Environmental Friendly Technologies and Measures
in the Energy Supply Sector

Technology for Enhancing Efficiency of Thermal Power Plant (Assessment of Equipment)

KOIZUMI Nobuchika

J-POWER

CONTENTS

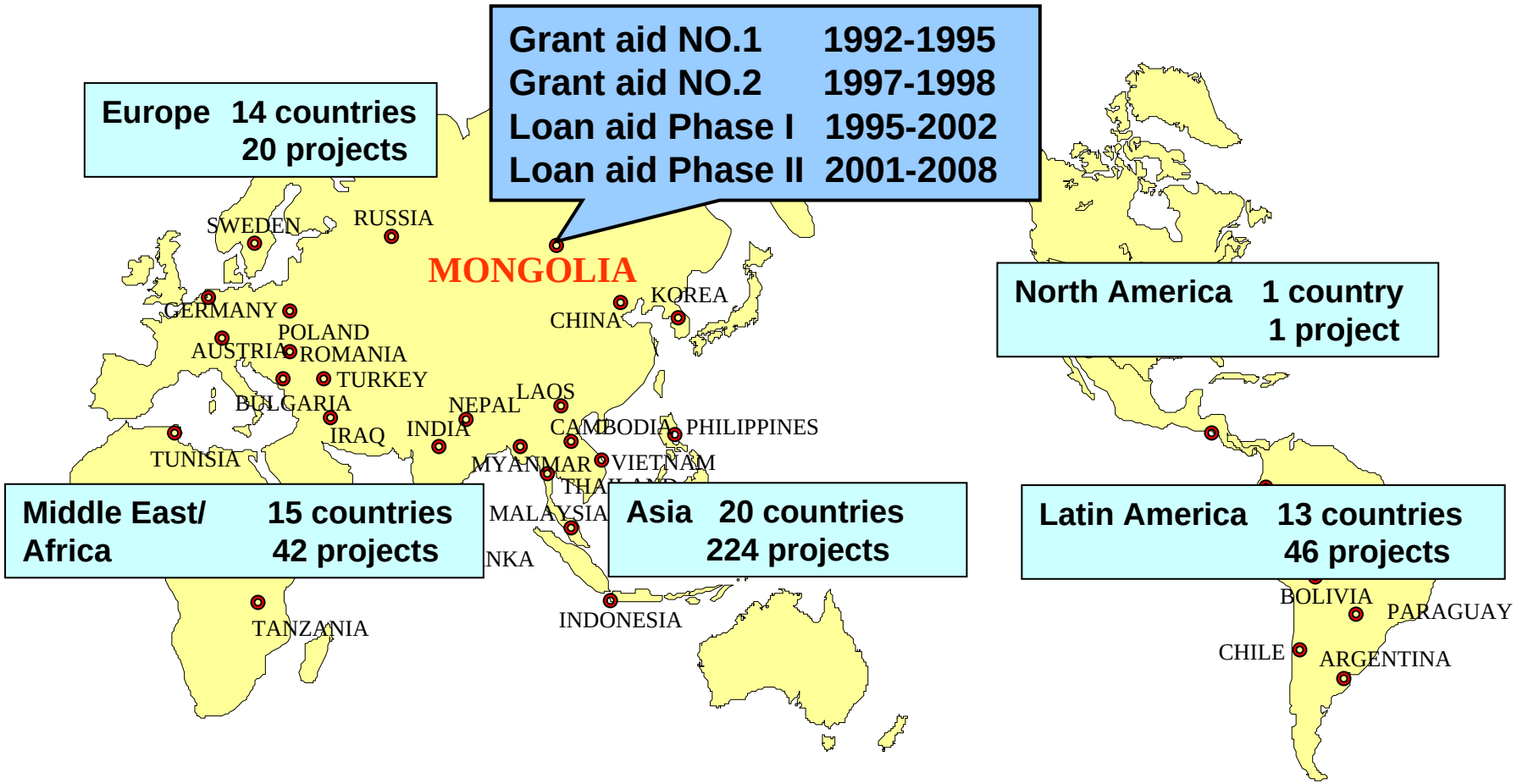
1.What is J-Power?

- Electric Power Development Company, Ltd.
- The largest wholesale electric power company
- Initially founded by the Japanese Government in 1952 and fully privatized in 2004
- Capacity

Coal:	8,412 MW (15 units)
Geo-thermal:	15 MW (1 unit)
Hydro:	8,566 MW (110 units)
Wind power:	353 MW (18 stations)

- Global power business
  - ✓ Consulting service: 333 projects in 63 countries
  - ✓ IPP: 3,700MW(share eq.) by 29 projects in 7 countries

International Consulting Service



333 projects in 63 countries (as of March 2012)

2.Assessment of Pump

Performance measuring technology using Yates meter by Torishima

Comparison of Measurement

	Efficiency	Head	Power	Flow
Conventional	?	○	○	○
Yates meter	○	○	○	?

Note :Assessment can not be done without design data.

Yates Meter Theory (1/2)

Work Input (*Win*)
= Work output (*Wout*)+ Losses

Pump efficiency : *E* = *Wout* / *Win*

In pump, losses are heat energy to increase fluid temperature.

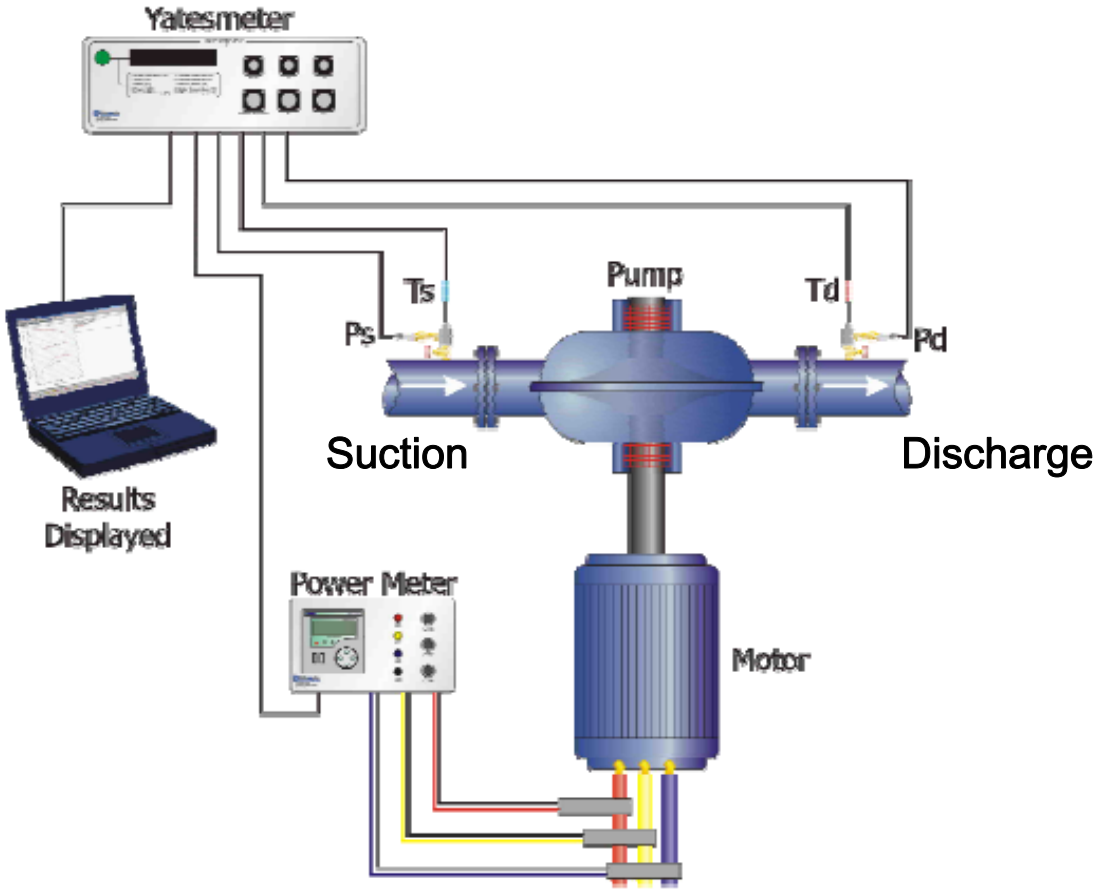
Yates Meter Theory (2/2)

