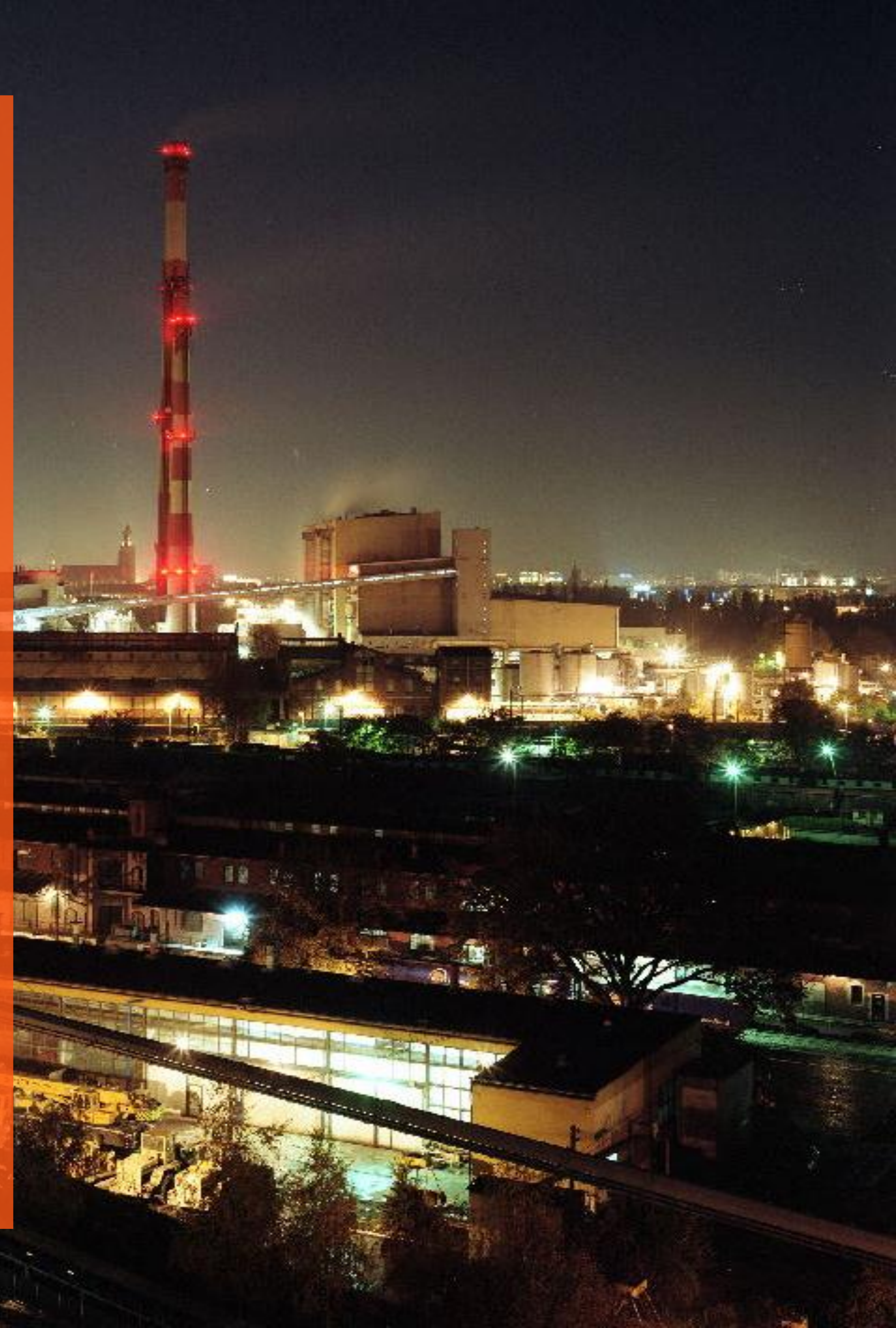
EDF TRAINING TO EUAŞ

FUNDAMENTAL PARAMETERS PERFORMANCE ASSESSMENT

JULY 2017



EDF Thermal Generation & Engineering Division

SESSION OBJECTIVE

- **Ensure that Çan units thermodynamical performance are optimized.**
  - Parameters to monitor for an “at-once” performance assessment
  - Impact of the performance parameters on the heat rate
  - Indicators and degradation causes
  - Performing an efficiency audit

Fundamental parameters

1 Parameters for performance
2 Impact of the performance parameters
3 Indicators and degradation causes
4 Performing an efficiency audit

1.

- Overview of the key parameters for the operator for an “at-once” performance assessment

PARAMETERS FOR PERFORMANCE

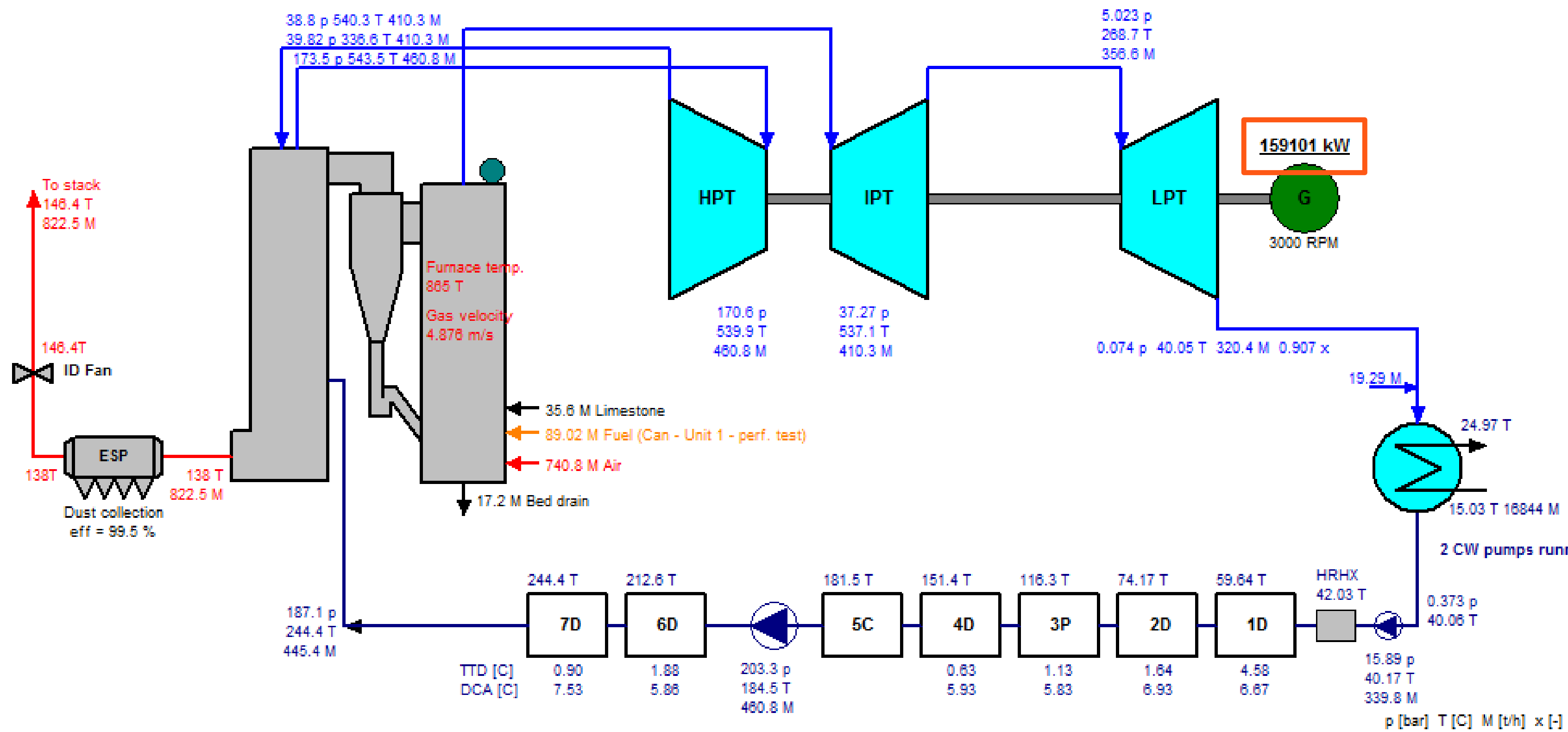
- **Overview of key parameters to be monitored by the operator for a rapid performance assessment**
  - Gross power
  - Heat rate
  - Coal flow
  - Air flow
  - Air excess
  - HP steam pressure
  - HP steam flow
  - Feedwater flow
  - HP steam temperature
  - RH steam temperature
  - Condenser vacuum
  - Chemistry

OVERVIEW OF KEY PARAMETERS

Power

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
Plant net eff (LHV)	37.07	%
Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



OVERVIEW OF KEY PARAMETERS

Heat rate

$$Plant\ gross\ heat\ rate = \frac{Fuel\ input}{Generator\ power} = \frac{1}{Efficiency} \times 3600$$

$$Boiler\ heat\ rate \approx \frac{Fuel\ input}{Generated\ HP\ and\ RH\ steams - ...}$$

$$Steam\ cycle\ heat\ rate \approx \frac{Generated\ HP\ and\ RH\ steams - ...}{Generator\ power}$$

$$Plant\ net\ heat\ rate = \frac{Generator\ power}{Generator\ power - Auxiliaries}\ Plant\ gross\ heat\ rate$$

OVERVIEW OF KEY PARAMETERS

Coal flow

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
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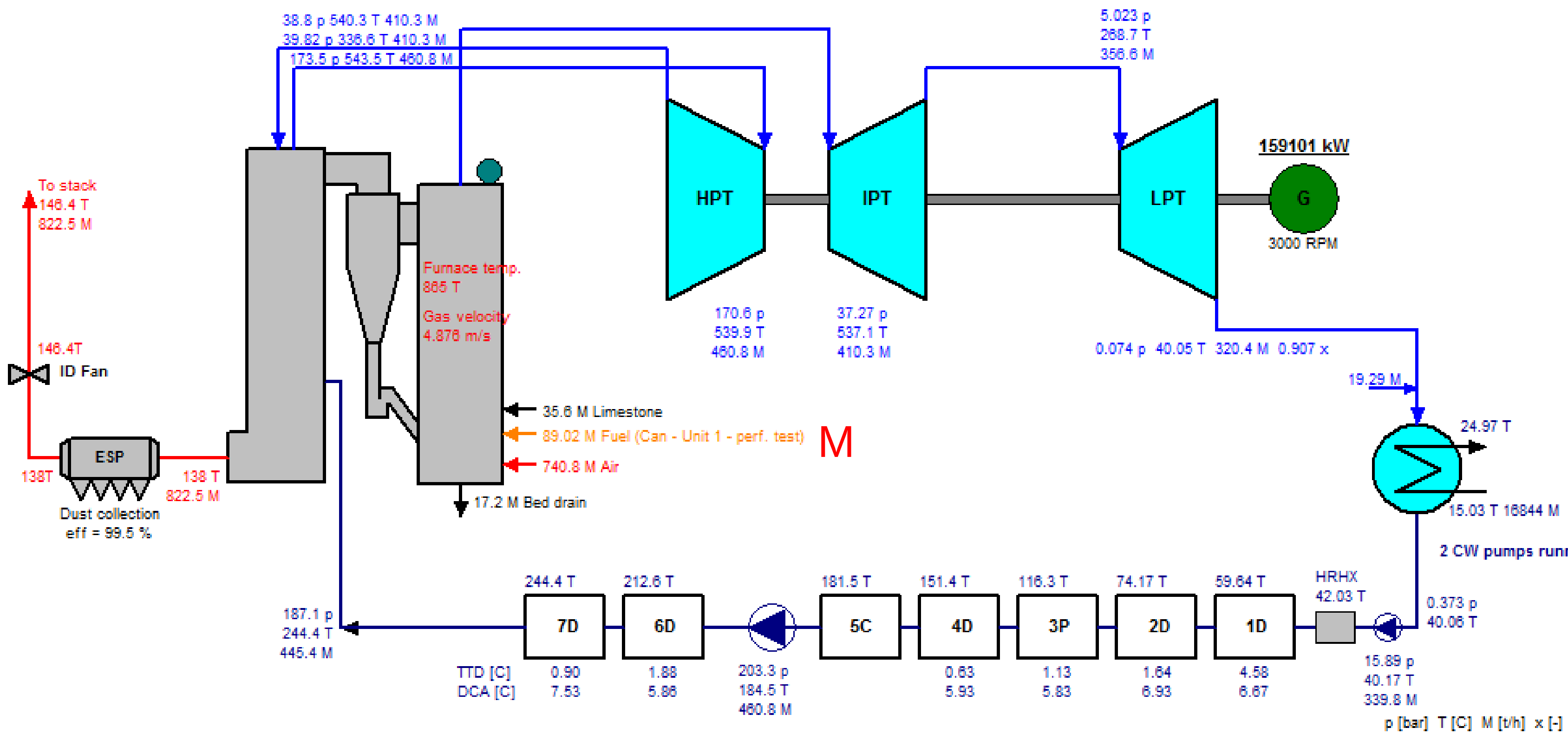

OVERVIEW OF KEY PARAMETERS

Air flow

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
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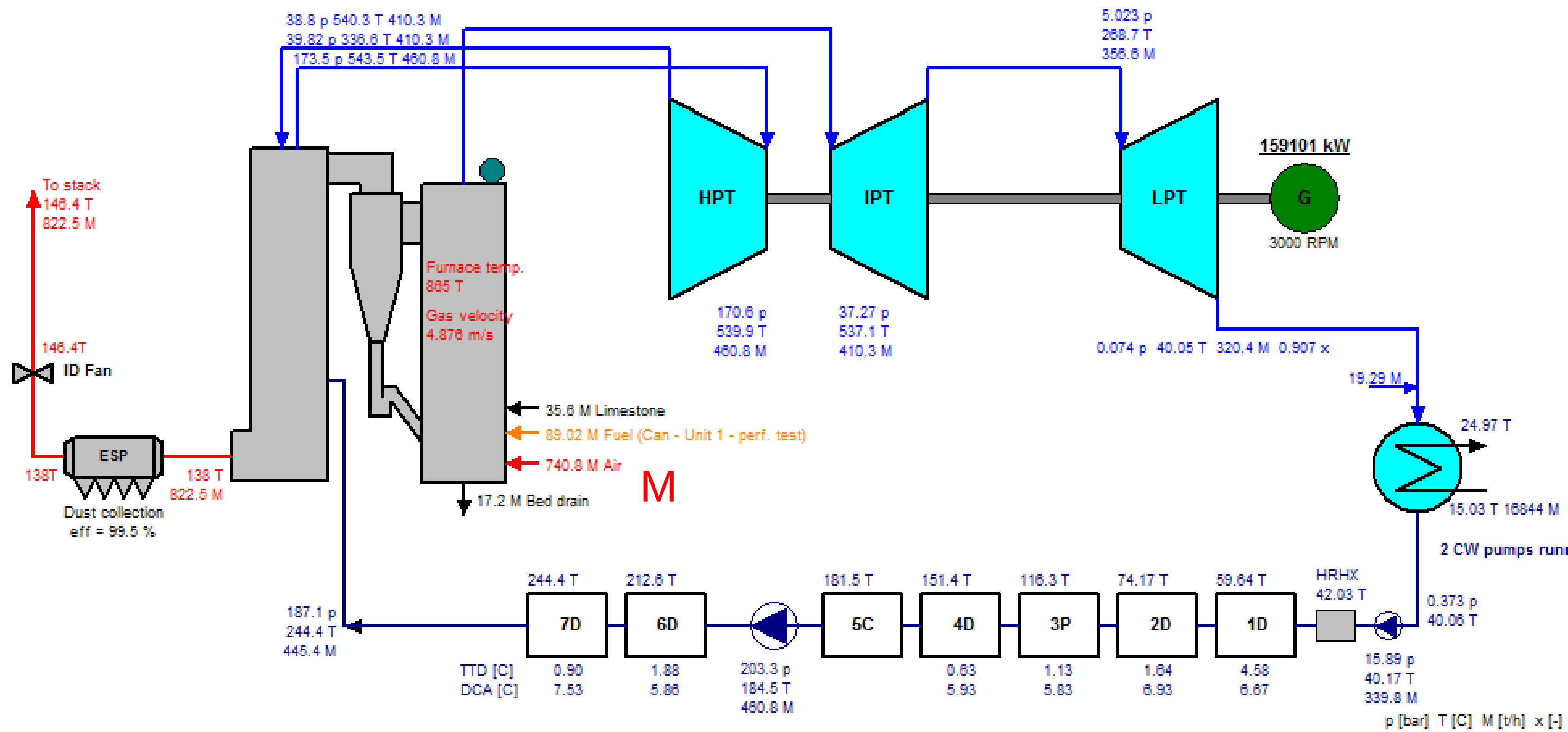

