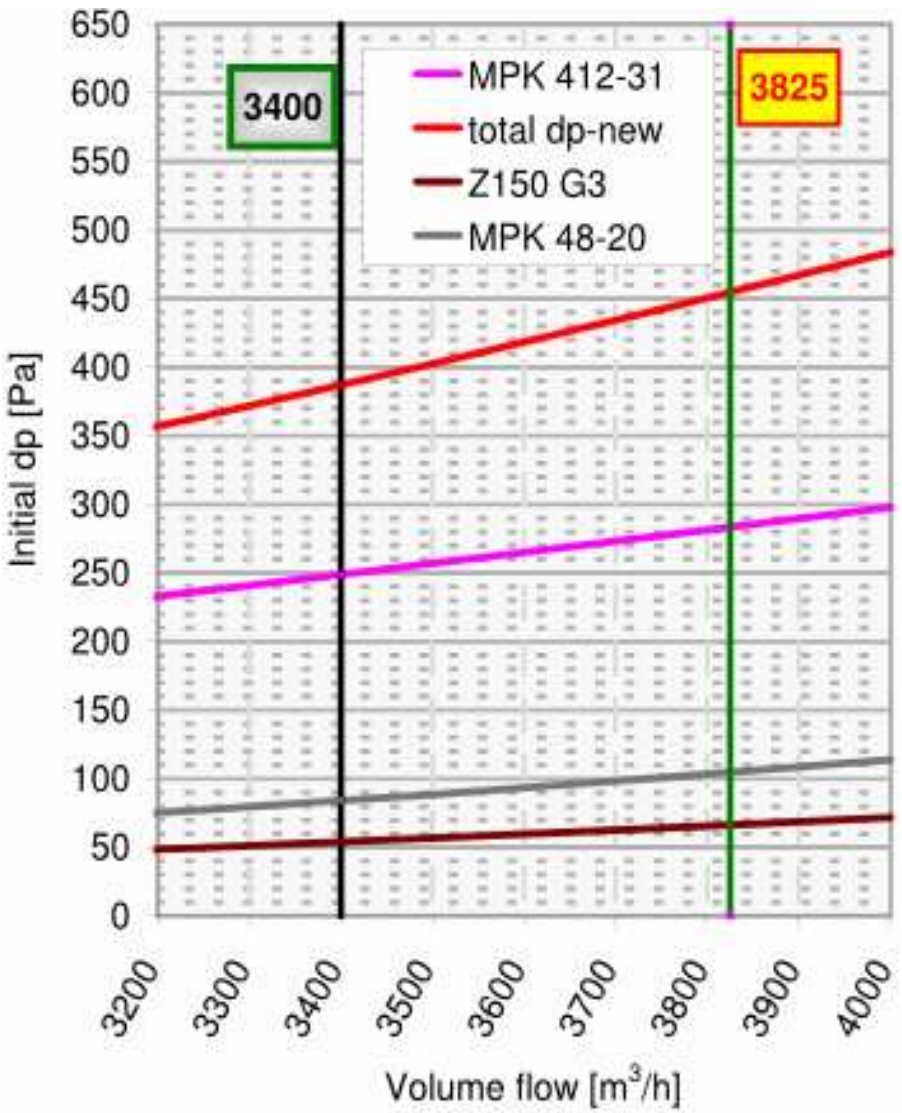
View to VIGV (original system)