$$Wout = gQH \qquad Losses = \Delta TQC_p$$

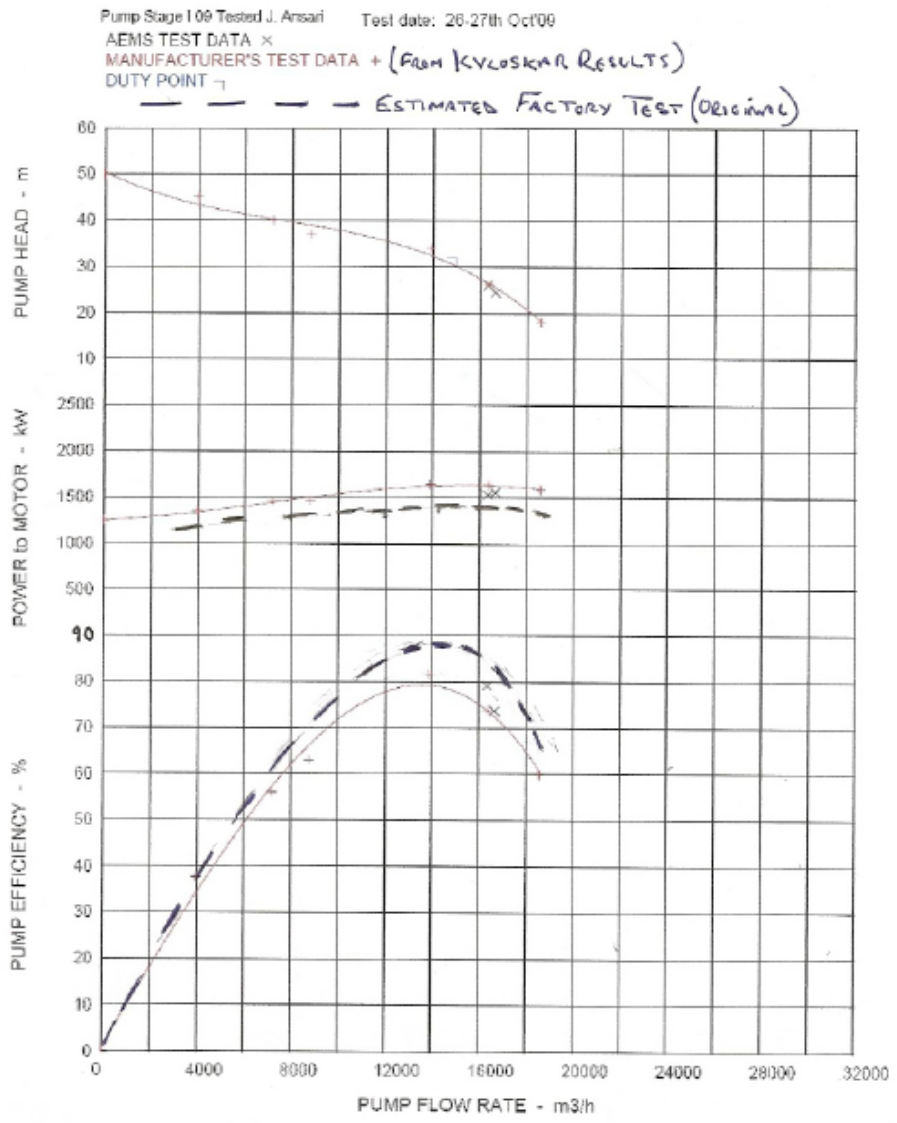
Where,
C_p = Specific heat of fluid H = Total head
Q = Flow ΔT = Temperature difference