OVERVIEW OF KEY PARAMETERS

Air excess

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
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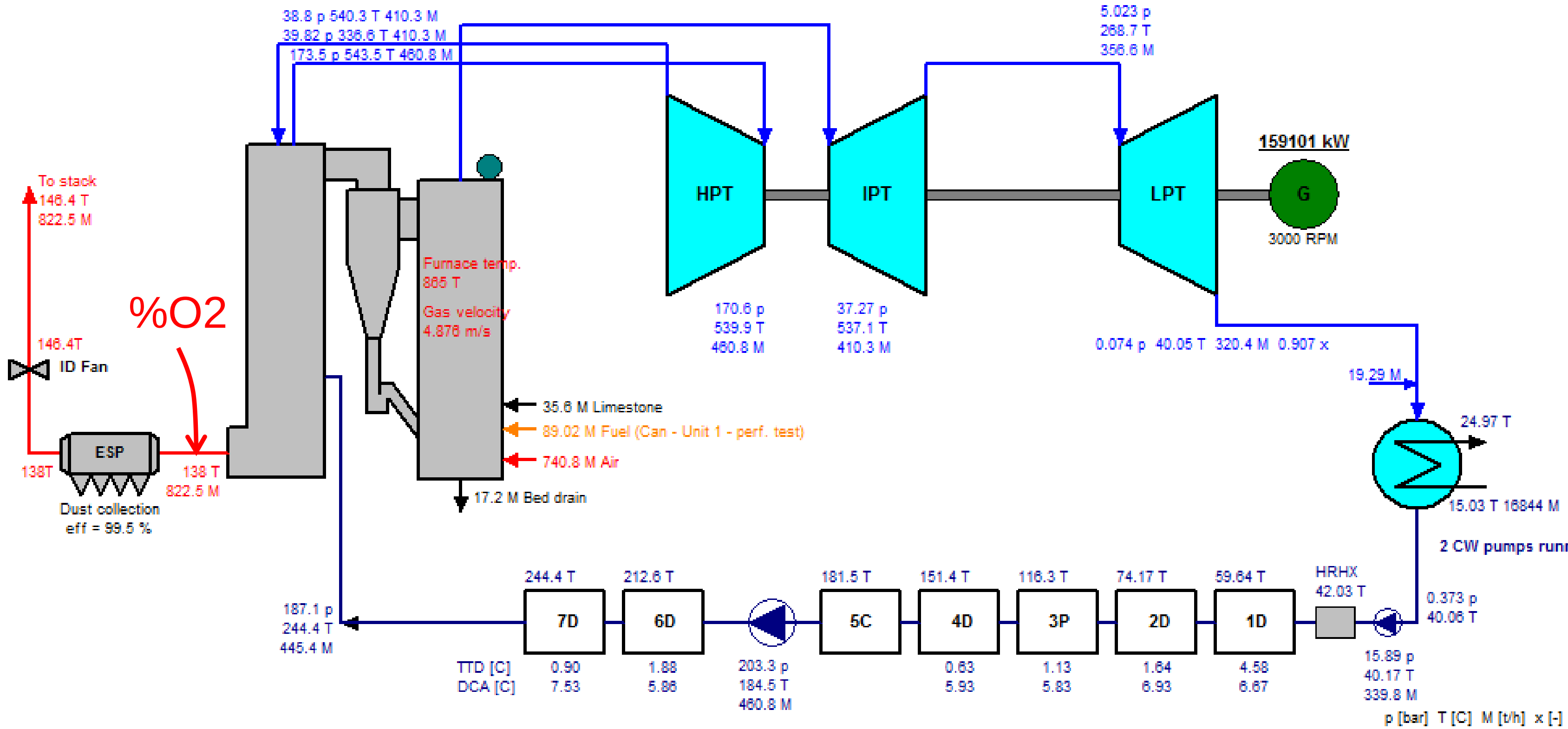

OVERVIEW OF KEY PARAMETERS

HP steam pressure

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
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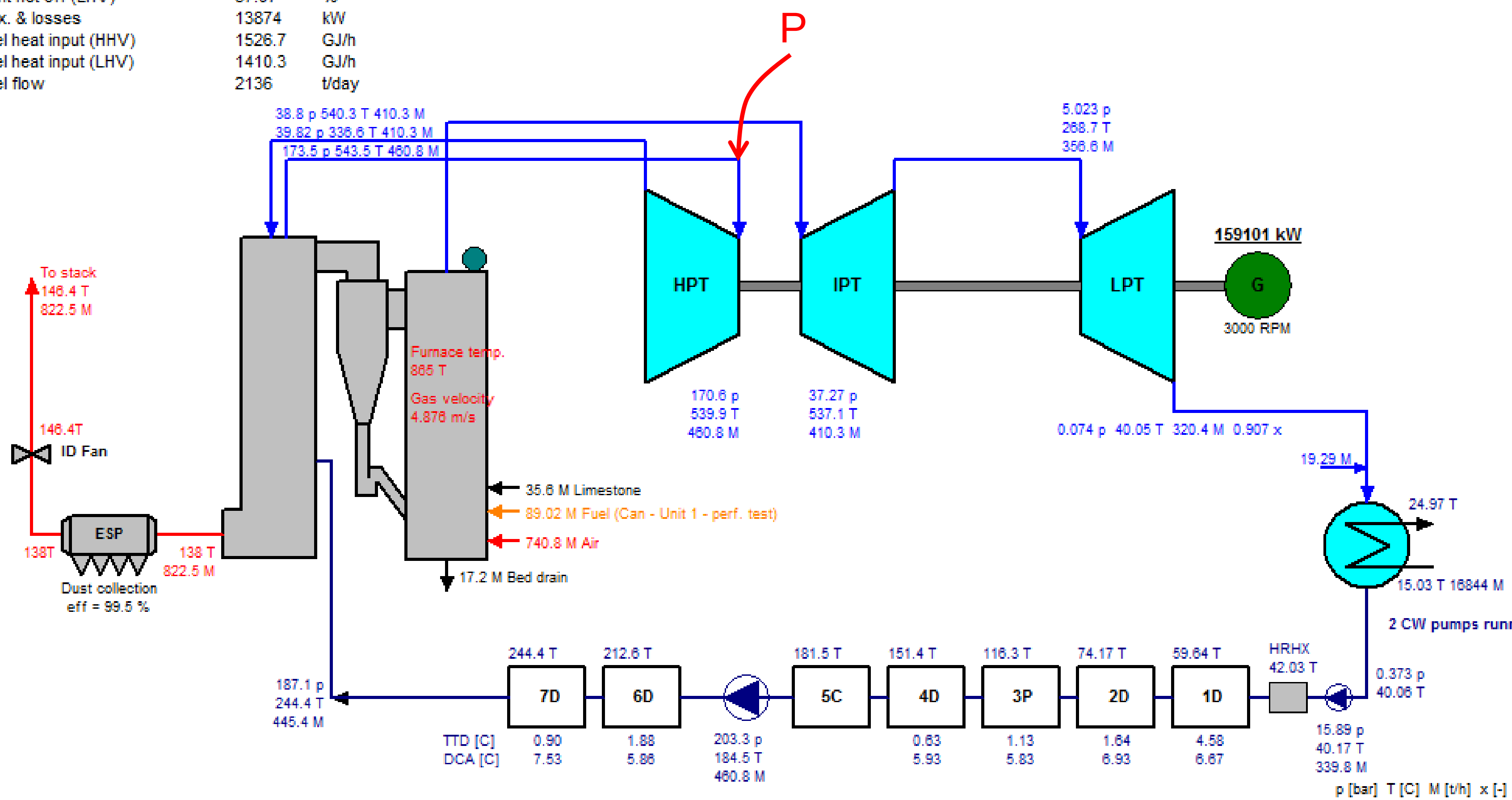

OVERVIEW OF KEY PARAMETERS

HP steam flow

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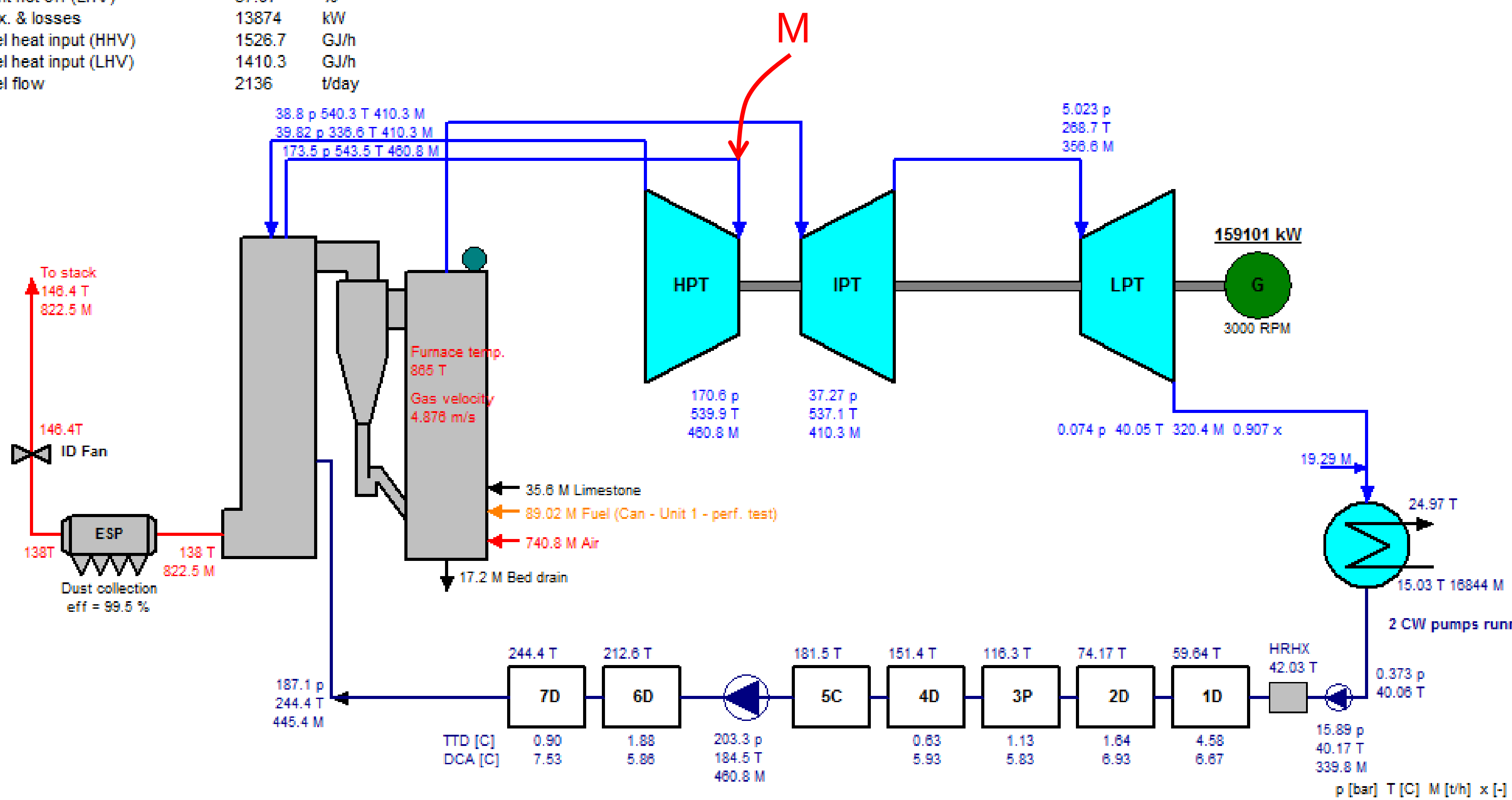

OVERVIEW OF KEY PARAMETERS

Feedwater flow

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
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Aux. & losses	13874	kW
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Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day

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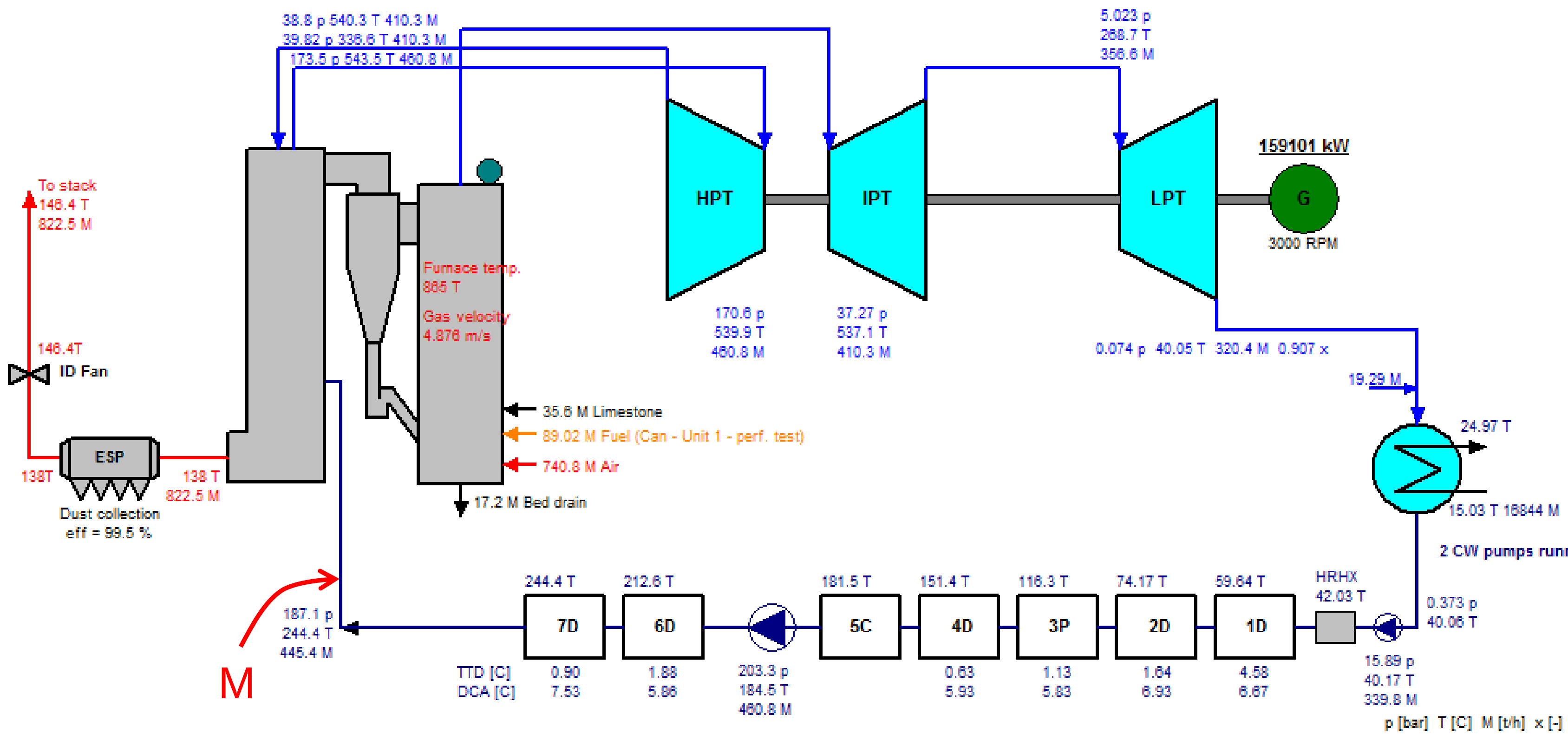

OVERVIEW OF KEY PARAMETERS

HP steam temperature

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
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Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
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Fuel flow	2136	t/day