After 04 months operation

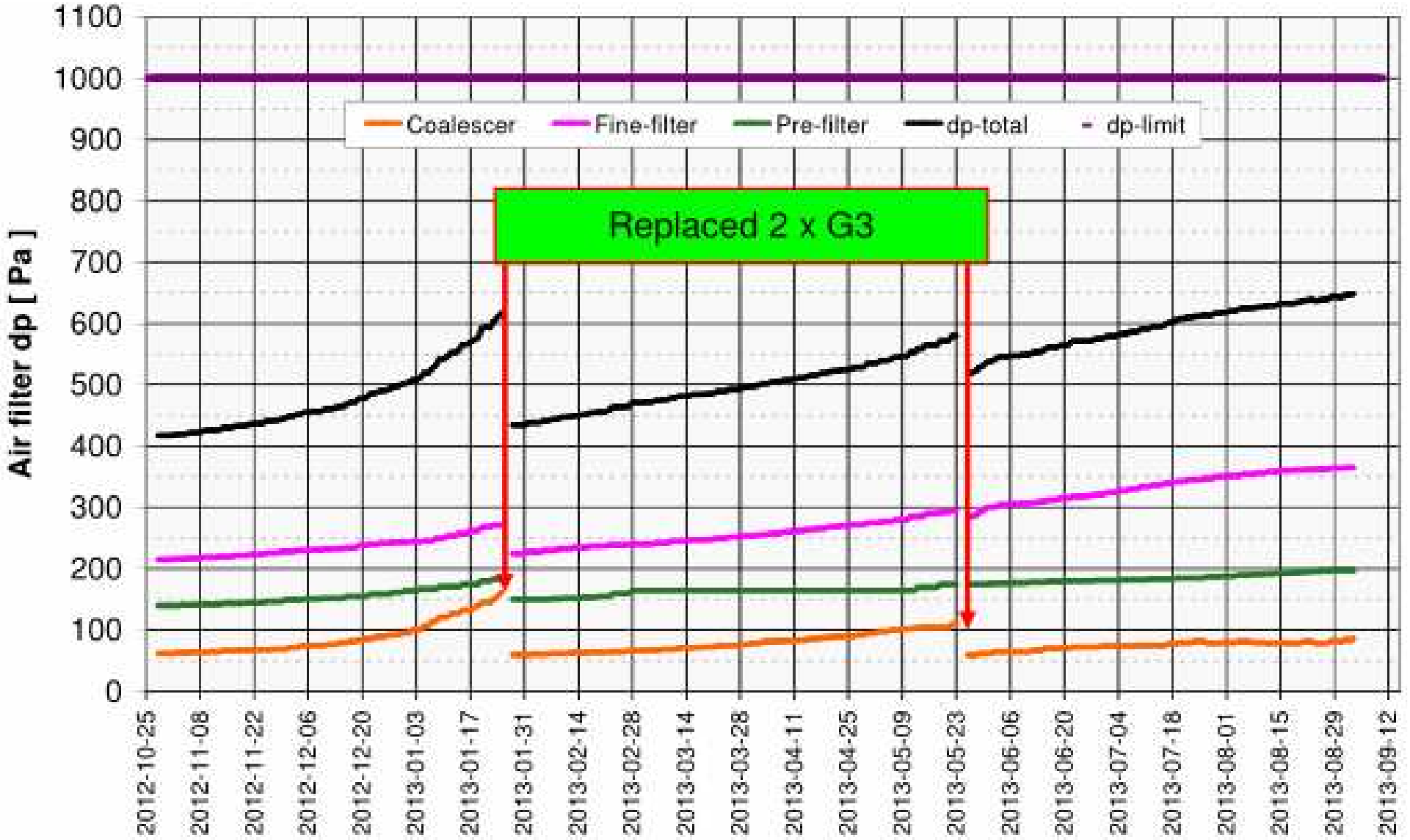
After 11 months operation

Original Air Filter - dp compared to the new AFS





New Air Filter in Operation

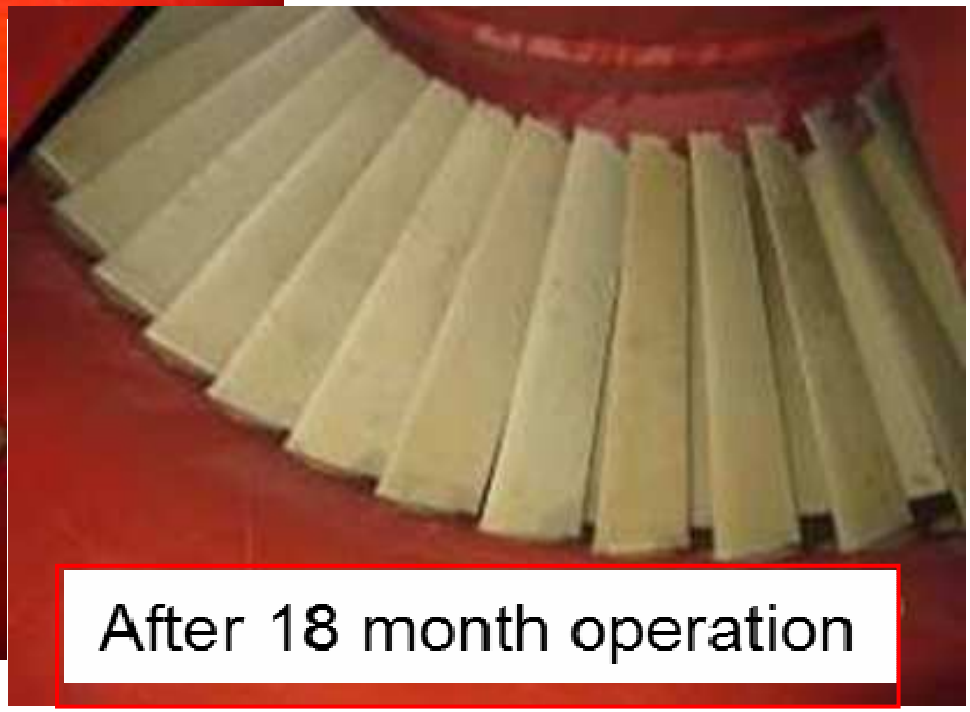