$$E = \frac{Wout}{Wout + Losses} = \frac{1}{1 + \Delta TCp / gH}$$

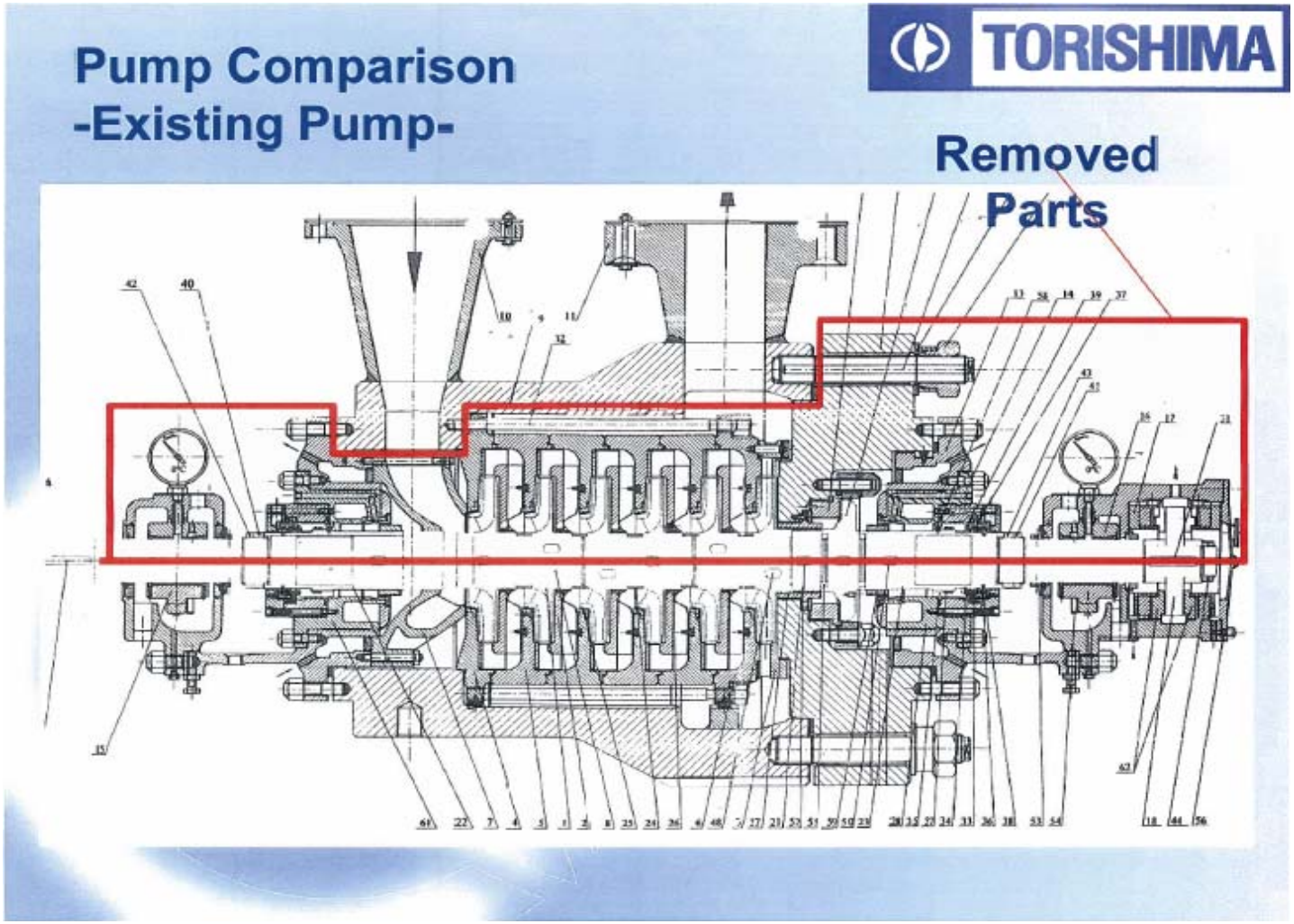
Measuring System



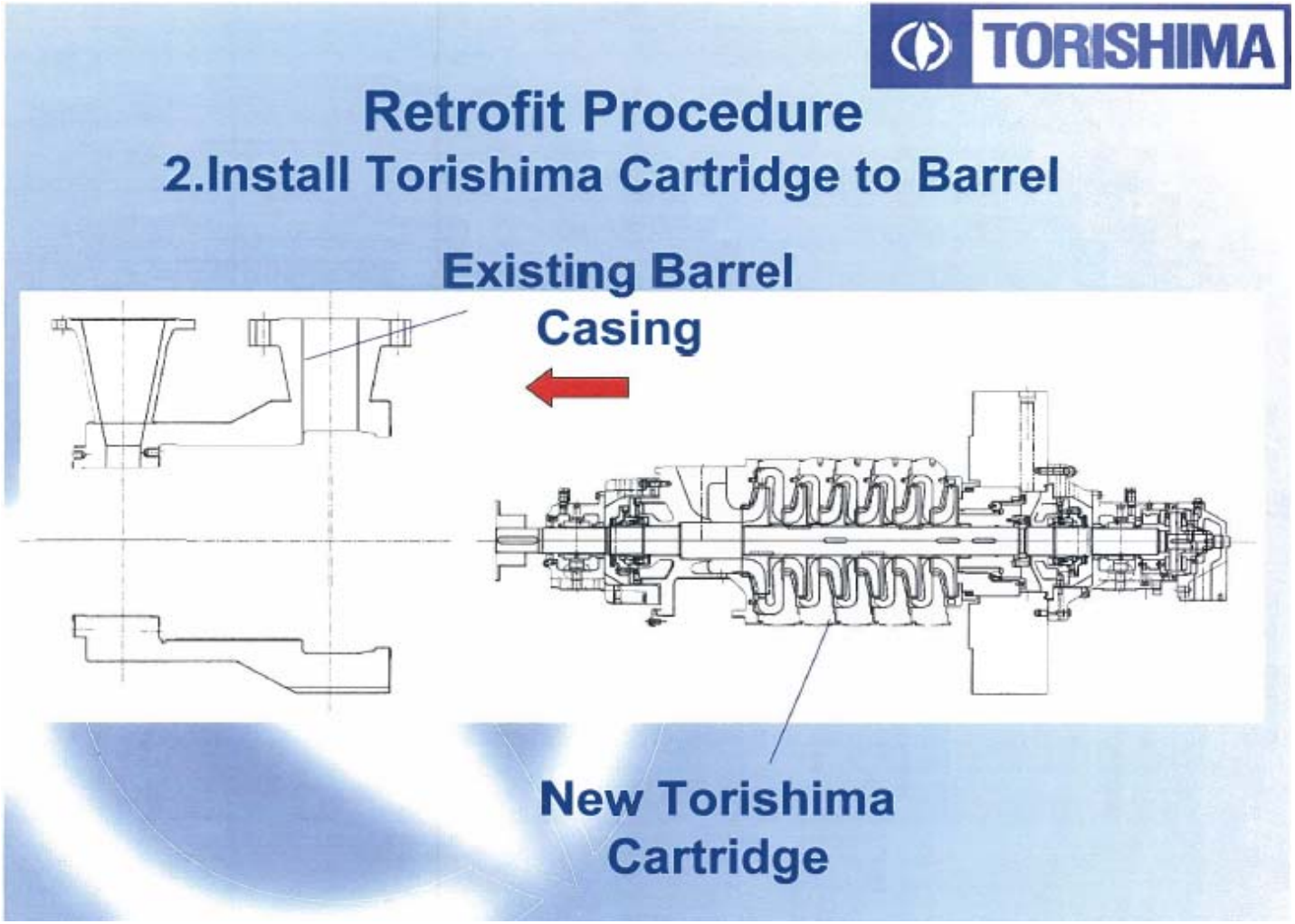
Result


Pump Stage I 09 Tested J. Ansari
Test date: 26-27th Oct'09
AEMS TEST DATA ×
MANUFACTURER'S TEST DATA + (FROM KVLOSKAR RESULTS)
DUTY POINT
ESTIMATED FACTORY TEST (ORIGINAL)
PUMP HEAD - m
POWER to MOTOR - kW
PUMP EFFICIENCY - %
PUMP FLOW RATE - m3/h
0
4000
8000
12000
16000
20000
24000
28000
32000