Ambient
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17.3 T
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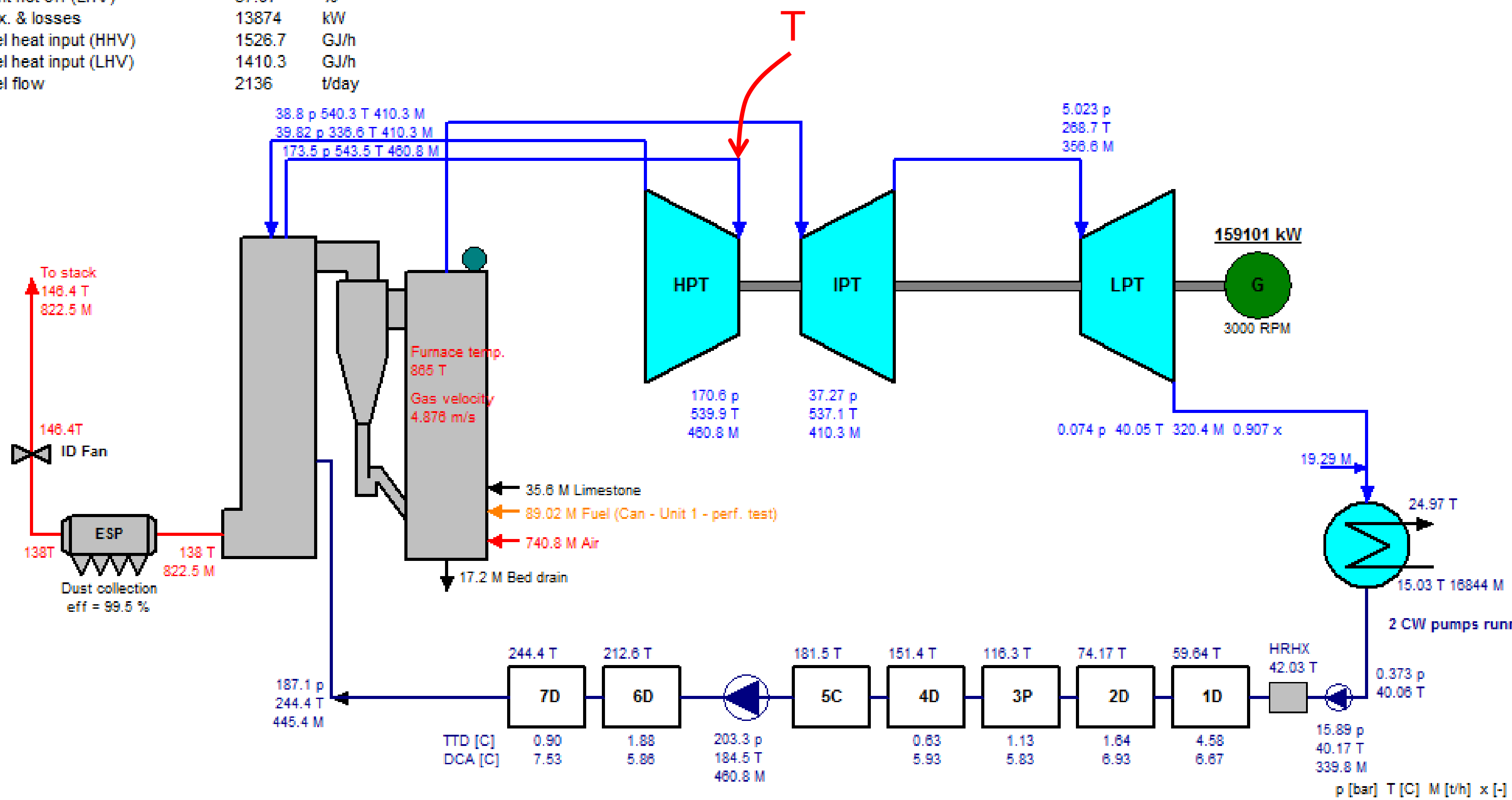
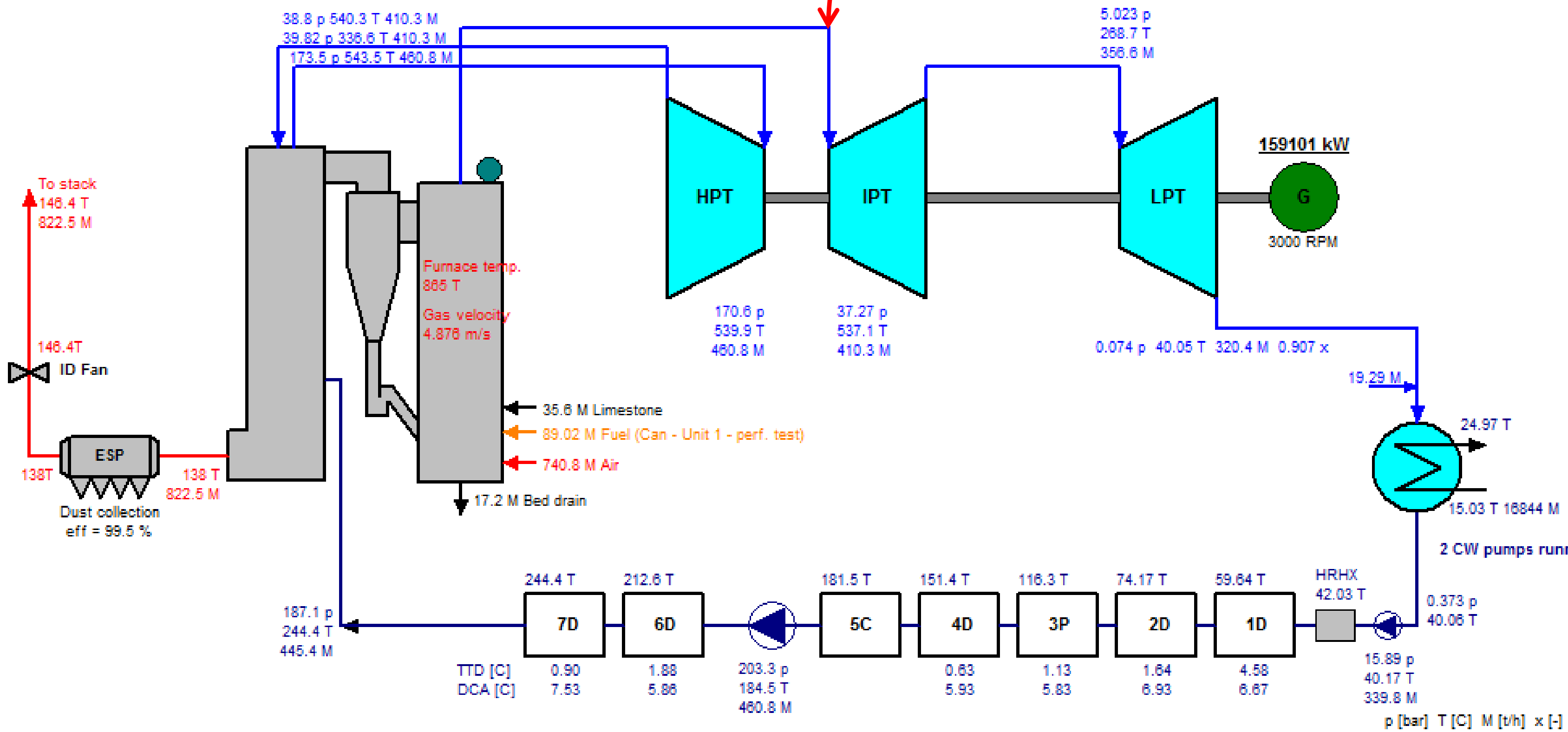


OVERVIEW OF KEY PARAMETERS

RH steam temperature

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
Plant net eff (LHV)	37.07	%
Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb

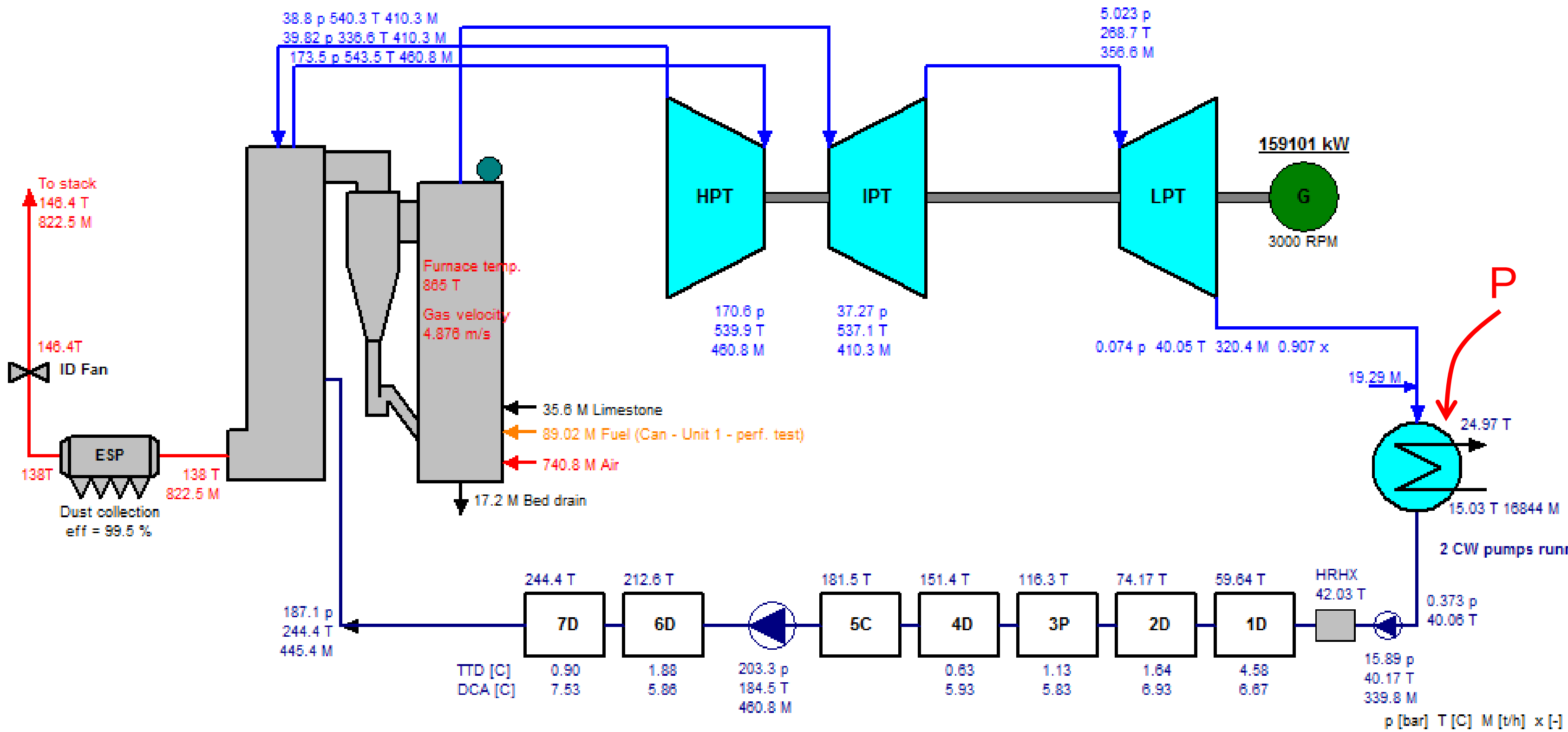


OVERVIEW OF KEY PARAMETERS

Condenser vacuum

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
Plant net eff (LHV)	37.07	%
Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day

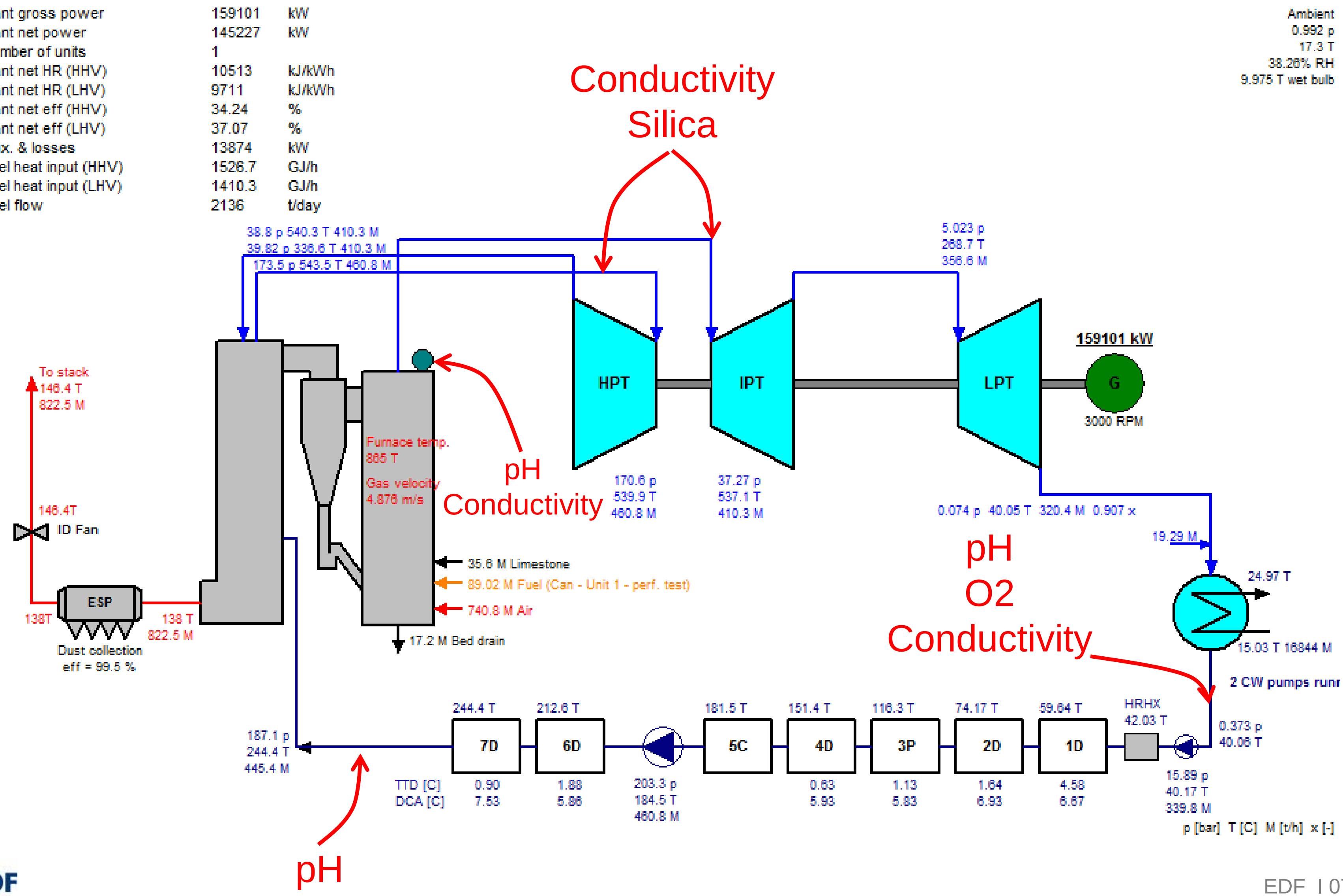
Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



OVERVIEW OF KEY PARAMETERS

Chemistry

Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
Plant net eff (LHV)	37.07	%
Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day



OVERVIEW OF KEY PARAMETERS

Table for the operators

	Reference	Current situation	Deviation
Power (MW)	159		
Heat rate (kJ/kWh)	9711		
Coal flow (t/h)	89		
Air flow (t/h)	741		
Air excess (%O2)	4.6		
HP steam pressure (bar)	175		
HP steam flow (t/h)	461		
Feedwater flow (t/h)	461		
HP steam temperature (°C)	543		
RH steam temperature (°C)	542		
Condenser vacuum (mbar)	74		
Chemistry	OK		

OVERVIEW OF KEY PARAMETERS

Table for the operators

	Reference	Current situation	Deviation
Power (MW)	159	159	
Heat rate (kJ/kWh)	9711		
Coal flow (t/h)	89		
Air flow (t/h)	741		
Air excess (%O2)	4.6		
HP steam pressure (bar)	175		
HP steam flow (t/h)	461		
Feedwater flow (t/h)	461		
HP steam temperature (°C)	543		
RH steam temperature (°C)	542		
Condenser vacuum (mbar)	74		
Chemistry	OK		

OVERVIEW OF KEY PARAMETERS

Table for the operators

	Reference	Current situation	Deviation
Power (MW)	159	159	
Heat rate (kJ/kWh)	9711	9818	
Coal flow (t/h)	89	90	
Air flow (t/h)	741	749	
Air excess (%O2)	4.6	4.6	
HP steam pressure (bar)	175	175	
HP steam flow (t/h)	461	442	
Feedwater flow (t/h)	461	442	
HP steam temperature (°C)	543	543	
RH steam temperature (°C)	542	541	
Condenser vacuum (mbar)	74	77	
Chemistry	OK	OK	

OVERVIEW OF KEY PARAMETERS

Table for the operators

	Reference	Current situation	Deviation
Power (MW)	159	159	=
Heat rate (kJ/kWh)	9711	9818	+
Coal flow (t/h)	89	90	+
Air flow (t/h)	741	749	+
Air excess (%O2)	4.6	4.6	=
HP steam pressure (bar)	175	175	=
HP steam flow (t/h)	461	442	- -
Feedwater flow (t/h)	461	442	- -
HP steam temperature (°C)	543	543	=
RH steam temperature (°C)	542	541	=
Condenser vacuum (mbar)	74	77	+
Chemistry	OK	OK	OK

Fundamental parameters

2.