Improved Air Filter Installation

Before Upgrade:
Power Output loss - 3.07%
Heat Rate loss + 1.36%

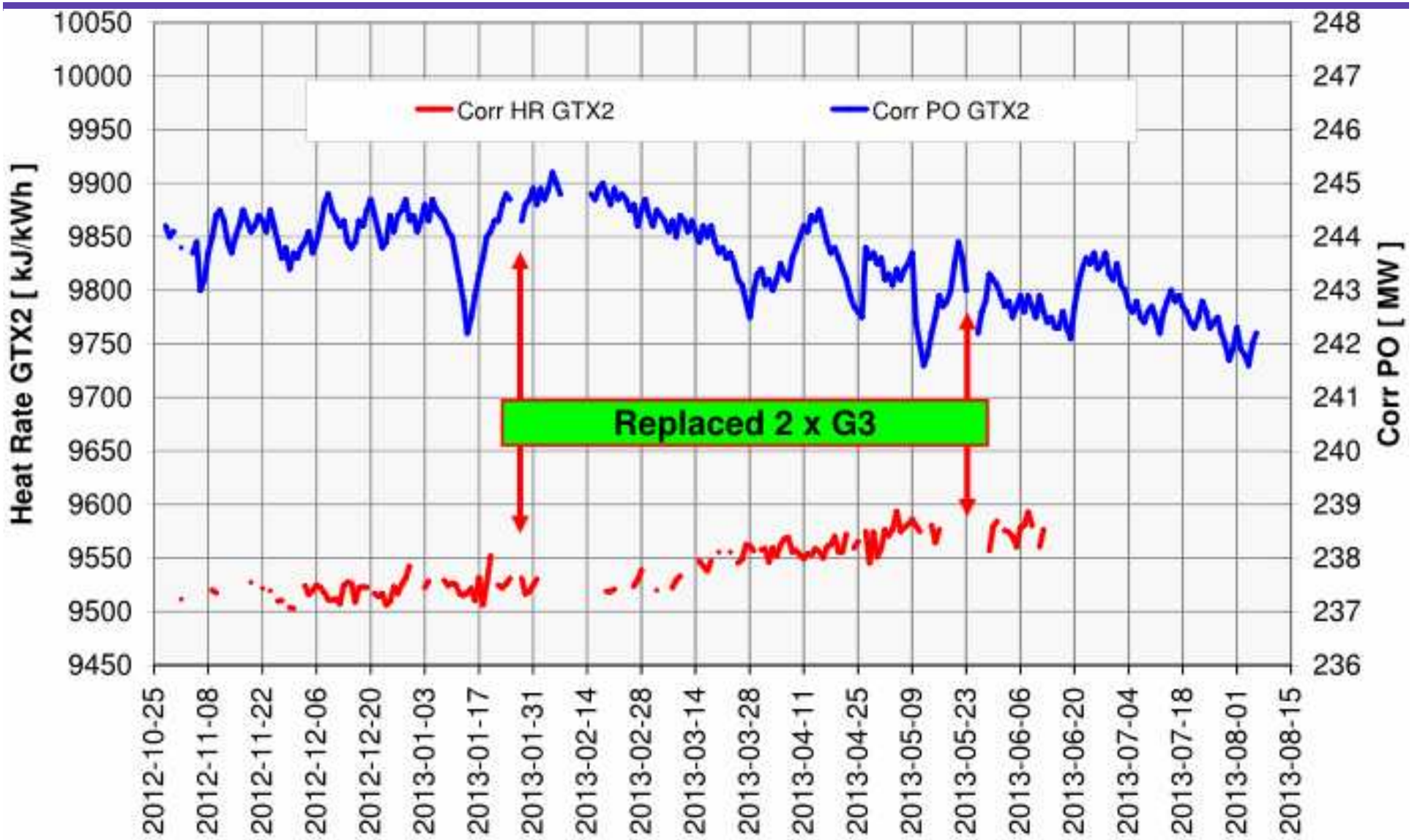
After Upgrade:
Power Output loss: - 0.78%
Heat Rate loss: + 0.63%