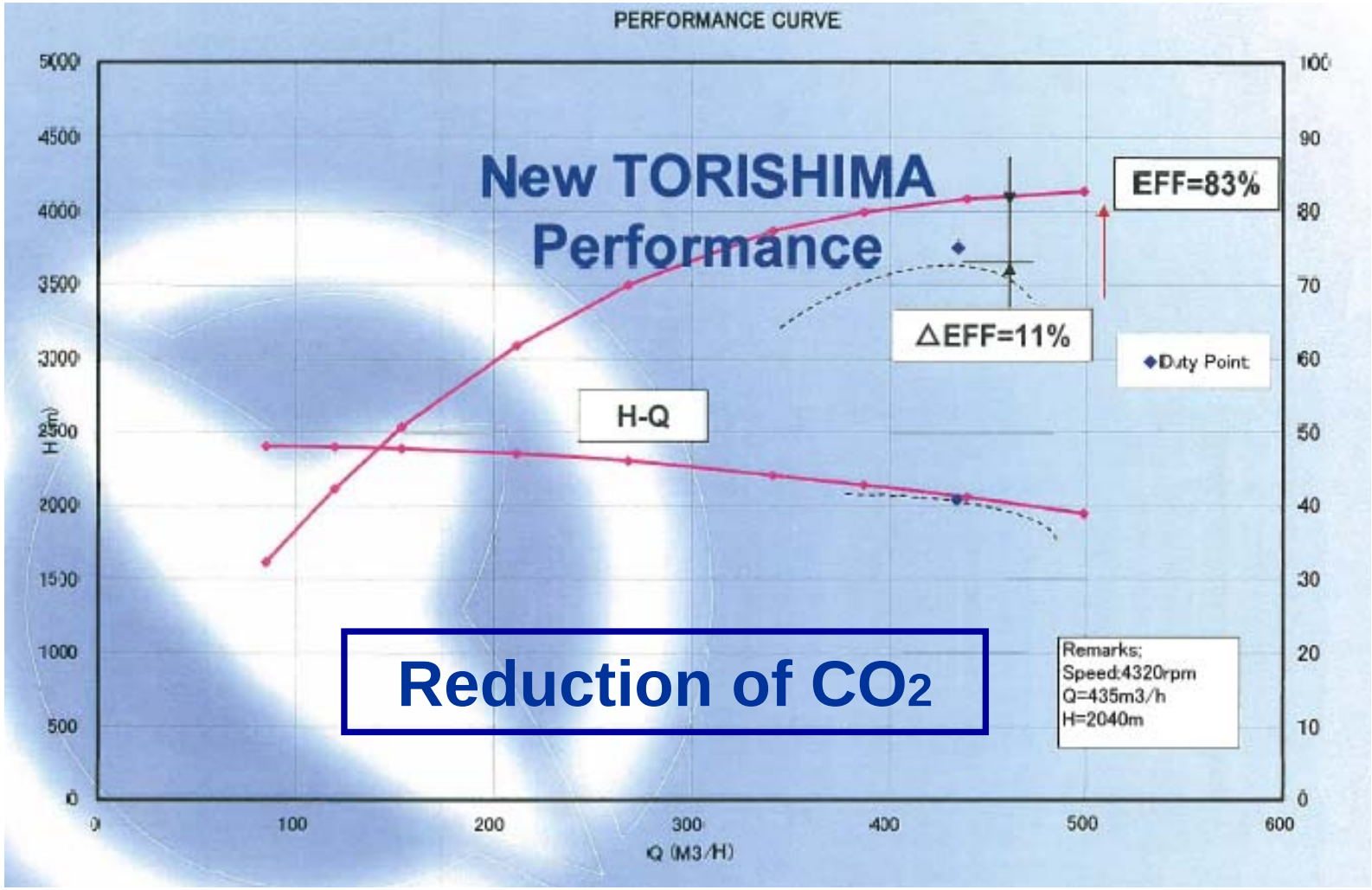
Pump Retrofit (1/3)



Pump Retrofit (2/3)



Pump Retrofit (3/3)