- Coal flow
- Air flow
- Air excess
- HP steam pressure
- HP steam flow
- Feedwater flow
- HP steam temperature
- RH steam temperature
- Condenser vacuum

IMPACT OF THE PERFORMANCE PARAMETERS

- **What will be the impact on the performance if one parameter deviates?**
  - Example on Unit 2 (as of March 29th 2017) with:
    - Fixed ambient conditions, coal and limestone characteristics
    - Fixed power and grid conditions
  - Observed deviations compared to a reference situation:
    - Coal flow
    - Air flow
    - Air excess
    - HP steam pressure
    - HP steam flow
    - Feedwater flow
    - HP steam temperature
    - RH steam temperature
    - Condenser vacuum

IMPACT OF THE PERFORMANCE PARAMETERS

Coal flow

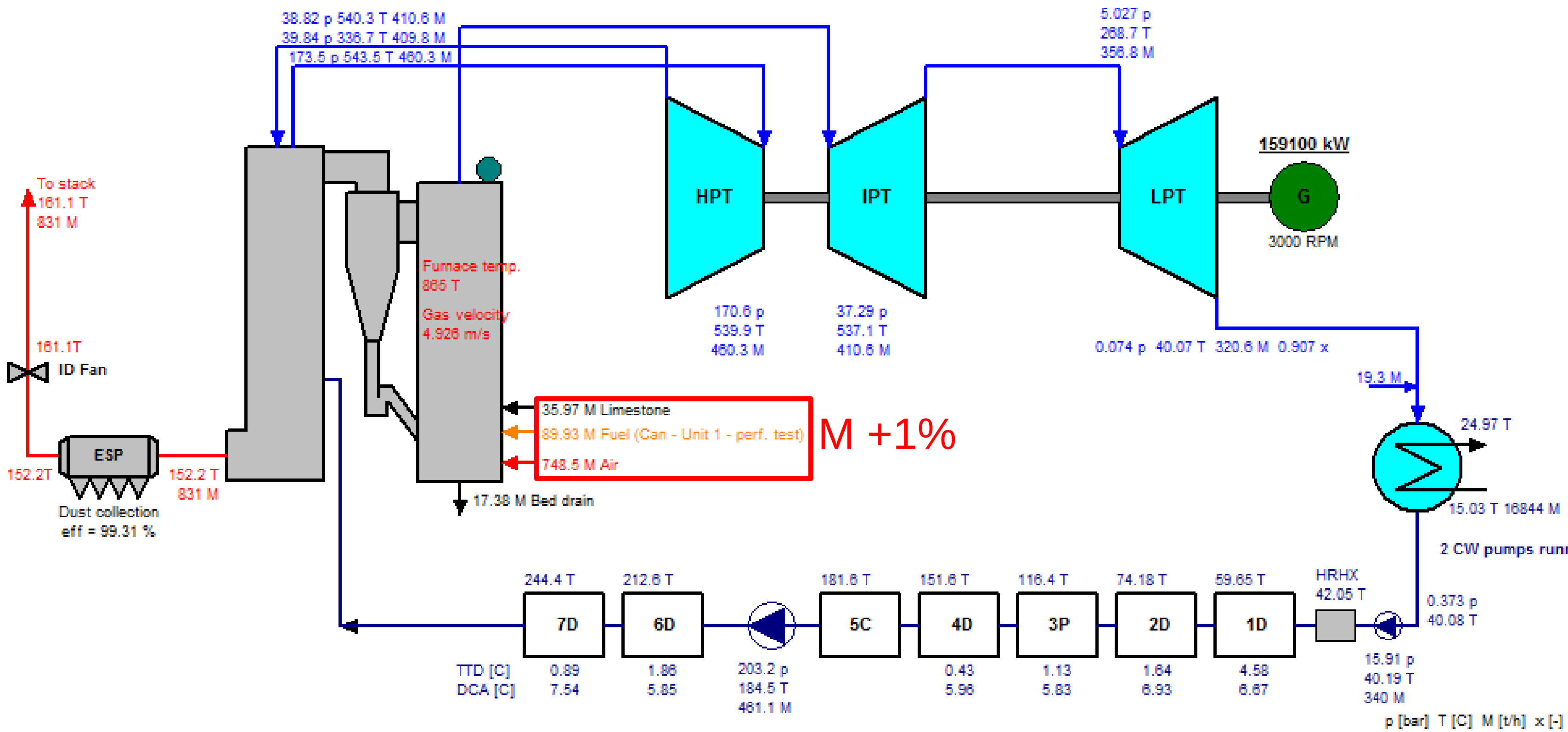
Plant gross power	159100	kW
Plant net power	144975	kW
Number of units	1	
Plant net HR (HHV)	10640	kJ/kWh
Plant net HR (LHV)	9828	kJ/kWh
Plant net eff (HHV)	33.84	%
Plant net eff (LHV)	36.63	%
Aux. & losses	14125	kW
Fuel heat input (HHV)	1542.5	GJ/h
Fuel heat input (LHV)	1424.8	GJ/h
Fuel flow	2158	t/day

P

HR +1%

Economizer and air heater fouling

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



IMPACT OF THE PERFORMANCE PARAMETERS

Air flow

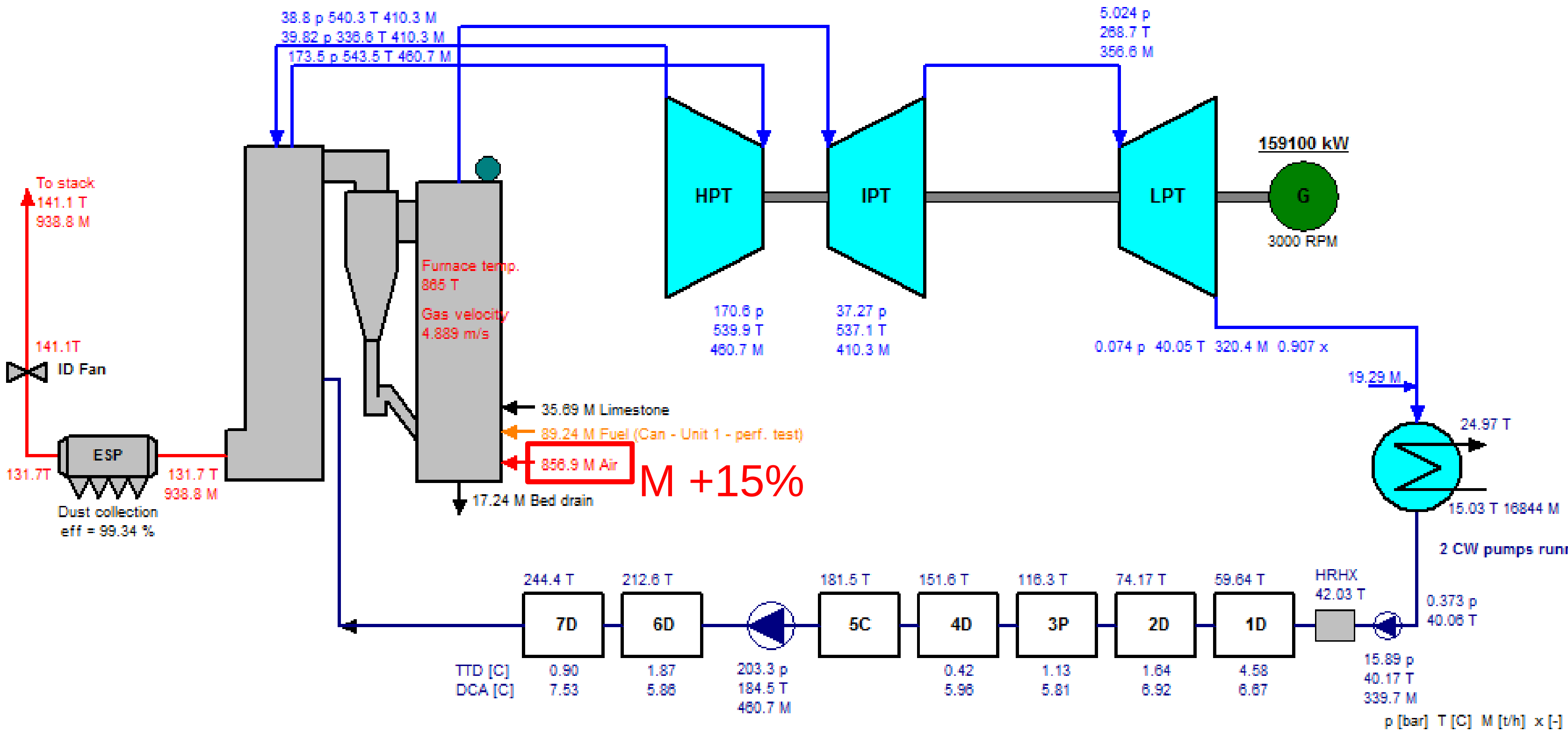
P

Plant gross power	159100	kW
Plant net power	143431	kW
Number of units	1	
Plant net HR (HHV)	10671	kJ/kWh
Plant net HR (LHV)	9857	kJ/kWh
Plant net eff (HHV)	33.74	%
Plant net eff (LHV)	36.52	%
Aux. & losses	15669	kW
Fuel heat input (HHV)	1530.6	GJ/h
Fuel heat input (LHV)	1413.8	GJ/h
Fuel flow	2142	t/day

HR +1.5%

Air heater leaks

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



IMPACT OF THE PERFORMANCE PARAMETERS

Air excess

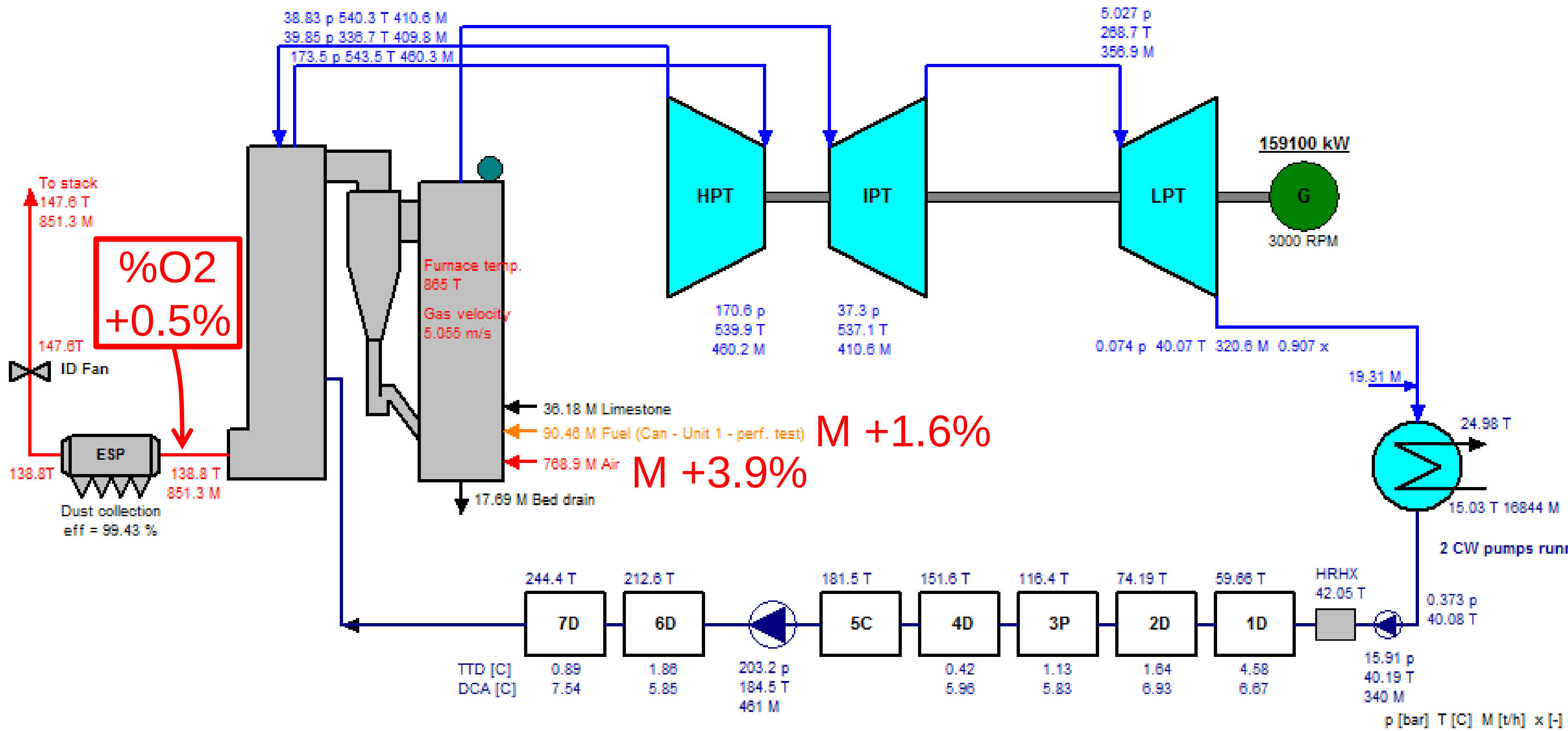
Plant gross power	159100	kW
Plant net power	144696	kW
Number of units	1	
Plant net HR (HHV)	10722	kJ/kWh
Plant net HR (LHV)	9904	kJ/kWh
Plant net eff (HHV)	33.58	%
Plant net eff (LHV)	36.35	%
Aux. & losses	14404	kW
Fuel heat input (HHV)	1551.4	GJ/h
Fuel heat input (LHV)	1433.1	GJ/h
Fuel flow	2171	t/day

P

HR +2%

Air excess law changed

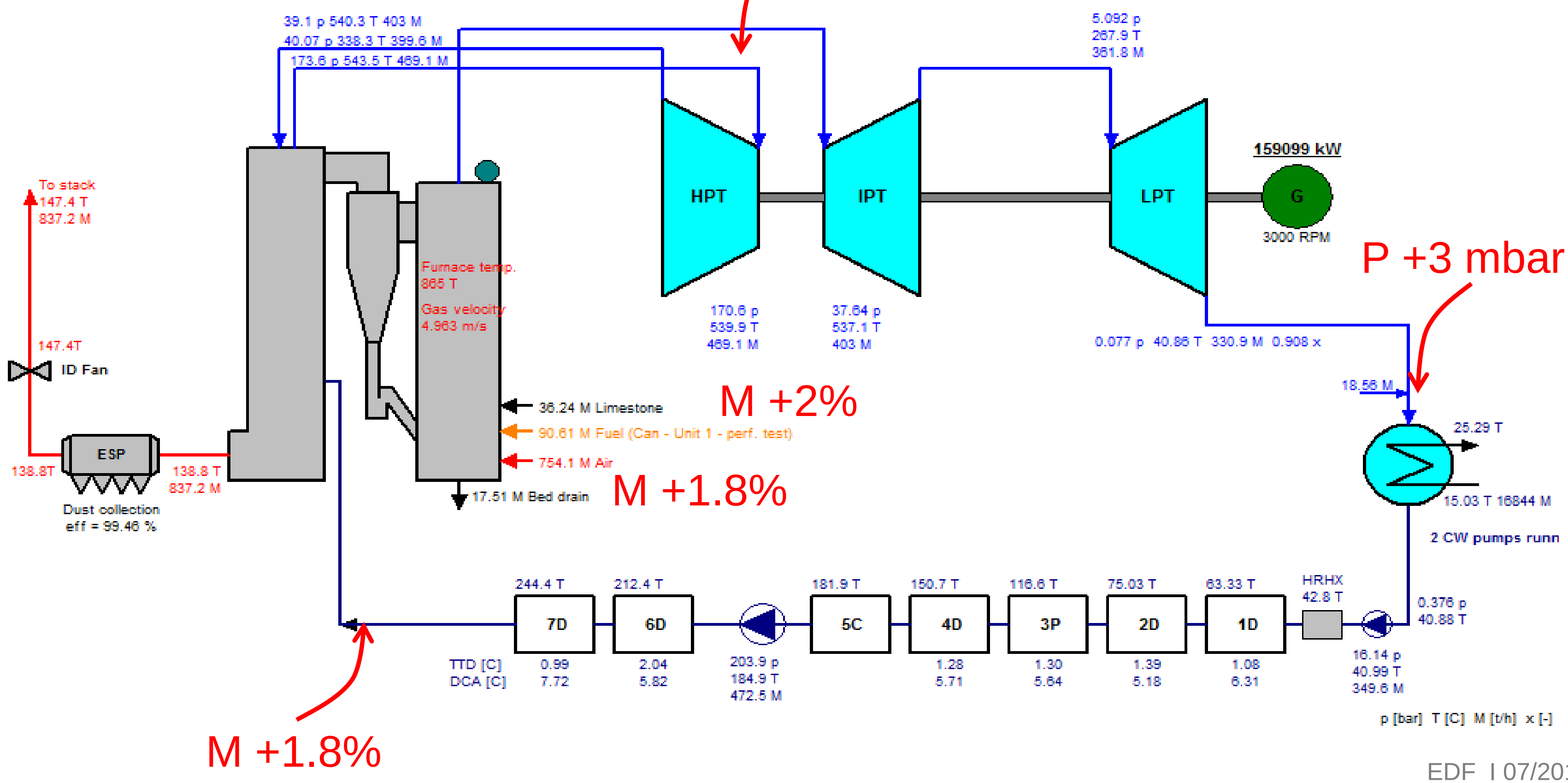
Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