View to VIGV

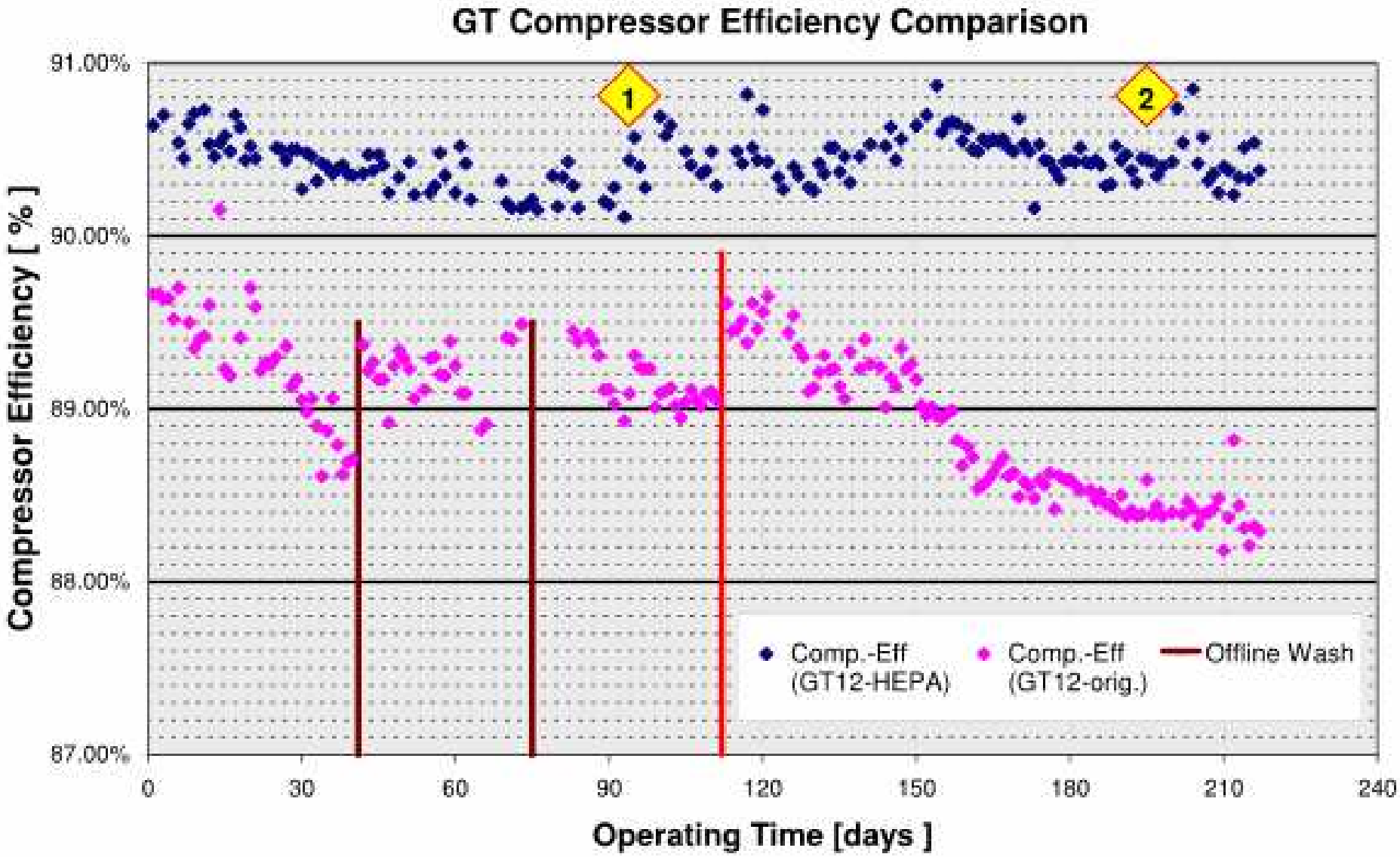


PO Improvement
after 5952h HEPA operation

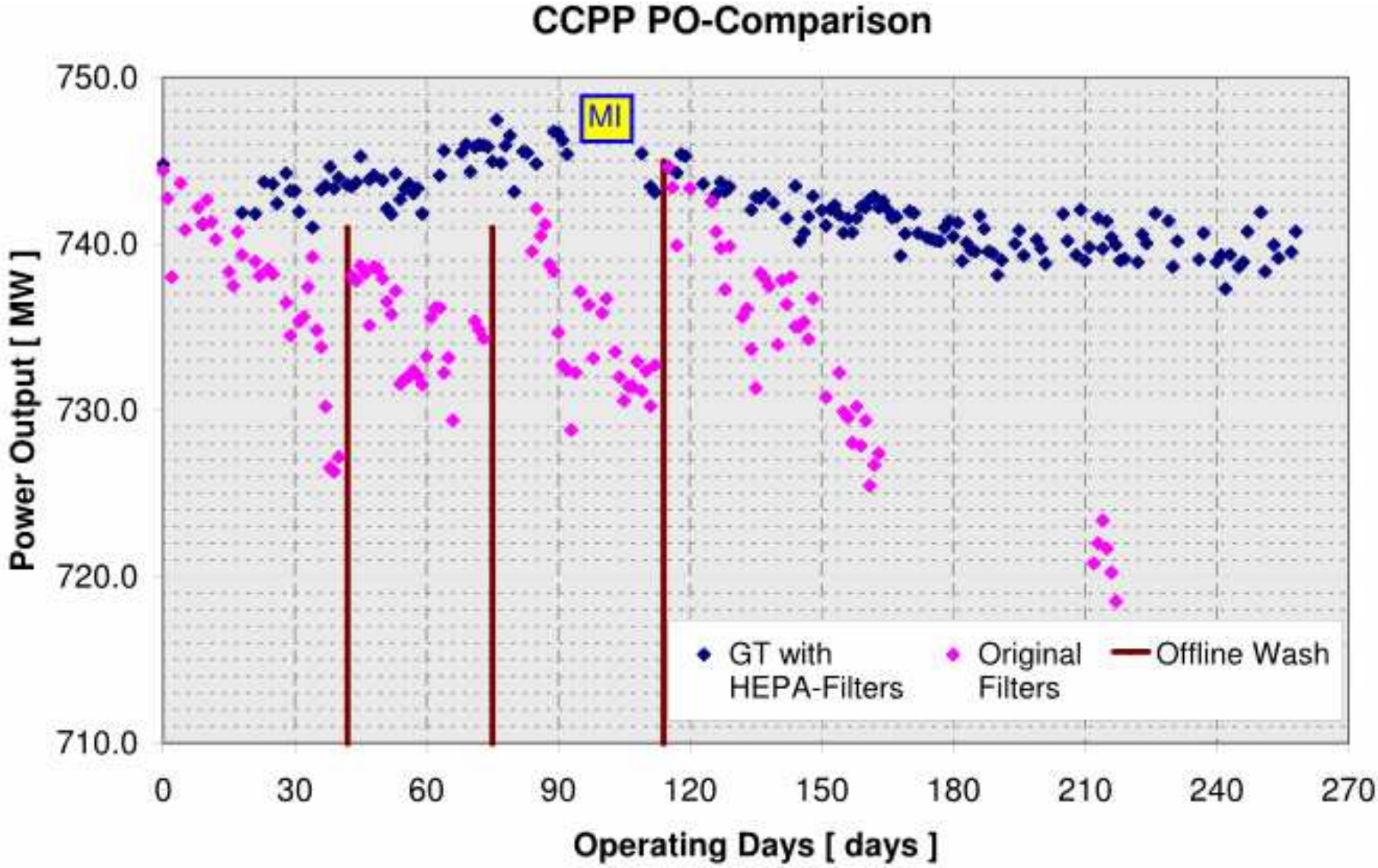
PO and HR Improvement after 5952h HEPA operation