3.Assessment of Condenser

Detection technology of air ingress into condenser by Fuji Electric

Major Reason for Low Vacuum

1) Increase of air ingress

2) Decrease of cleanliness of tubes

3) Decrease of cooling water flow

4) Decrease of performance of ejector

5) Wrong indication of instruments

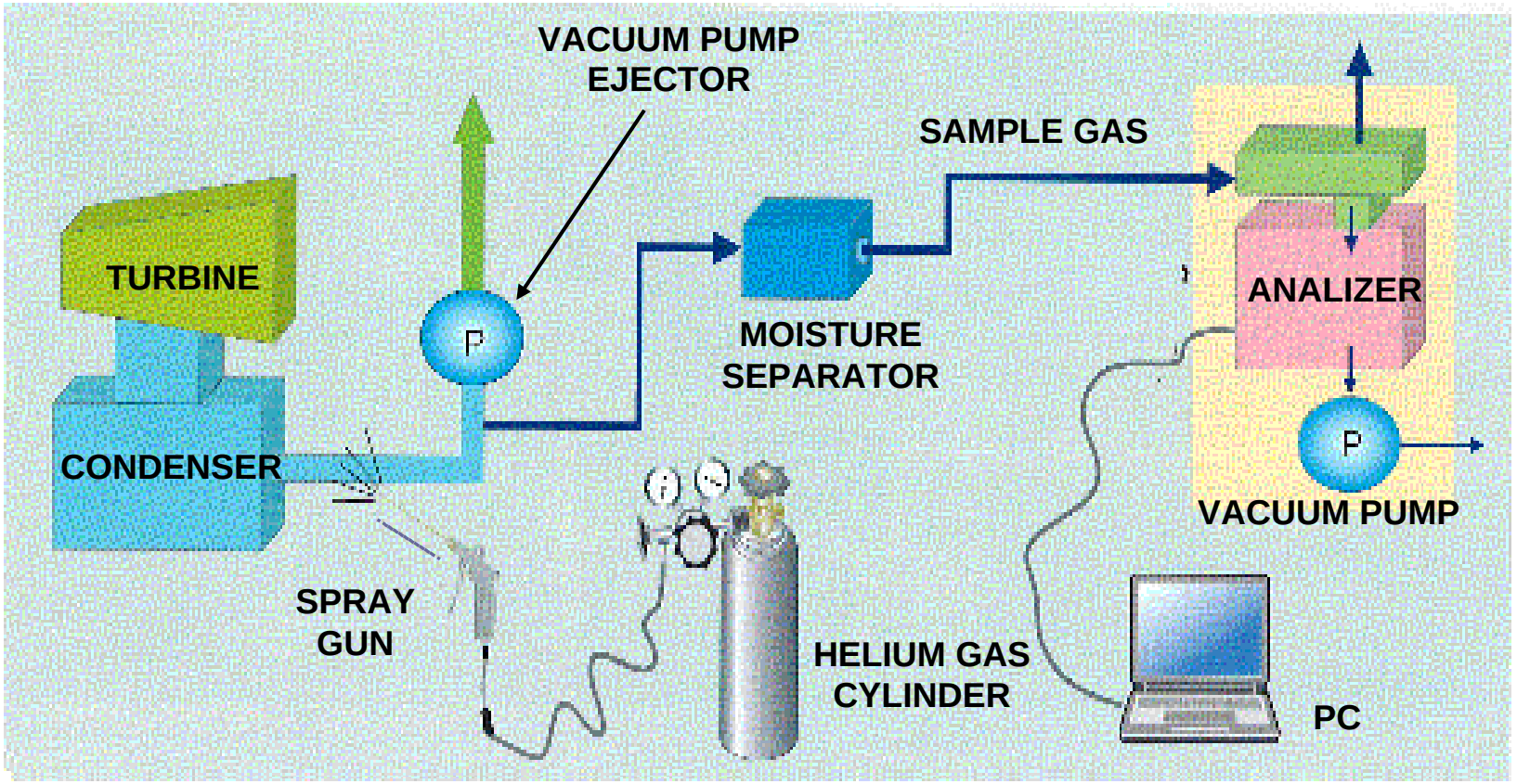
Features

1) Measurement of approx. air ingress volume
2) Measurement during turbine operation
3) Measurement without removal of heat insulation
4) Measurement in 3 to 4 days
5) No major set up of measuring equipment
6) Using Helium gas which gives no impact to equipment

Features Using Helium Gas

1) Chemical symbol : He
2) Specific weight: 0.14 (Air : 1.0)
3) High sensitivity
4) No impact to existing equipment, such as condenser, turbine and piping
5) Non toxic

Measuring System

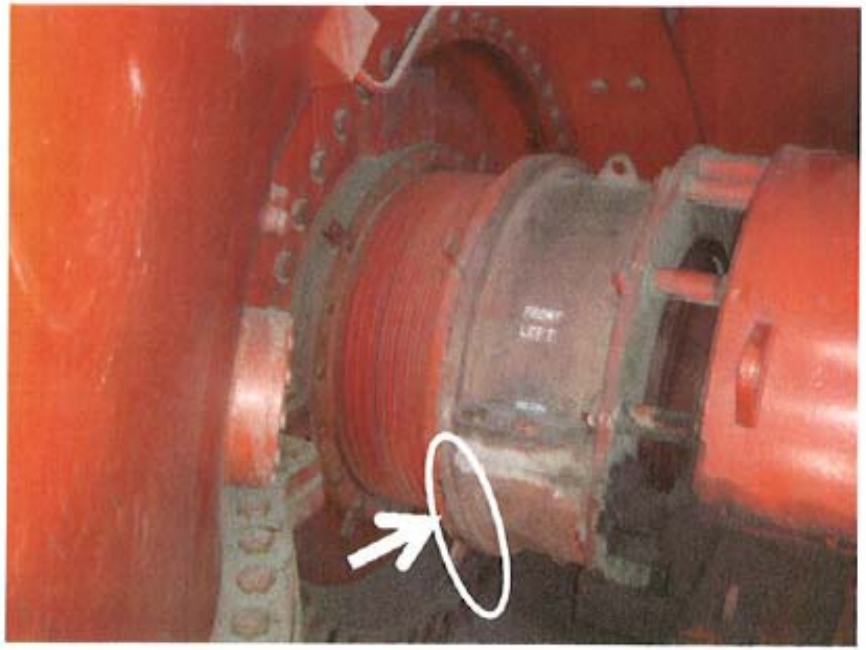


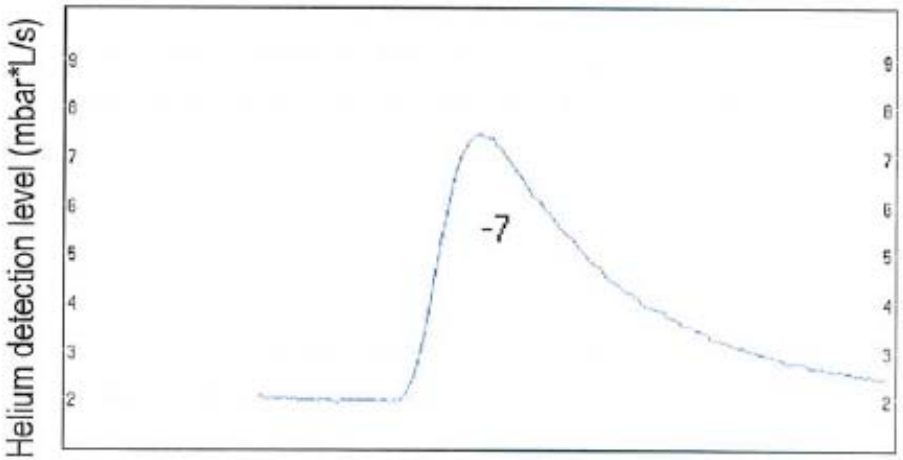
Helium Spraying

Analysis Tool

Example of Measurement Result

LP Turbine Gland





Max. Value	7.46×10^{-7}
Air ingress volume	Approx. 2.2 kg/h

Example of Test Result

No.	Helium test position	Air leak rate [Kg/h]	Detection No.
1	A BFP-T gland sealing portion (Rear)	49.3	Photo No.11
2	B BFP-T gland sealing portion (Rear)	23.5	Photo No.12
3	LP turbine gland sealing portion (Packingland and Bellow flange)	13.3	Photo No.1～5
4	HP Flush tank , Flush box-1 and Drain flush Tank B	12.3	Photo No.6～10
5	Others	14.6	
	Total	**113.0**	

4.Assessment of Turbine

Major Reason for Efficiency Decrease (1/2)