IMPACT OF THE PERFORMANCE PARAMETERS

HP steam pressure

Plant gross power	159099	kW
Plant net power	144860	kW
Number of units	1	
Plant net HR (HHV)	10728	kJ/kWh
Plant net HR (LHV)	9910	kJ/kWh
Plant net eff (HHV)	33.56	%
Plant net eff (LHV)	36.33	%
Aux. & losses	14239	kW
Fuel heat input (HHV)	1554	GJ/h
Fuel heat input (LHV)	1435.5	GJ/h
Fuel flow	2175	t/day



IMPACT OF THE PERFORMANCE PARAMETERS

HP steam flow

Plant gross power	159099	kW
Plant net power	145101	kW
Number of units	1	
Plant net HR (HHV)	10574	kJ/kWh
Plant net HR (LHV)	9767	kJ/kWh
Plant net eff (HHV)	34.05	%
Plant net eff (LHV)	36.86	%
Aux. & losses	13998	kW
Fuel heat input (HHV)	1534.3	GJ/h
Fuel heat input (LHV)	1417.3	GJ/h
Fuel flow	2147	t/day

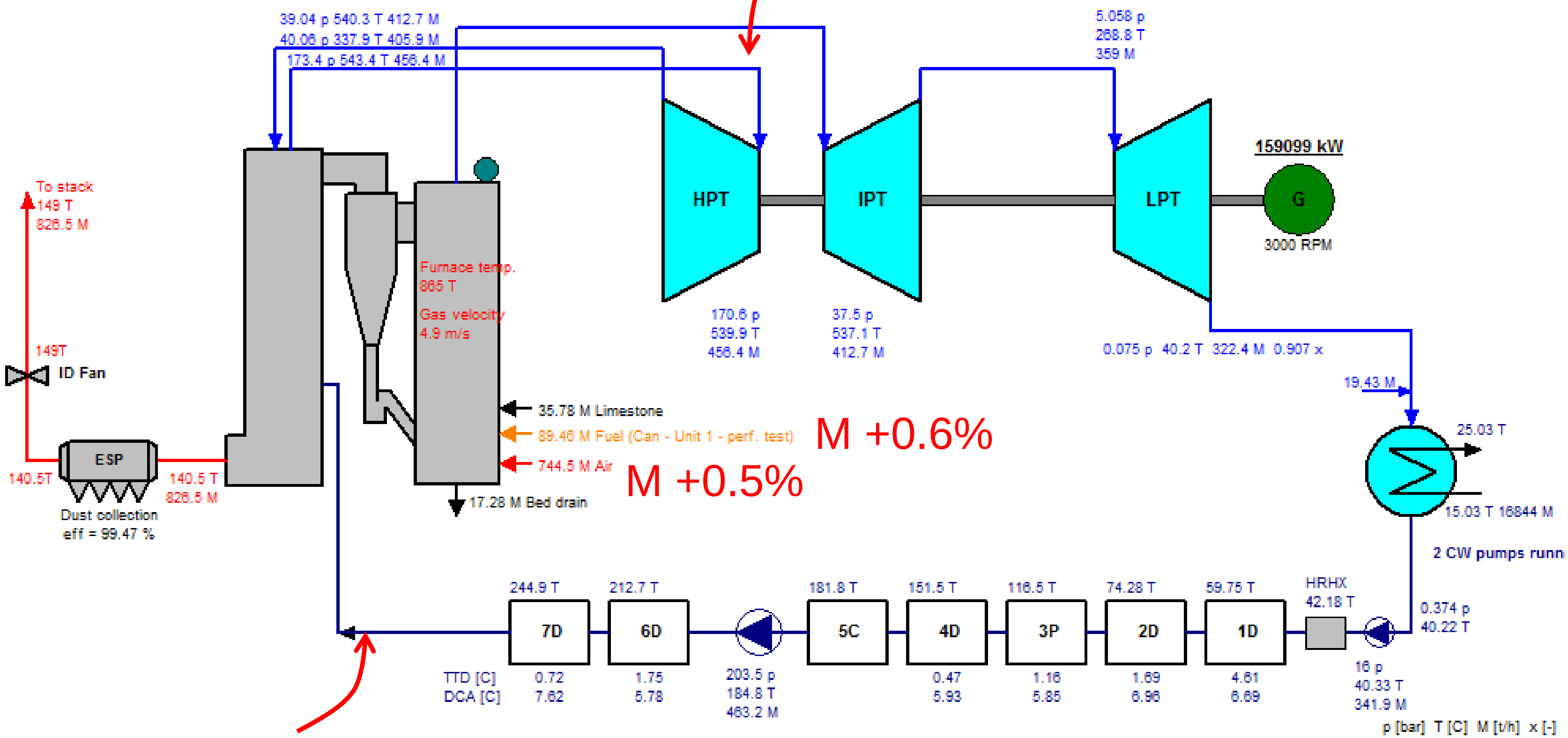
P

HR +0.6%

Waterwalls and superheaters fouling

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb

M -0.3%



IMPACT OF THE PERFORMANCE PARAMETERS

Feedwater flow

Plant gross power	159099	kW
Plant net power	145031	kW
Number of units	1	
Plant net HR (HHV)	10609	kJ/kWh
Plant net HR (LHV)	9800	kJ/kWh
Plant net eff (HHV)	33.93	%
Plant net eff (LHV)	36.74	%
Aux. & losses	14069	kW
Fuel heat input (HHV)	1538.6	GJ/h
Fuel heat input (LHV)	1421.3	GJ/h
Fuel flow	2153	t/day

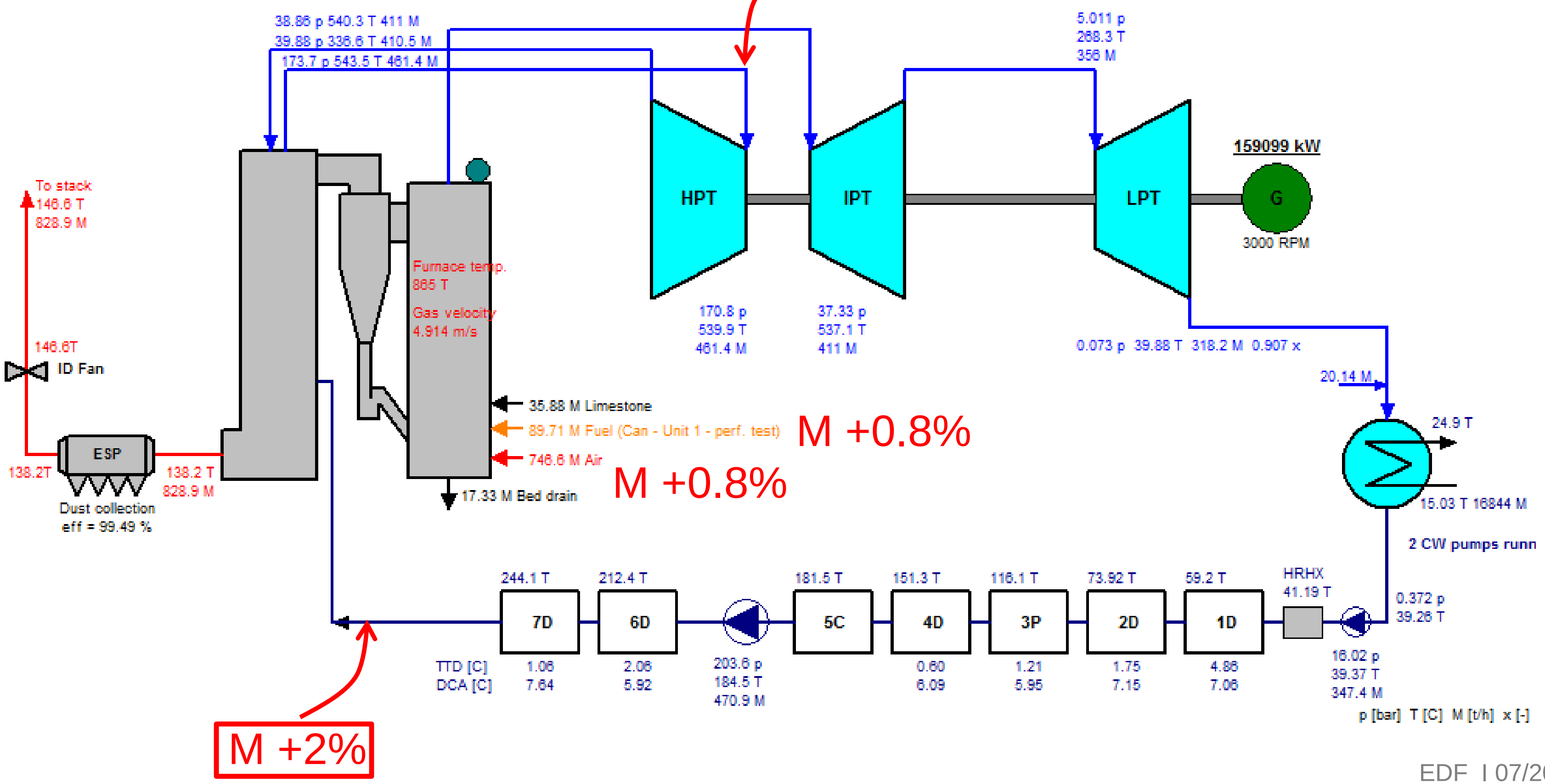
P

HR +0.9%

Excessive blowdown

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb

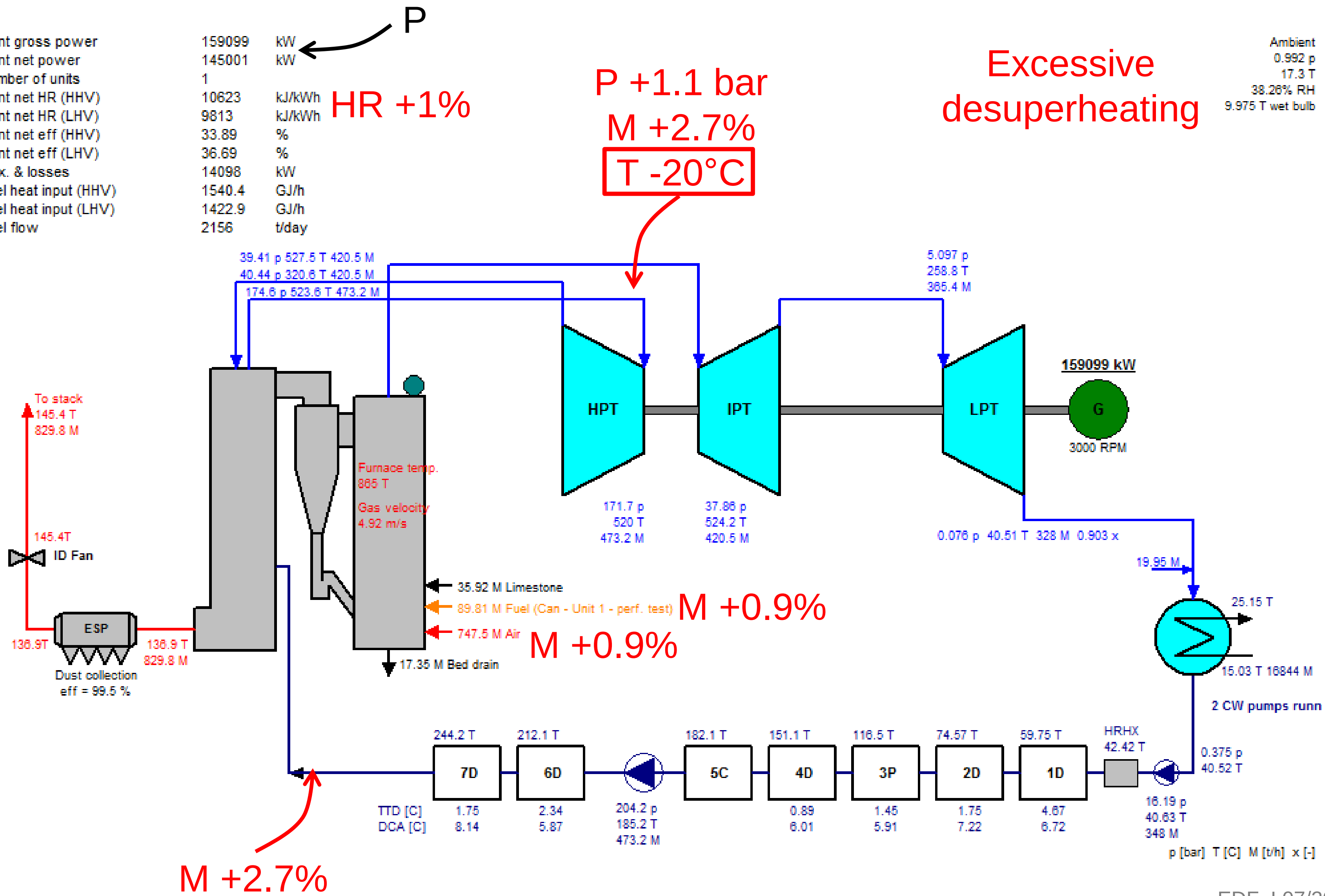
P +0.2 bar
M +0.1%



IMPACT OF THE PERFORMANCE PARAMETERS

HP steam temperature

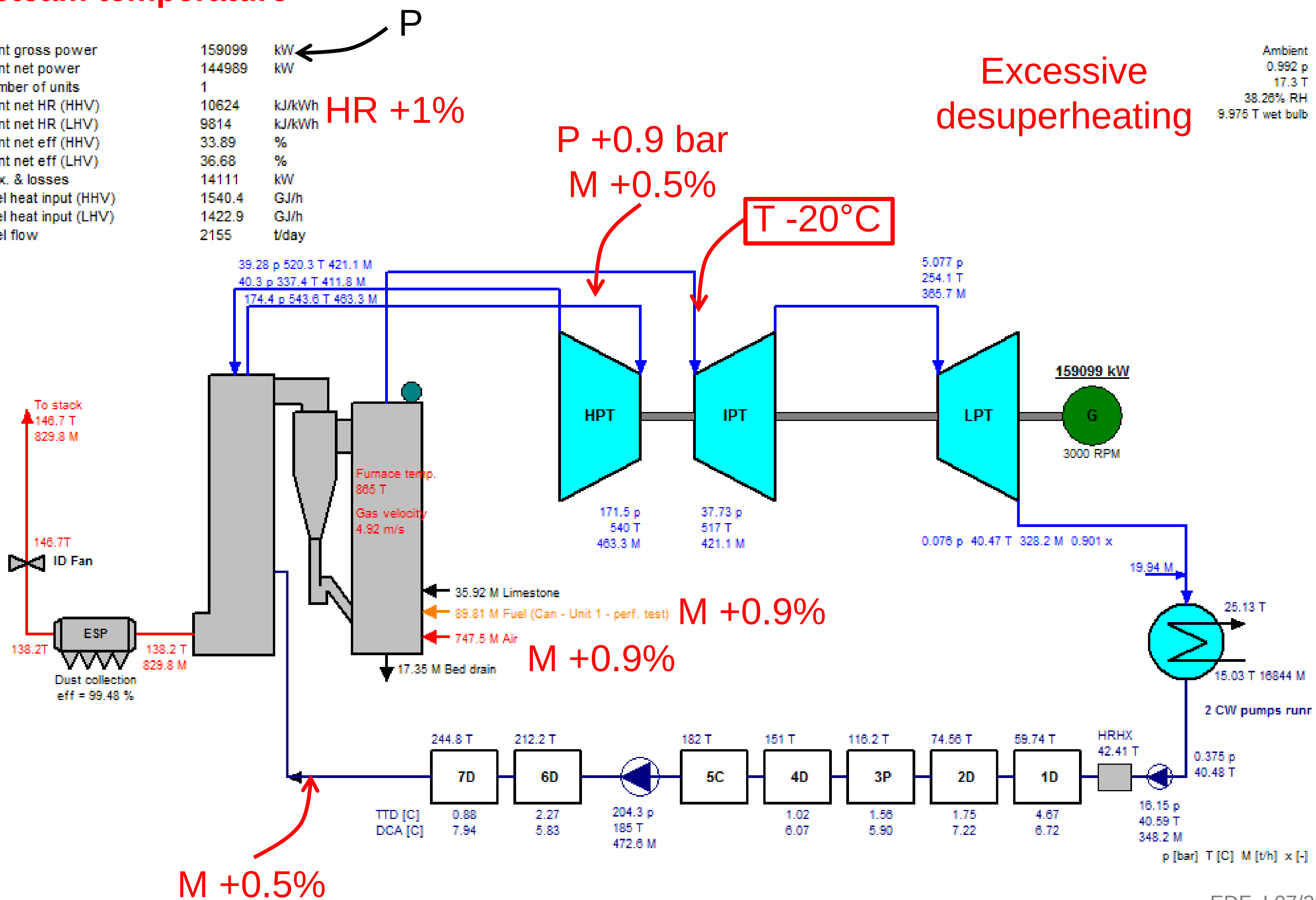
Plant gross power	159099	kW
Plant net power	145001	kW
Number of units	1	
Plant net HR (HHV)	10623	kJ/kWh
Plant net HR (LHV)	9813	kJ/kWh
Plant net eff (HHV)	33.89	%
Plant net eff (LHV)	36.69	%
Aux. & losses	14098	kW
Fuel heat input (HHV)	1540.4	GJ/h
Fuel heat input (LHV)	1422.9	GJ/h
Fuel flow	2156	t/day