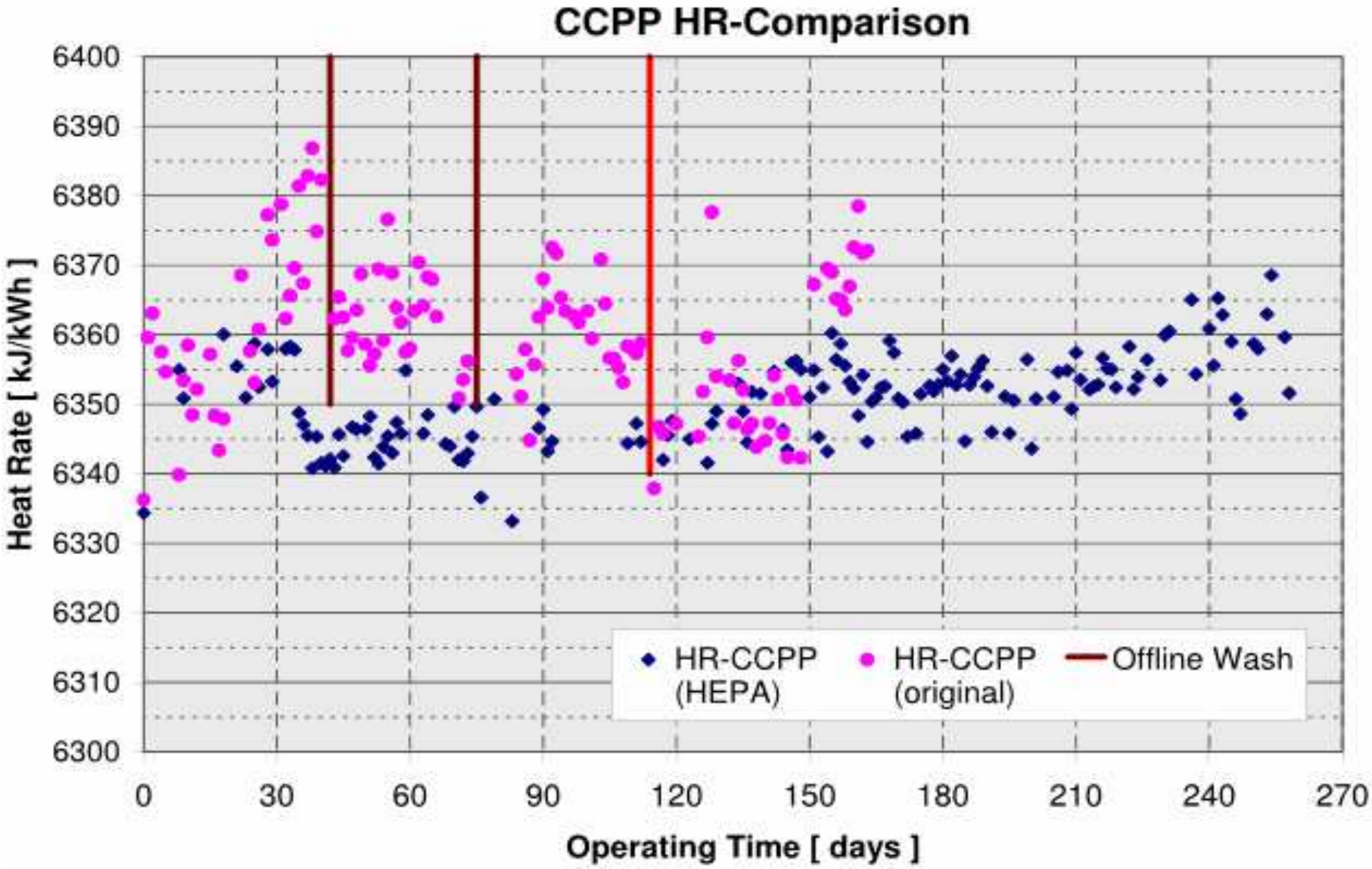
GT Efficiency Comparison



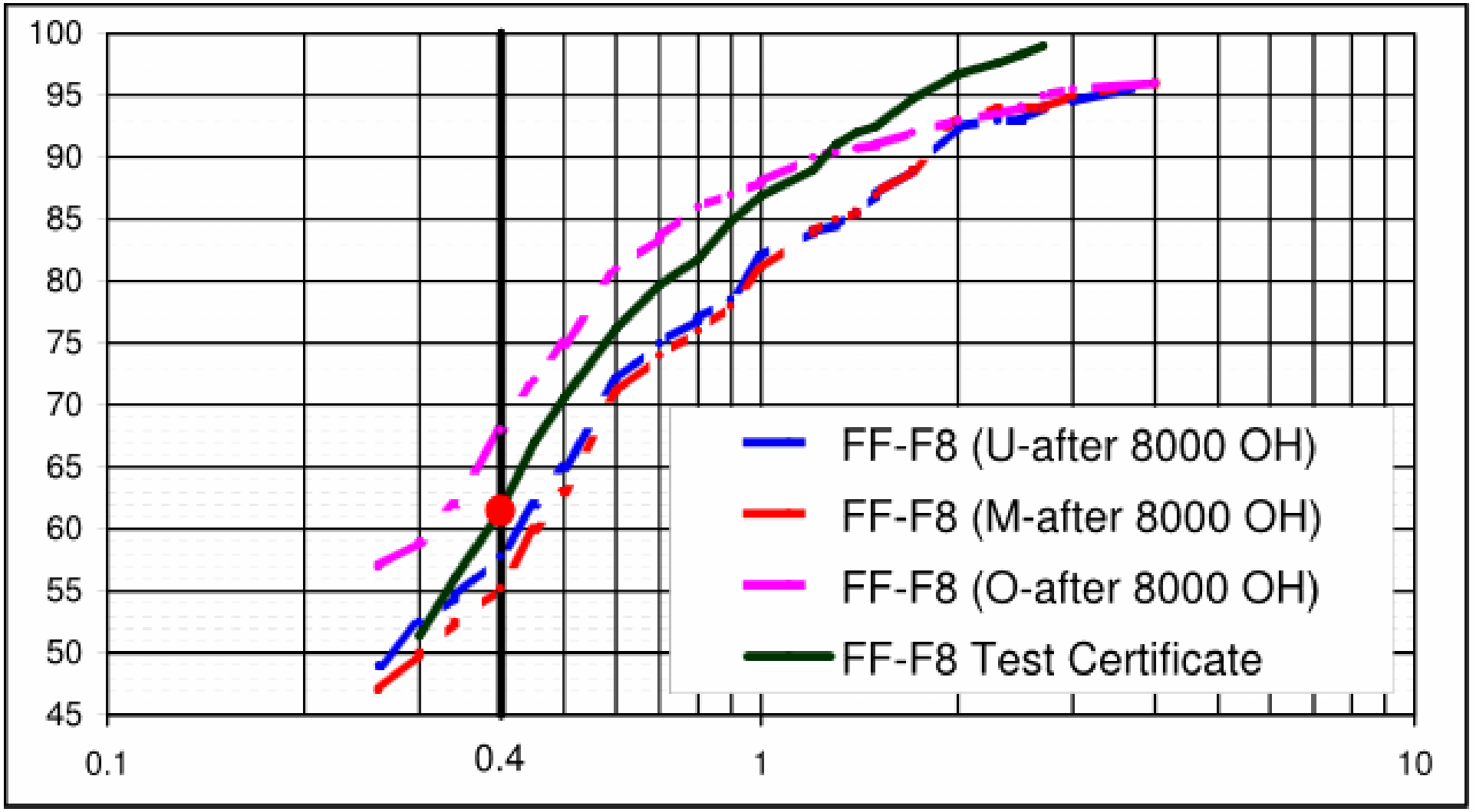