1) Increase of seal clearance

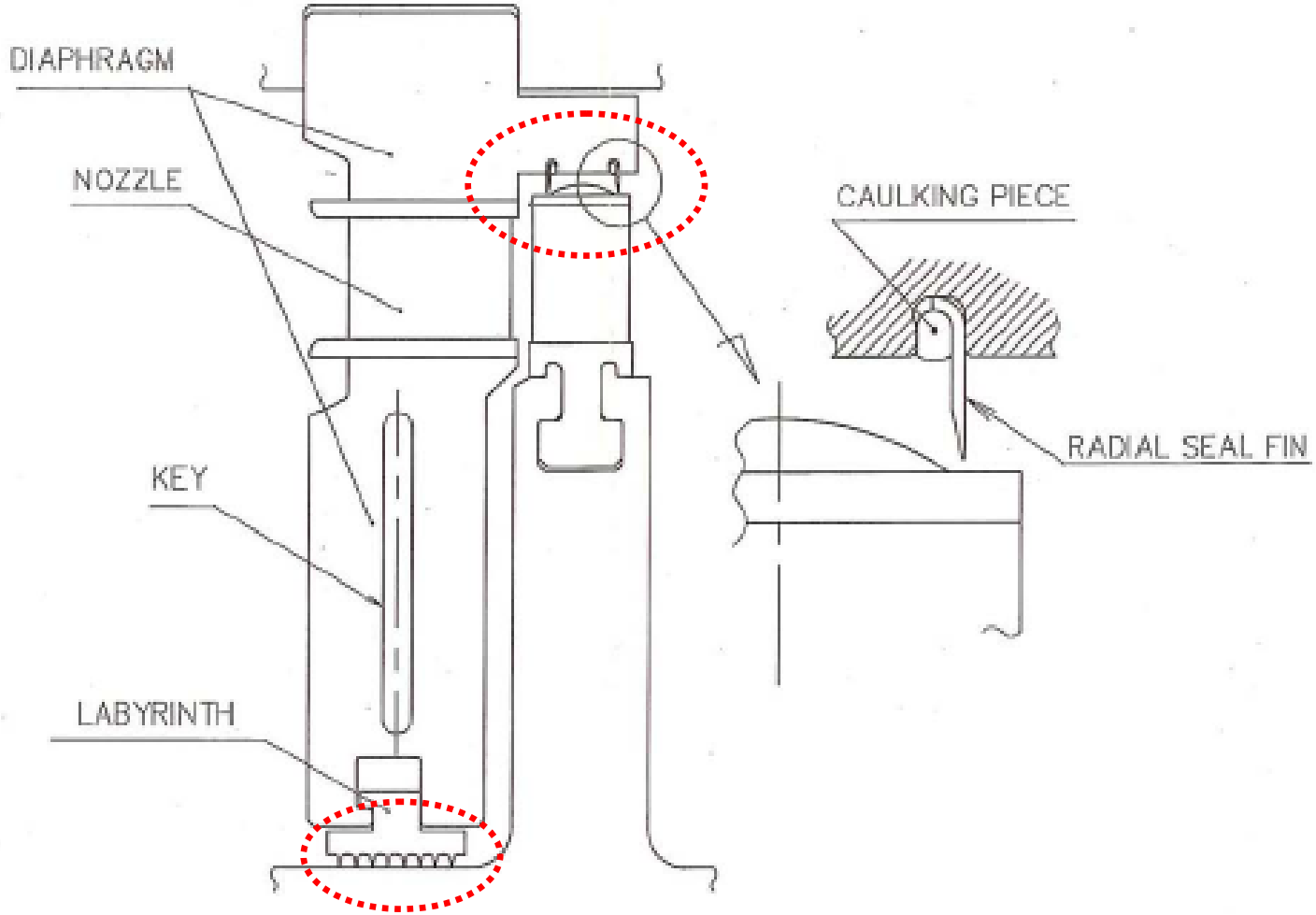
2) Erosion

3) Surface roughness

4) Mechanical damage

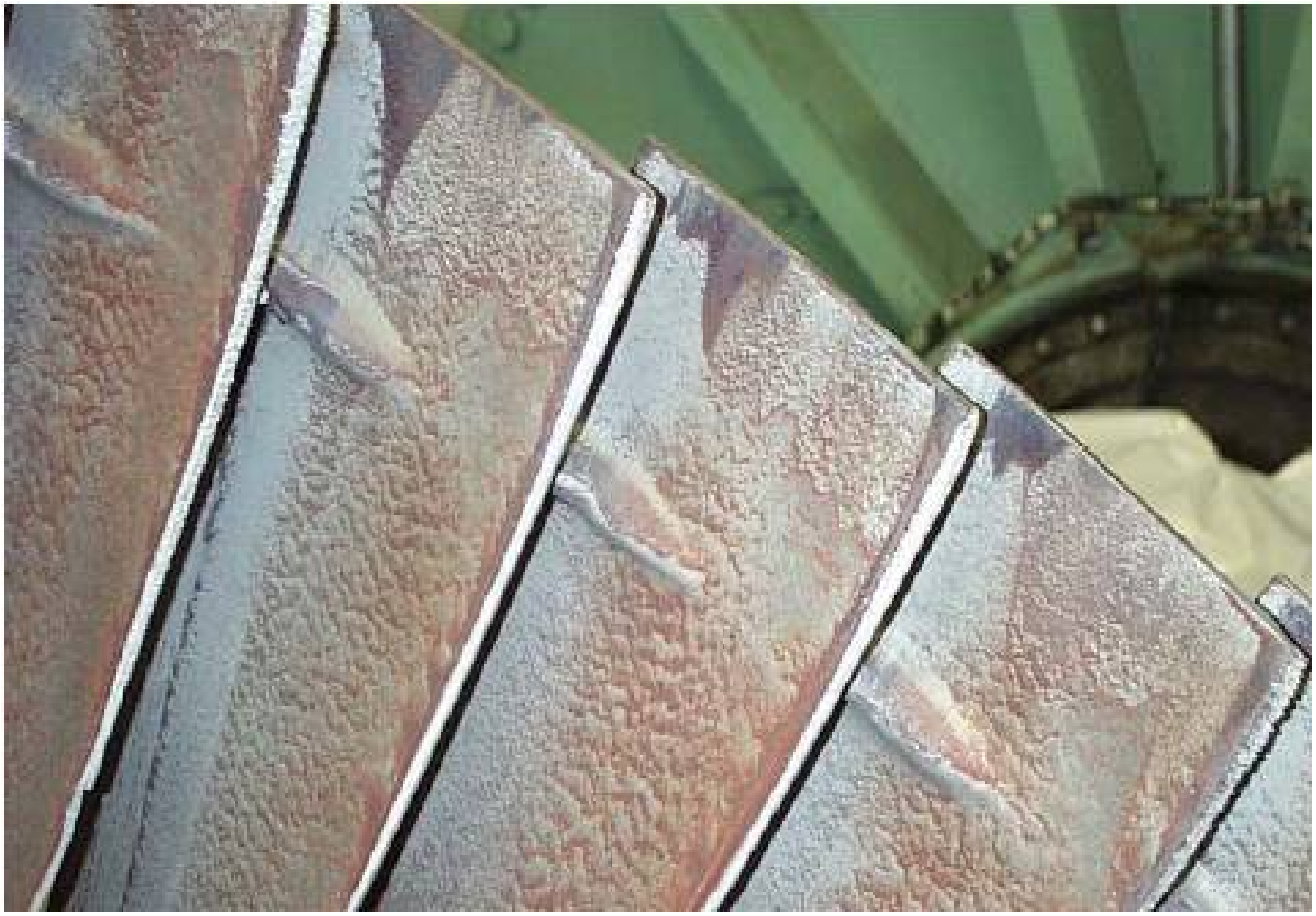
5) Deposit

1）Increase of seal clearance

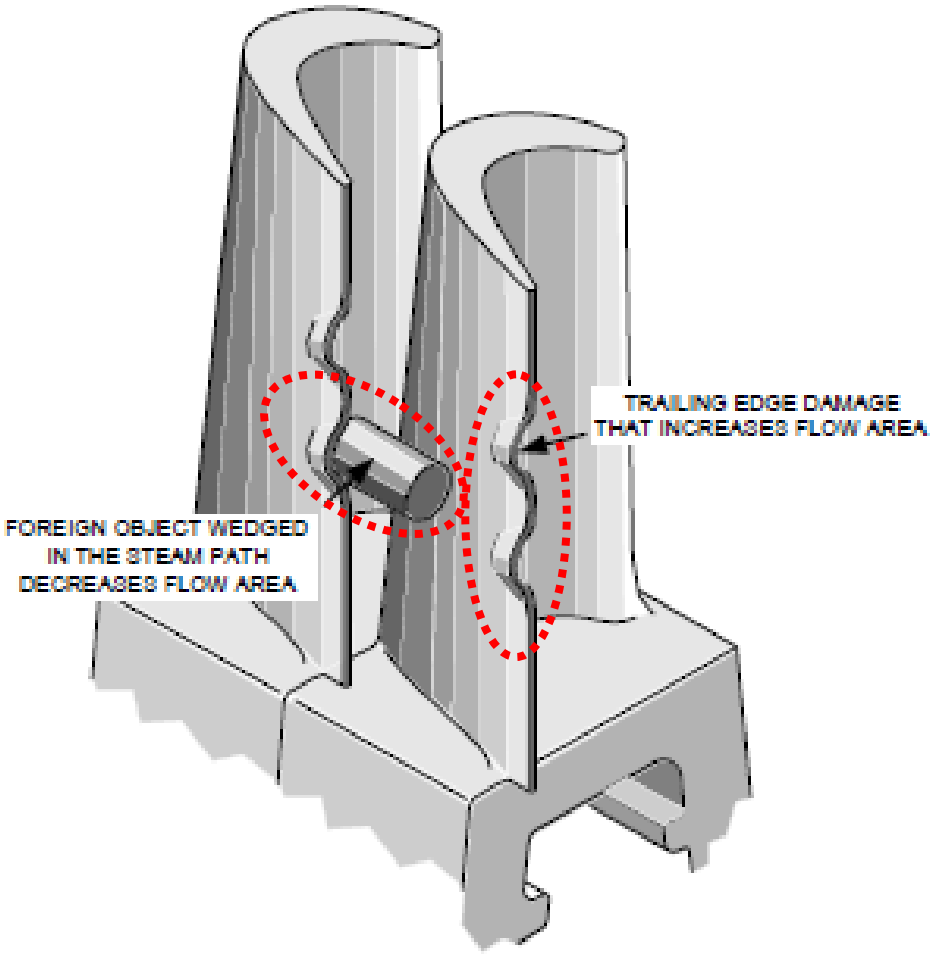


2）Erosion

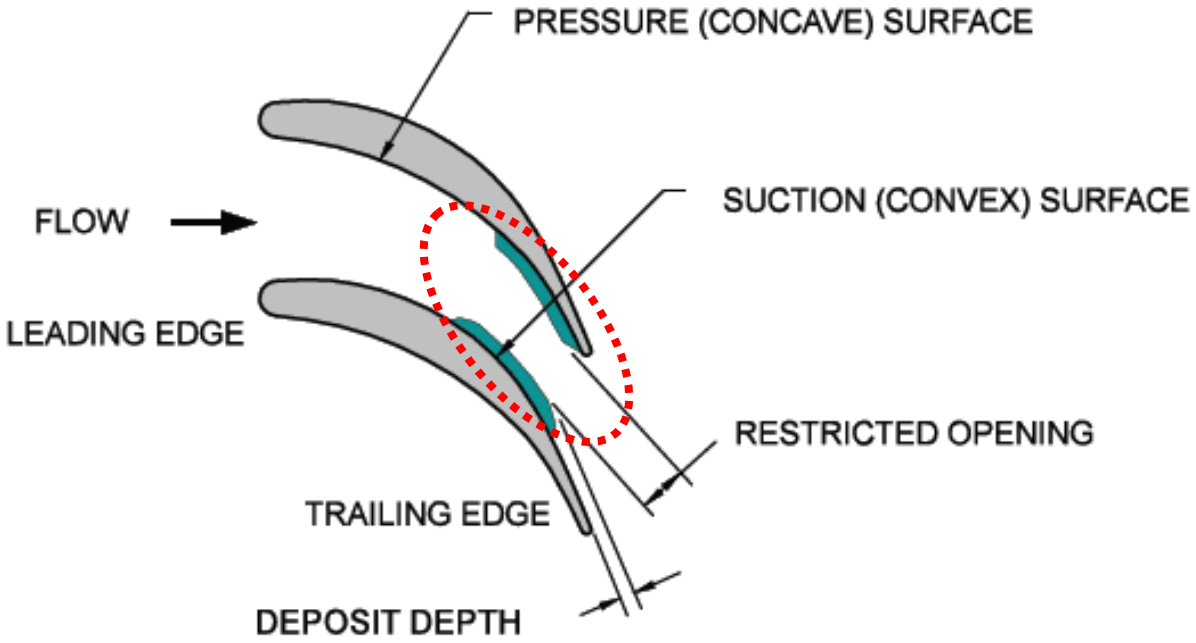
3）Surface Roughness