IMPACT OF THE PERFORMANCE PARAMETERS

RH steam temperature

Plant gross power	159099	kW
Plant net power	144989	kW
Number of units	1	
Plant net HR (HHV)	10624	kJ/kWh
Plant net HR (LHV)	9814	kJ/kWh
Plant net eff (HHV)	33.89	%
Plant net eff (LHV)	36.68	%
Aux. & losses	14111	kW
Fuel heat input (HHV)	1540.4	GJ/h
Fuel heat input (LHV)	1422.9	GJ/h
Fuel flow	2155	t/day



IMPACT OF THE PERFORMANCE PARAMETERS

Condenser vacuum

Plant gross power	159099	kW
Plant net power	145090	kW
Number of units	1	
Plant net HR (HHV)	10590	kJ/kWh
Plant net HR (LHV)	9782	kJ/kWh
Plant net eff (HHV)	34	%
Plant net eff (LHV)	36.8	%
Aux. & losses	14009	kW
Fuel heat input (HHV)	1536.5	GJ/h
Fuel heat input (LHV)	1419.3	GJ/h
Fuel flow	2150	t/day

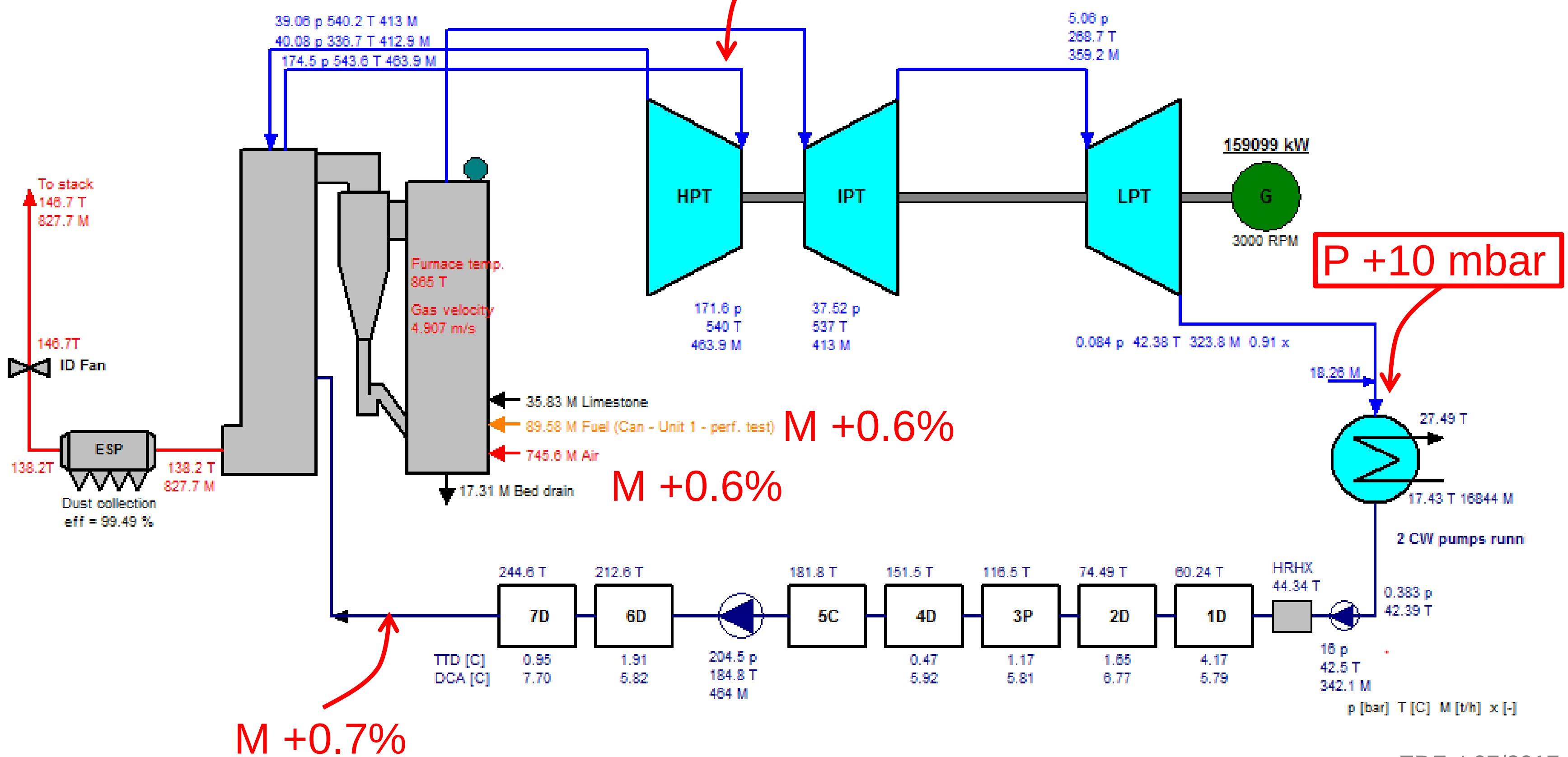
P

HR +0.7%

Cooling tower fouling

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb

P +1 bar
M +0.7%



IMPACT OF THE PERFORMANCE PARAMETERS

What will be the impact on the performance if one parameter deviates?

- Example on Unit 2 (as of March 29th 2017) with:
  - Fixed ambient conditions, coal and limestone characteristics
  - Fixed power and grid conditions

- Observed deviations compared to a reference situation:
  - Coal flow
  - Air flow
  - Air excess
  - HP steam pressure
  - HP steam flow
  - Feedwater flow
  - HP steam temperature
  - RH steam temperature
  - Condenser vacuum

Usually, all these deviations happen simultaneously, which makes it difficult for the operators to evaluate the real unit degradation cause.

Solutions:

- Equipment dedicated indicators
- Unit thermodynamical model

Fundamental parameters

3.

- Cooling system
- Feedwater heaters
- Boiler
- Steam turbine
- Auxiliaries

INDICATORS AND DEGRADATION CAUSES

- **What are the main equipments to be monitored ?**
  - Cooling system
  - Feedwater heaters
  - Boiler
  - Steam turbine
  - Auxiliaries

INDICATORS AND DEGRADATION CAUSES

What indicators for what degradation ?

- Cooling system
  - Fouling – spraying efficiency
    - Circulating water circuit – condenser – cooling tower pressure losses
    - Cooling tower approach to the ambient air temperature ← Unit 2: 0.1% net efficiency (LHV) at base load
    - Corrected condenser vacuum ← Unit 2: 0.4% net efficiency (LHV) at base load
  - Air ingress
    - Condenser subcooling
    - Corrected condenser vacuum
    - O_2 measurement at the extraction
    - Steam ejector efficiency
  - Other possible degradations
    - Decrease of the circulating water flow (degraded circulating water pumps performance, increased circulating water circuit pressure losses)
    - Degradation of the LP bloc rotor/stator clearances
    - LP bloc blades and vanes erosion

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

- **What indicators for what degradation ?**
  - Feedwater heaters
    - Fouling
      - Feedwater heater train pressure loss
      - Feedwater heater train efficiency (level, TTD, DCA)
    - Leaks
      - Feedwater heater drain valve positions ← Unit 2: 0.4% net efficiency (LHV) at base load
      - Feedwater heater train efficiency (bypass passing)
    - Other possible degradation
      - Increased pressure losses at the steam extractions

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

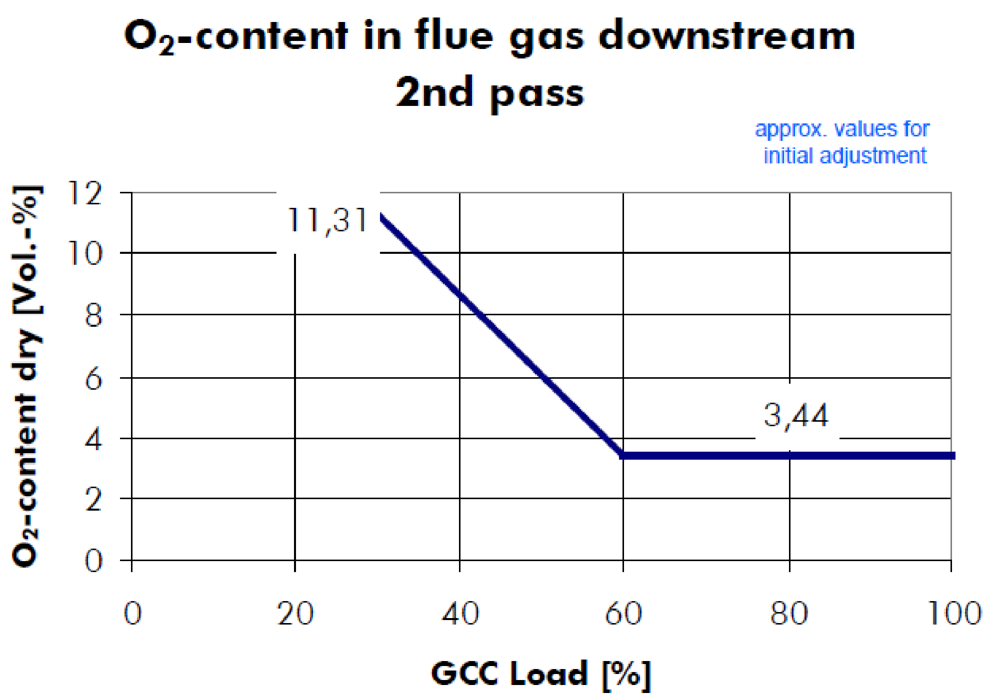
INDICATORS AND DEGRADATION CAUSES

- **What indicators for what degradation ?**
  - Boiler – combustion
    - Coal grinding capacity
      - Grinded coal particles size
    - Abnormal air excess
      - Air excess
      - Manual control
      - Measurement quality

INDICATORS AND DEGRADATION CAUSES

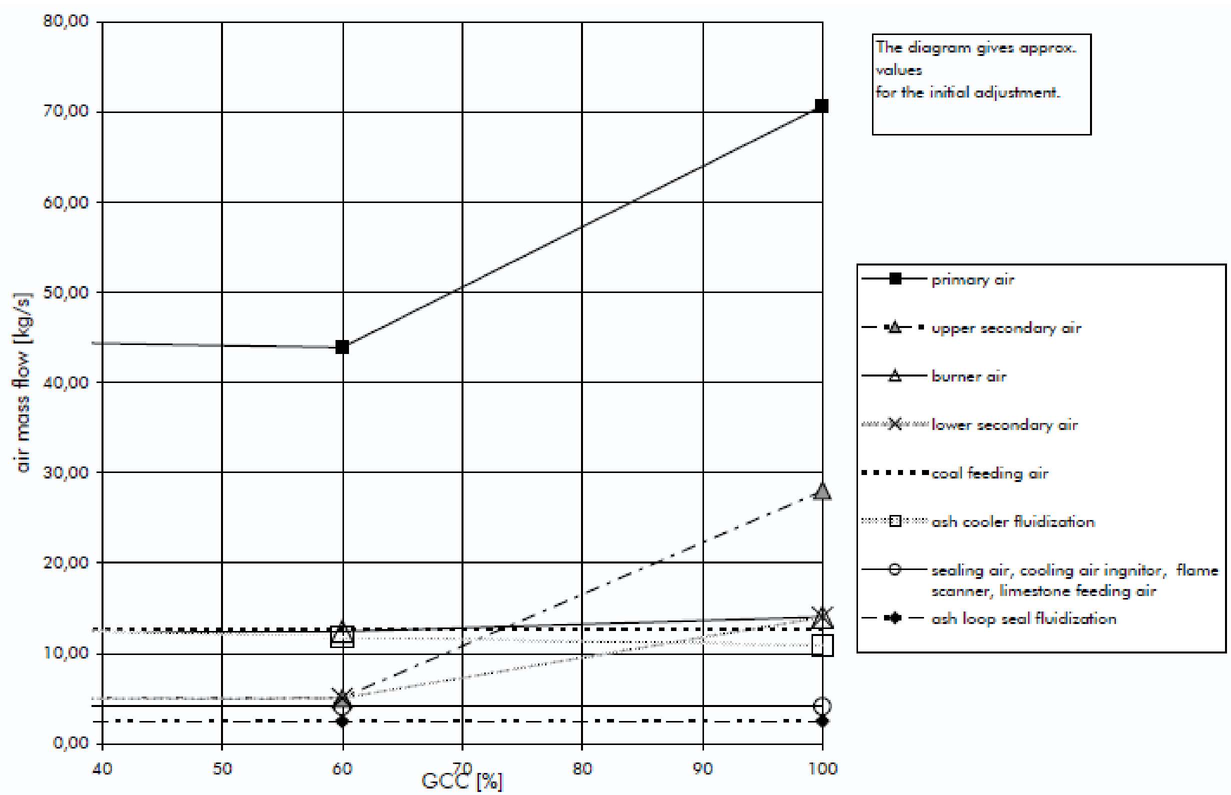
What indicators for what degradation ?

- Boiler – combustion
  - Coal grinding capacity
    - Grinded coal particles size
  - Abnormal air excess
    - Air excess
    - Manual control
    - Measurement quality



INDICATORS AND DEGRADATION CAUSES

- **What indicators for what degradation ?**
  - Boiler – combustion
    - Air management
      - Primary to secondary air flow ratio control
      - Other air controls
      - Manual control
      - Measurement quality



INDICATORS AND DEGRADATION CAUSES

What indicators for what degradation ?

- Boiler – combustion
  - Coal grinding capacity
    - Grinded coal particles size
  - Abnormal air excess
    - Air excess
    - Manual control
    - Measurement quality
  - Air management
    - Primary to secondary air flow ratio control
    - Other air controls
    - Manual control
    - Measurement quality

Unit 2: 3.6% net efficiency (LHV) at base load

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

What indicators for what degradation ?

- Boiler – air/fumes
  - Fouling
    - Pressure losses when available (air heater)
    - Fans consumption
    - Air heater efficiency ← Unit 2: 4.2% net efficiency (LHV) at base load
    - Economizer, waterwalls and superheaters efficiency
  - Leaks
    - Fans consumption
    - O_2 discrepancy between the economizer outlet and stack measurements
    - O_2 discrepancy between the economizer outlet and the rotary air heaters outlet (measurement campaign) (PTC 4.3) ← Unit 2: 0.6% net efficiency (LHV) at base load

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

What indicators for what degradation ?