CCPP PO-Comparison



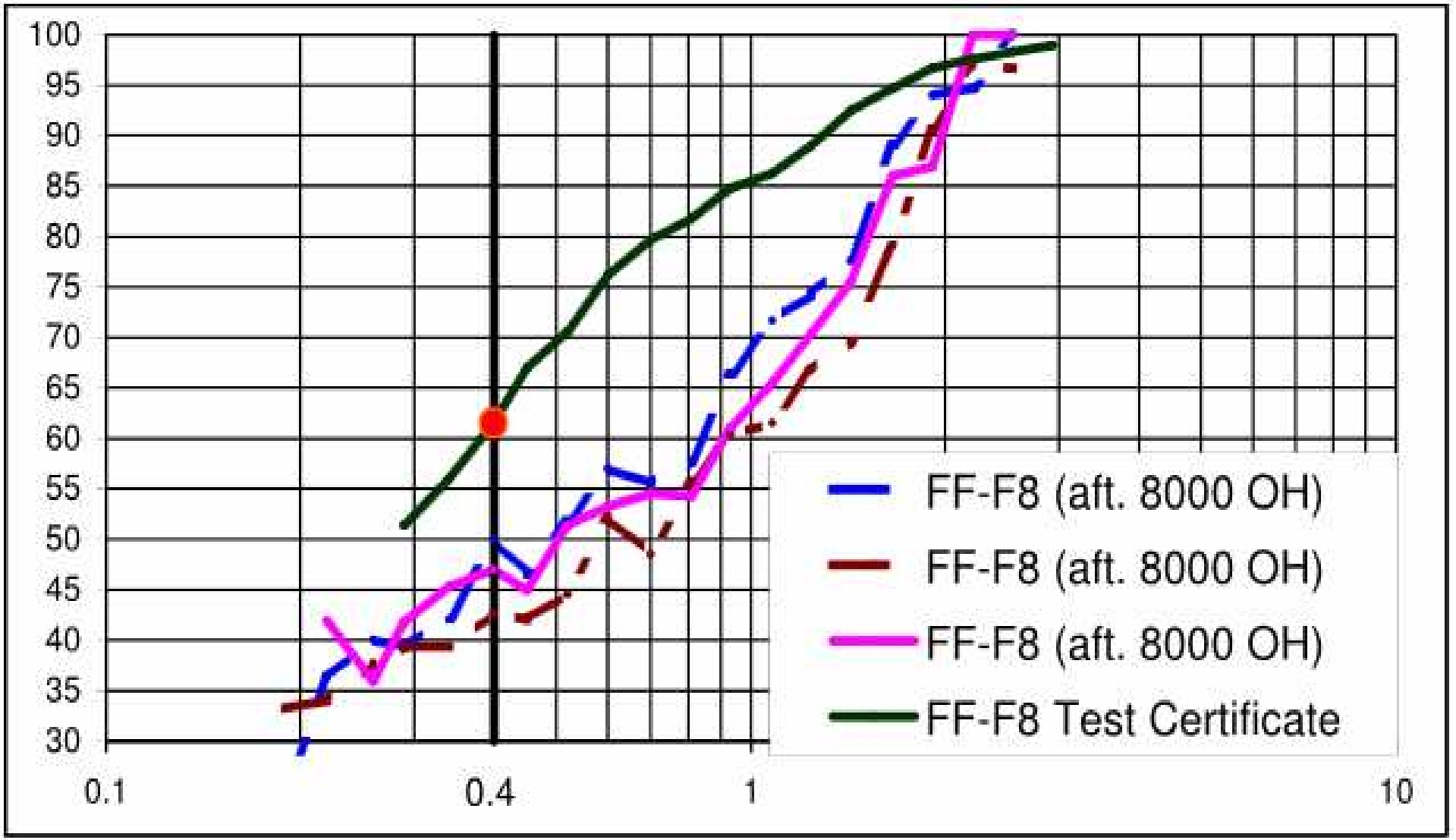
CCPP Heat Rate Comparison