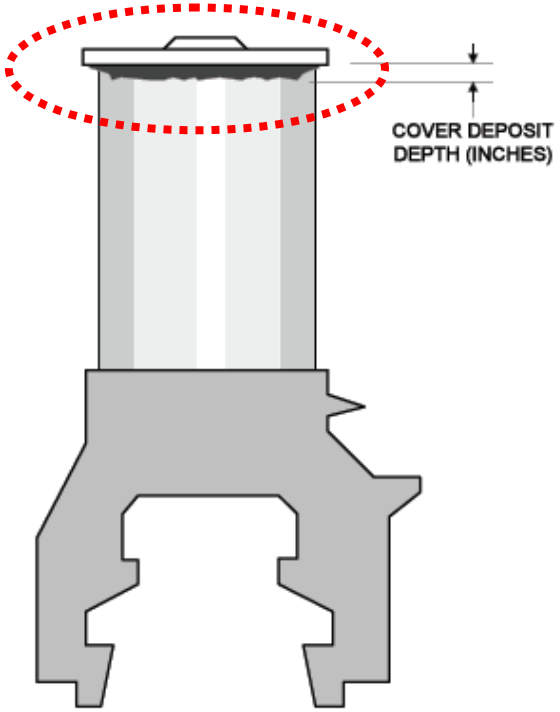


4）Mechanical damage

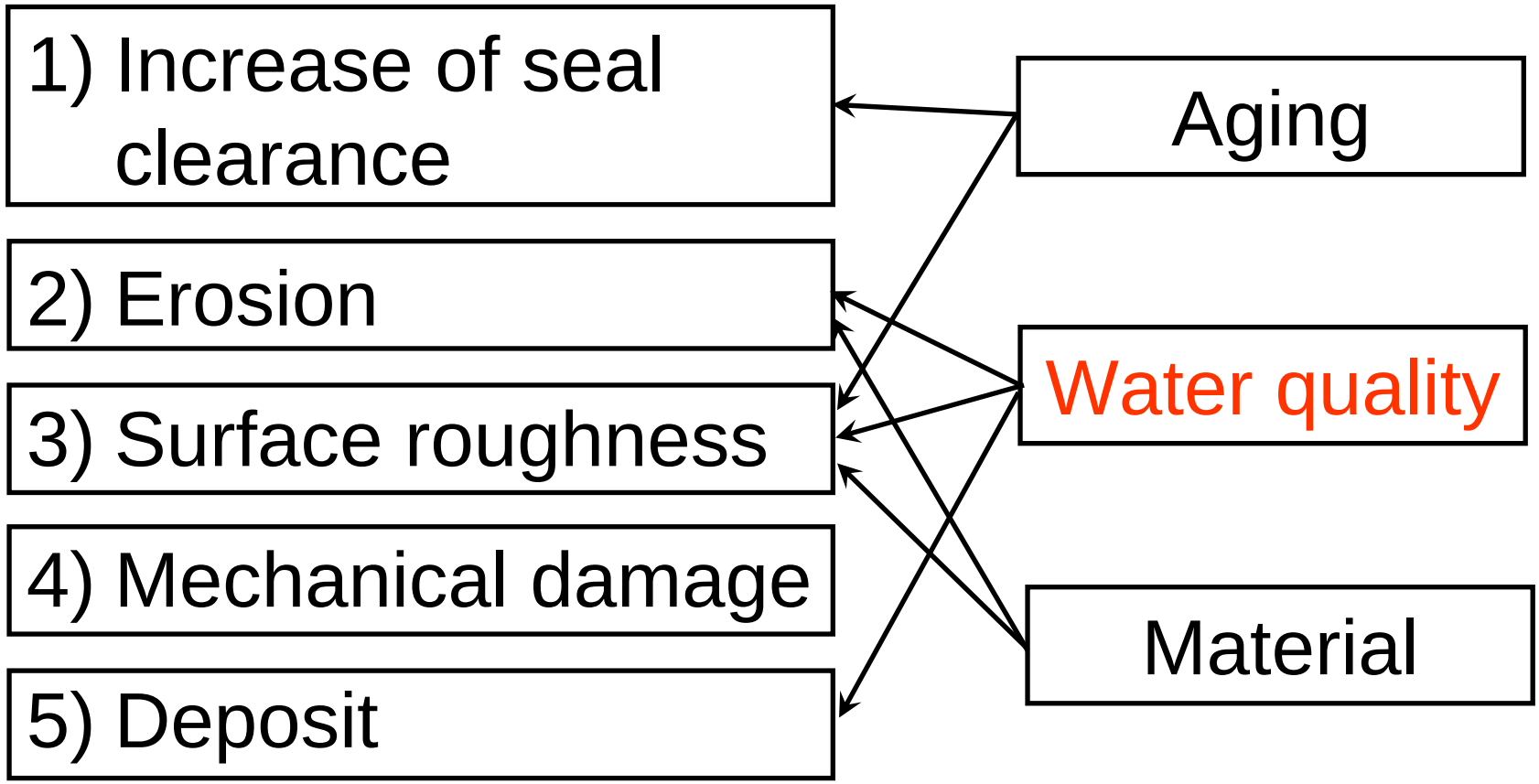


5）Deposit


PRESSURE (CONCAVE) SURFACE
SUCTION (CONVEX) SURFACE
FLOW
LEADING EDGE
RESTRICTED OPENING
TRAILING EDGE
DEPOSIT DEPTH


COVER DEPOSIT
DEPTH (INCHES)

Major Reason for Efficiency Decrease (2/2)