- Boiler – water/steam
  - Fouling
    - Pressure losses ← Unit 2: 0.2% net efficiency (LHV) at base load
    - Economizer, waterwalls and superheaters efficiency ← Unit 2: 2.4% net efficiency (LHV) at base load
  - Leaks
    - Blowdown
    - Flow discrepancy between feedwater and steam
    - Demineralized water consumption
  - Abnormal desuperheating
    - Temperature discrepancy between setpoint and measurement
    - Temperature discrepancy between several measurements
  - Fine diagnosis: performance test (EN 12952-15 / PTC 4)

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

What indicators for what degradation ?

- Steam turbine
  - Steam passing or leaks
    - Pressure discrepancy between expected and measured values ← Unit 2: 0.1% net efficiency (LHV) at base load
    - Seal system steam consumption: load at which the seal steam collector supply valve closes + gland steam condenser heat duty
    - Drains: thermography downstream to-be-kept-closed drains
  - Blading and clearances degradation
    - Steam turbine efficiency ← Unit 2: 1.6% net efficiency (LHV) at base load
  - Fine diagnosis: performance test (EN 60953-1 / PTC 6)

All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

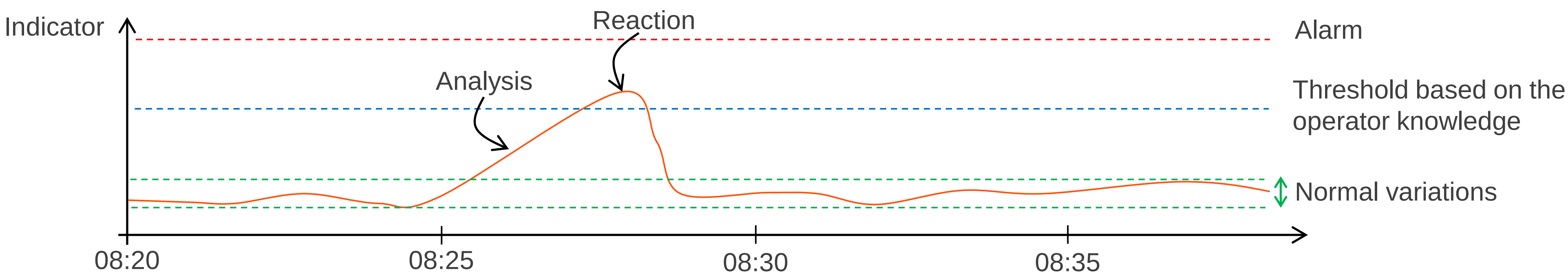
What indicators for what degradation ?

- Auxiliaries
  - Auxiliaries electric over-consumption
    - Consumption discrepancy between expected and measured values
    - Auxiliaries configuration in operation ← Unit 2: 0.4% net efficiency (LHV) at base load due to steam air heating
    - Auxiliaries efficiency ← Unit 2: 0.2% net efficiency (LHV) at base load
      - Degradation of the rotor/stator clearances
      - Internal parts erosion (cavitation, poor chemistry quality, foreign object damage)
      - Non-return valve passing
  - Auxiliary steam over-consumption
    - Direct measurement ← Unit 2: 0.2% net efficiency (LHV) at base load
    - Demineralized water consumption

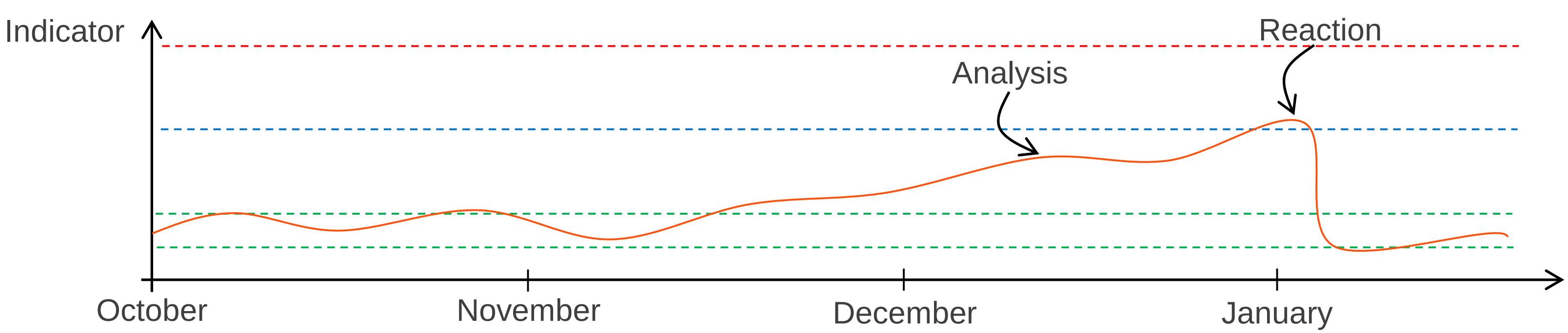
All performance comparisons are made between March 29th 2017 and 2006's performance tests.

INDICATORS AND DEGRADATION CAUSES

- **All these indicators must be monitored:**
  - Daily to spot as early as possible a failure

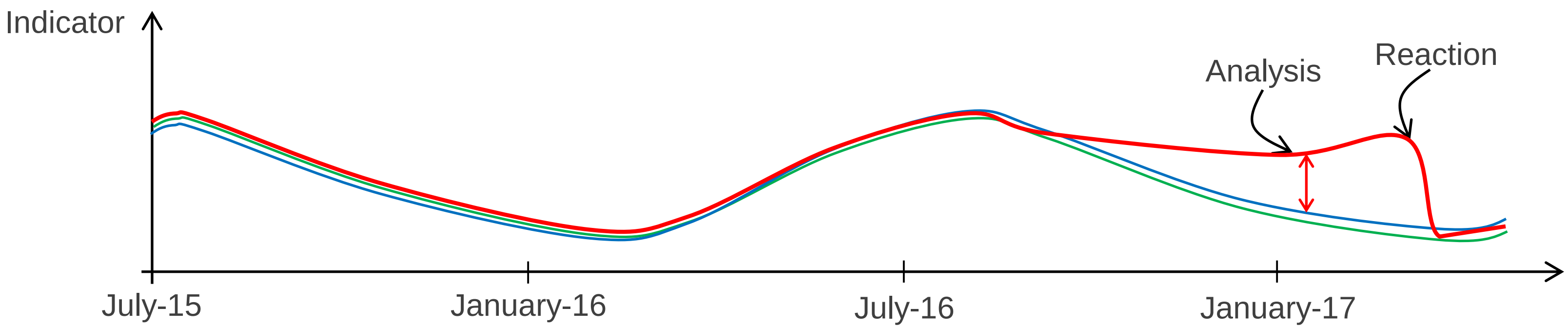


  - Monthly and yearly to notice long-term degradations



INDICATORS AND DEGRADATION CAUSES

- **All these indicators must be monitored:**
  - Daily to spot as early as possible a failure
  - Monthly and yearly to notice long-term degradation
  - By comparing identical units regularly to identify abnormal behaviors



Gap based on the operator knowledge

Fundamental parameters

1 Parameters for performance
2 Impact of the performance parameters
3 Indicators and degradation causes
4 Performing an efficiency audit

4.

- Necessary steps
- Special studies
- Thermoflow screenshots for Çan units

PERFORMING AN EFFICIENCY AUDIT

What necessary steps?

- Prerequisites
  - Data available in a historian
  - Good accuracy of the stored data
  - Sufficient process data: the more process data (flow rates, pressures, temperatures, power output or consumptions, levels…) the better

- Optional
  - Available complete reference data (design datasheets or performance reports)
  - If unavailable, a past period can be used for relative comparisons

- Data processing
  - Create all performance indicators thanks to the measured and reference data
  - Monitor the trends in the short and long terms
  - Quantify the performance losses thanks to the observed deviations
  - Plan the maintenance accordingly when most suitable

PERFORMING AN EFFICIENCY AUDIT

Special studies

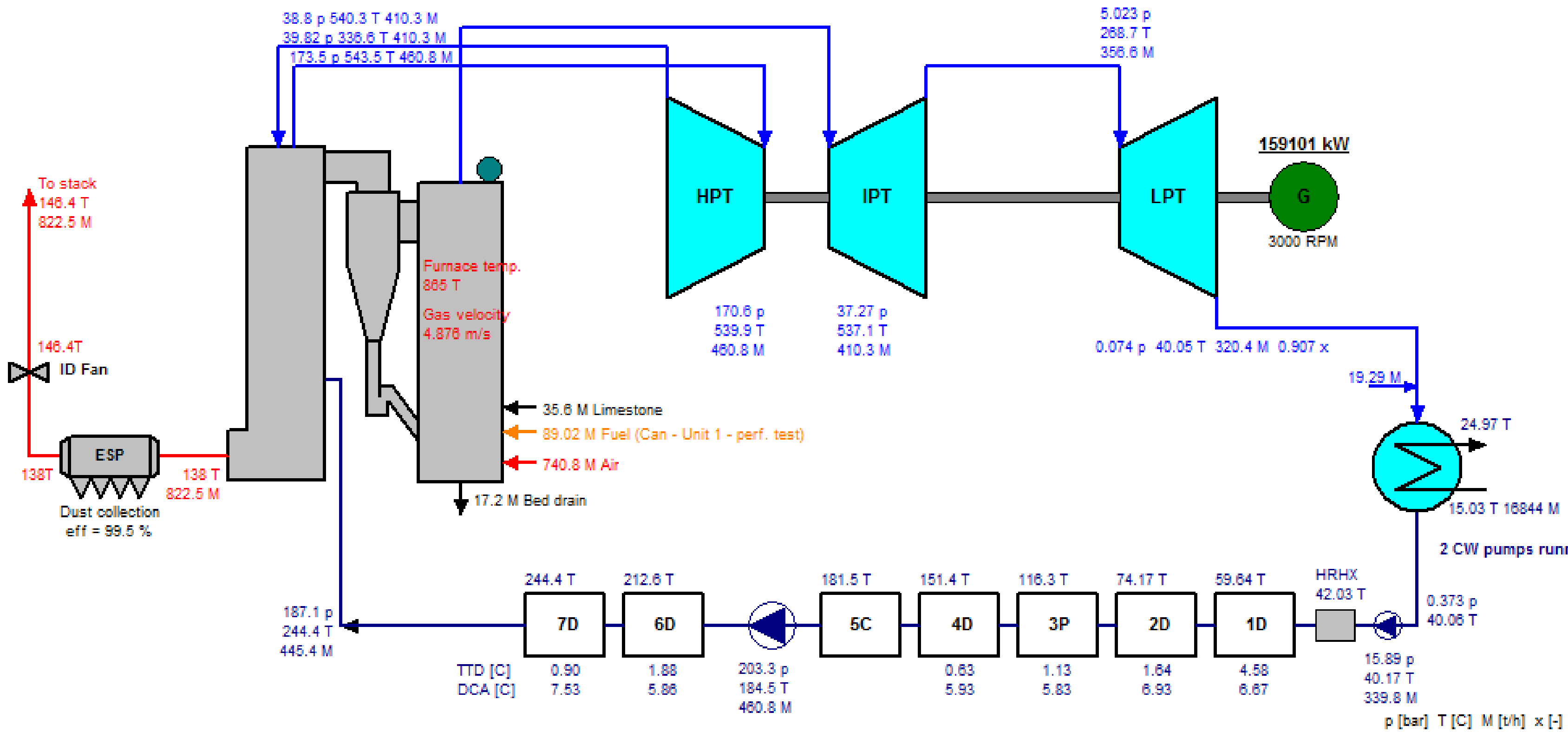
- Special studies can be needed when
  - The gain after an overhaul must be assessed
  - The analysis of an abnormal event is not straightforward
    - Cooling tower design review
      - Is the cooling tower really undersized in summer?
      - What is the wind effect on the natural draft?
      - How to improve the design?
    - Soot blowing optimization
      - Is the current soot blowing frequency optimized?
      - What is to be optimized? Heat rate? Metal temperatures?
- Tools
  - Available performance indicators
  - Thermodynamical performance model (which is what EDF used for EUAŞ)

PERFORMING AN EFFICIENCY AUDIT

Special studies

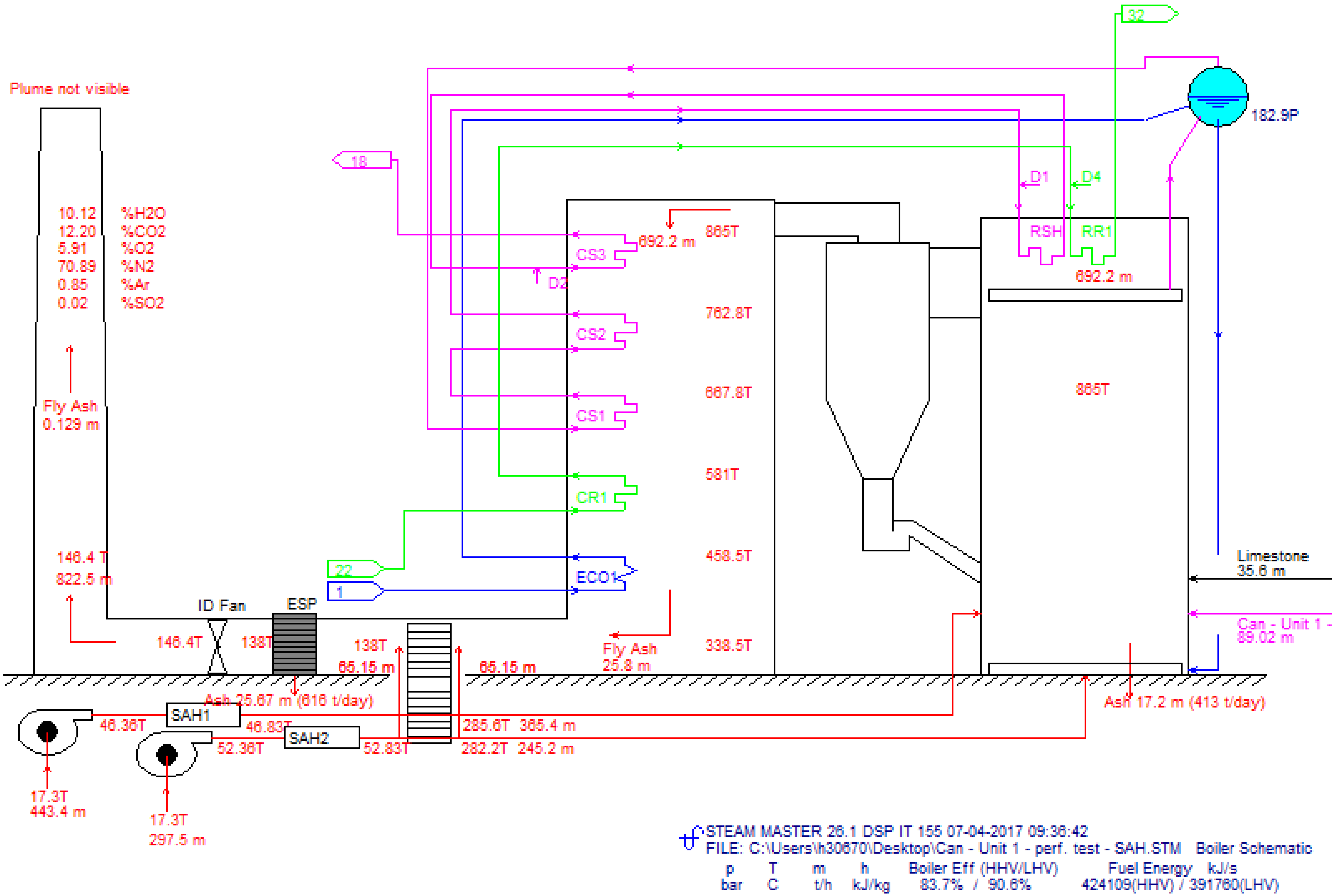
Plant gross power	159101	kW
Plant net power	145227	kW
Number of units	1	
Plant net HR (HHV)	10513	kJ/kWh
Plant net HR (LHV)	9711	kJ/kWh
Plant net eff (HHV)	34.24	%
Plant net eff (LHV)	37.07	%
Aux. & losses	13874	kW
Fuel heat input (HHV)	1526.7	GJ/h
Fuel heat input (LHV)	1410.3	GJ/h
Fuel flow	2136	t/day