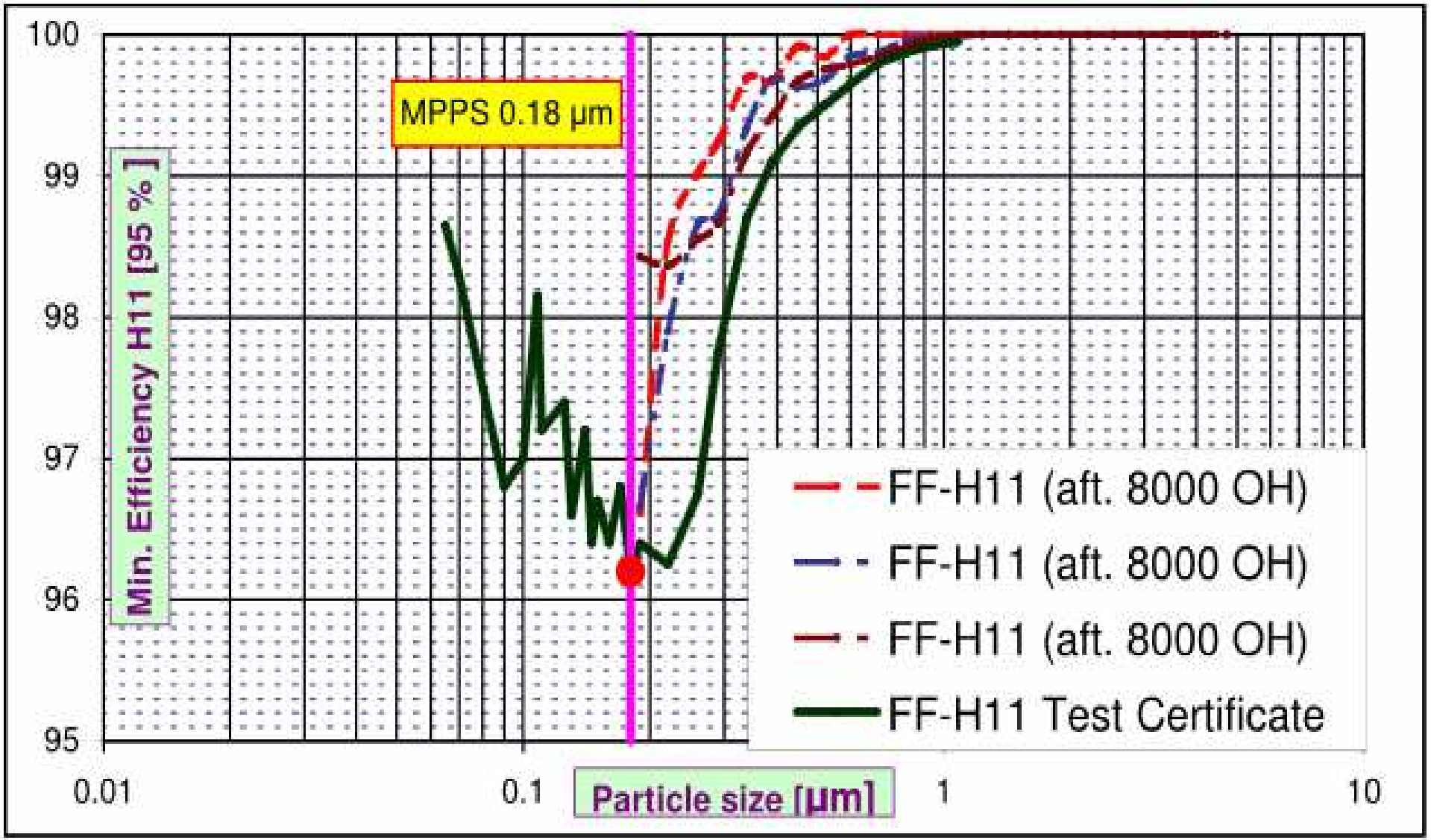
Filter Efficiency Test after 8000h operation