Ambient
0.992 p
17.3 T
38.26% RH
9.975 T wet bulb



PERFORMING AN EFFICIENCY AUDIT

Special studies



HX	Tin	Tout	M
ECO1	244.3	289.6	445.3
CS1	358.3	369.1	445.3
CS2	369.1	394.5	445.3
RSH	389.5	490	452.7
CS3	478.1	543.5	460.8
CR1	336.6	441.6	410.3
RR1	441.5	540.3	410.3

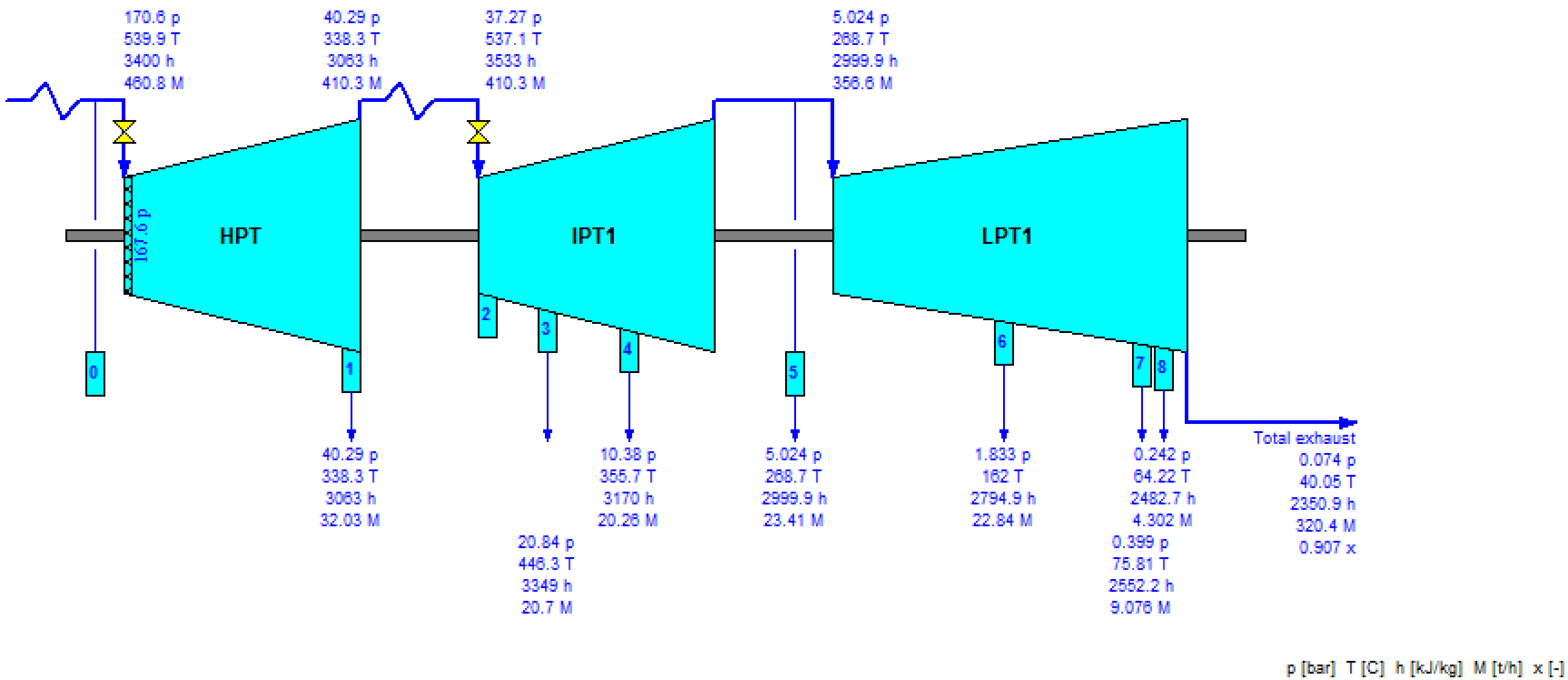
DESUP	m	h
D1	7.4	1060
D2	8.1	1060
D4	0.0	793

FUEL	WEIGHT%	
C	%	41.6
H	%	6
O	%	31.69
N	%	0.85
S	%	3.7
ASH %		16.15

PERFORMING AN EFFICIENCY AUDIT

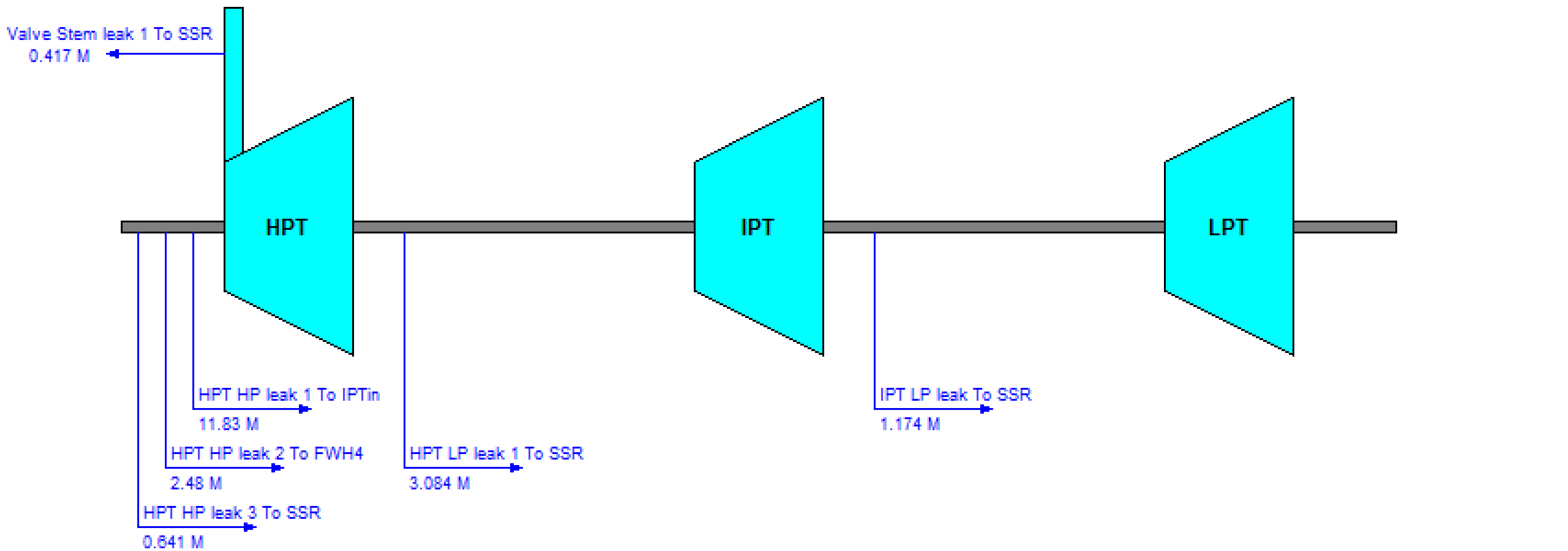
Special studies

Expansion power	161620	kW
Mechanical loss	404.1	kW
Generator loss	2117	kW
Generator power	159099	kW



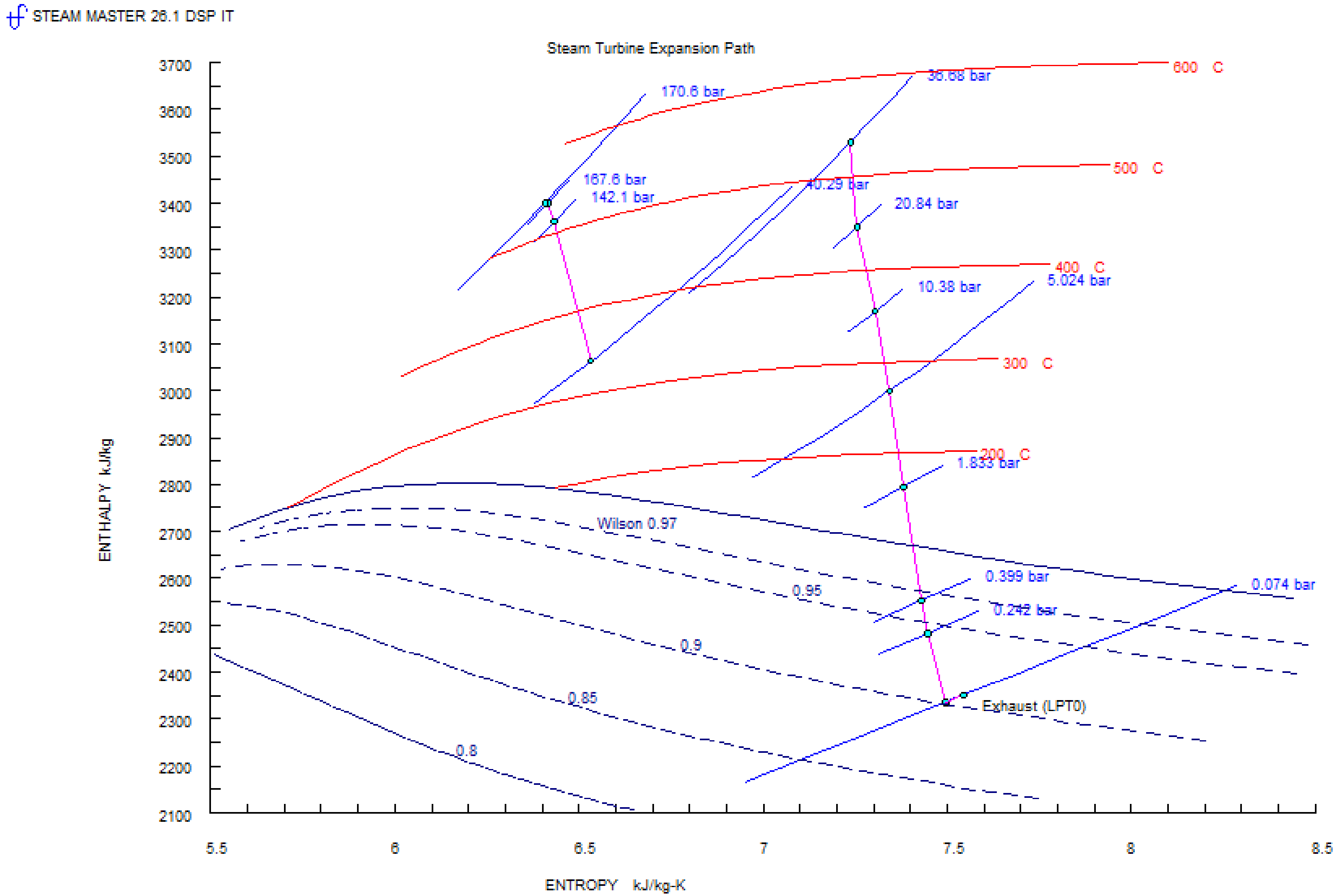
PERFORMING AN EFFICIENCY AUDIT

Special studies



PERFORMING AN EFFICIENCY AUDIT

Special studies



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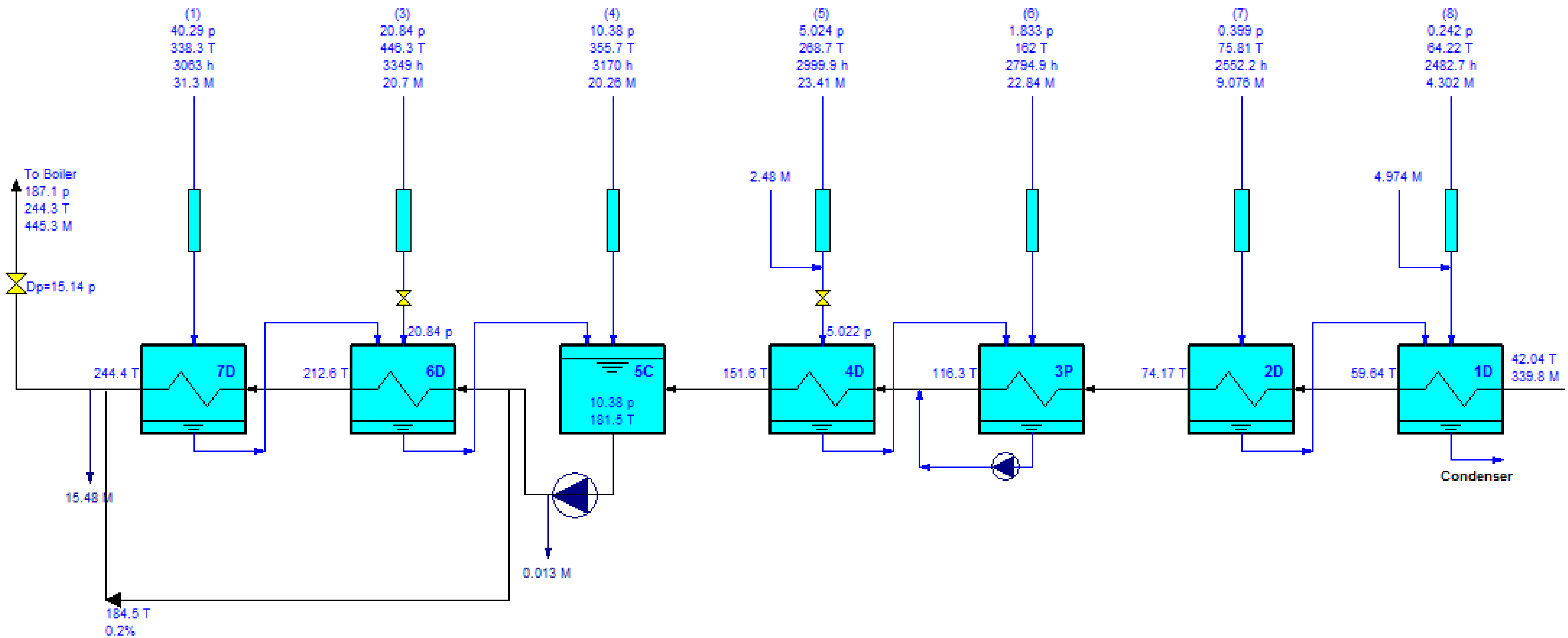
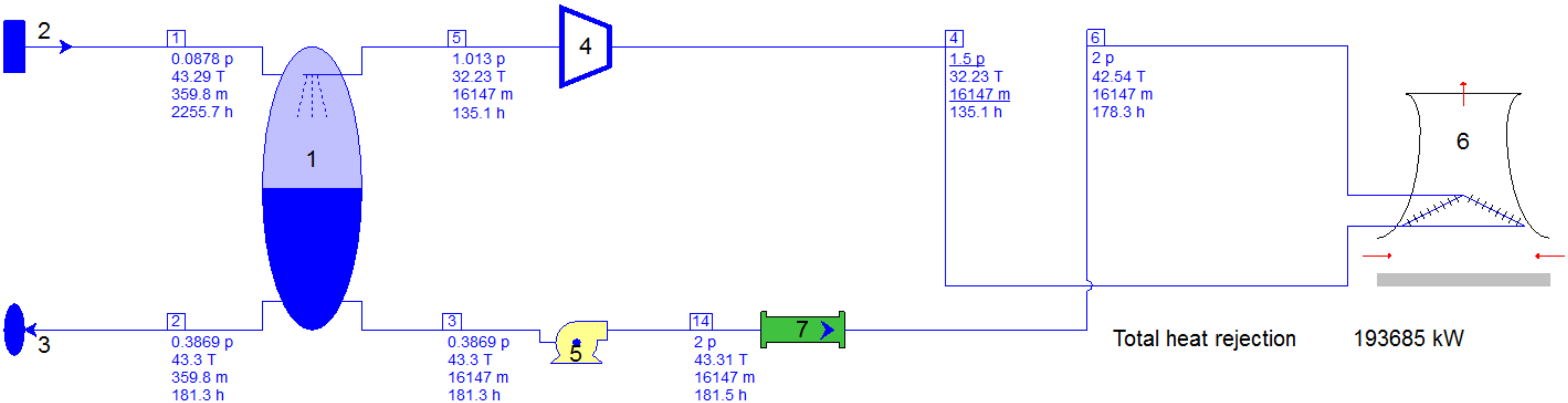
Special studies



PERFORMING AN EFFICIENCY AUDIT

Special studies



SESSION MESSAGES

- **Session objective: ensure that Çan units thermodynamical performance are optimized.**
  - Parameters to monitor for an “at-once” performance assessment exist… but it is not enough.
  - Heat rate monitoring has to be performed every day, month, year…
  - Thermodynamical models and data of good quality are essential for efficiency audits.

THANK YOU