Filter Efficiency Test after 8000 OH operation @ 3900 m³/h volume flow



Tested efficiency after 8000 OH @ 3900 m³/h volume flow



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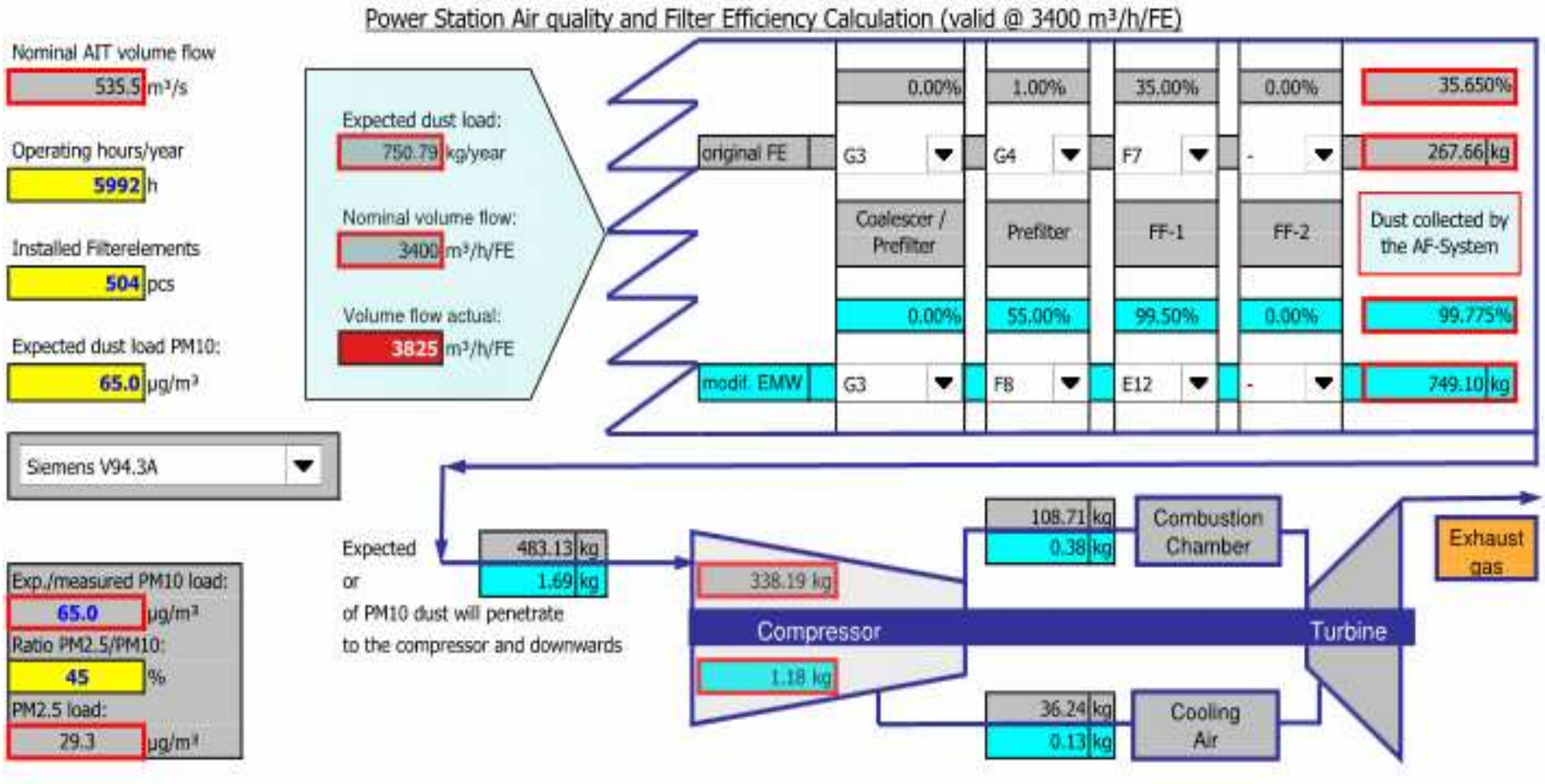
Calculation Tool AFS-Efficiency



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Summary

All power stations around the world have to cope with degradation issues.

One of the most important topics for Gas Turbine and Combined Cycle power plants in the field of deterioration and degradation is the compressor fouling.

The design of an appropriate Air Intake System including efficient working Air Filters are eminently to reduce the compressor fouling by particle pollution and increase the profitability.

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Questions & Answers

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References

(1) GUIDELINE FOR GASTURBINE INLET AIR FILTRATION SYSTEMS
Release 1.0; April 2010;
(Gas Maschinery Research Council; Southwest Research Institute)

(2) Book „Reinraumtechnik“ Hrsg.: 2004 Gail

(3) Internet „Wikipedia“

(4) US EPA Office of Air and Radiation
EPA-452/F-03-001

(5) Source: NOAA National Climatic Data Center

(6) HEPA Filter Evaluation Report (CCPP – 2xGT / 1 ST)