Assessment of Turbine Performance

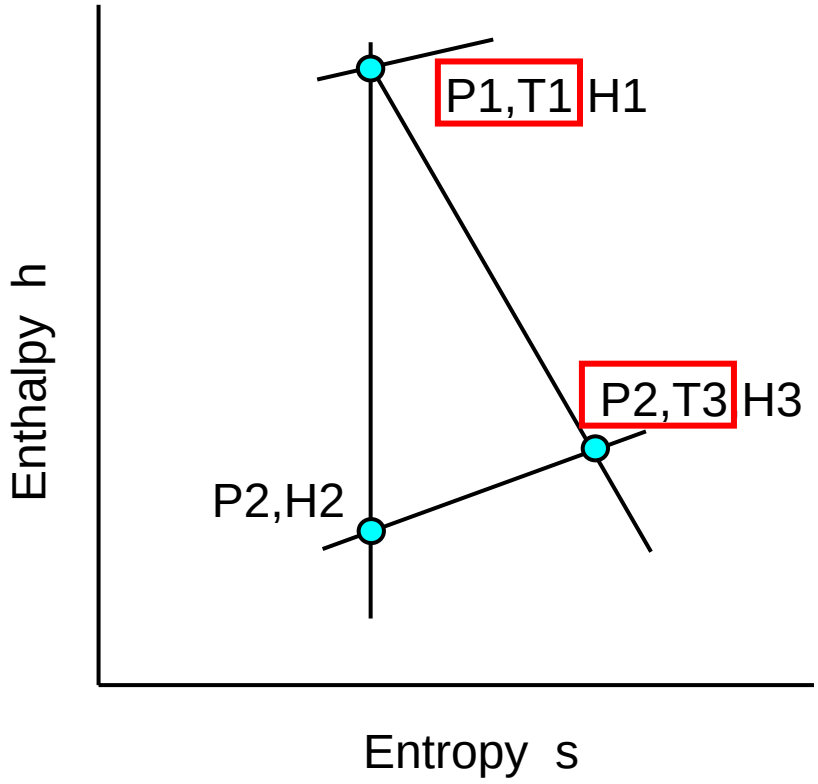
1) Heat rate test

2) Inner efficiency calculation

3) Steam path audit (SPA)

Inner Efficiency Calculation

Turbine expansion curve



Turbine inner efficiency

= (H1-H3)/(H1-H2) x 100 (%)

What is Steam Path Audit (SPA) ?

1) Inspection of steam path component

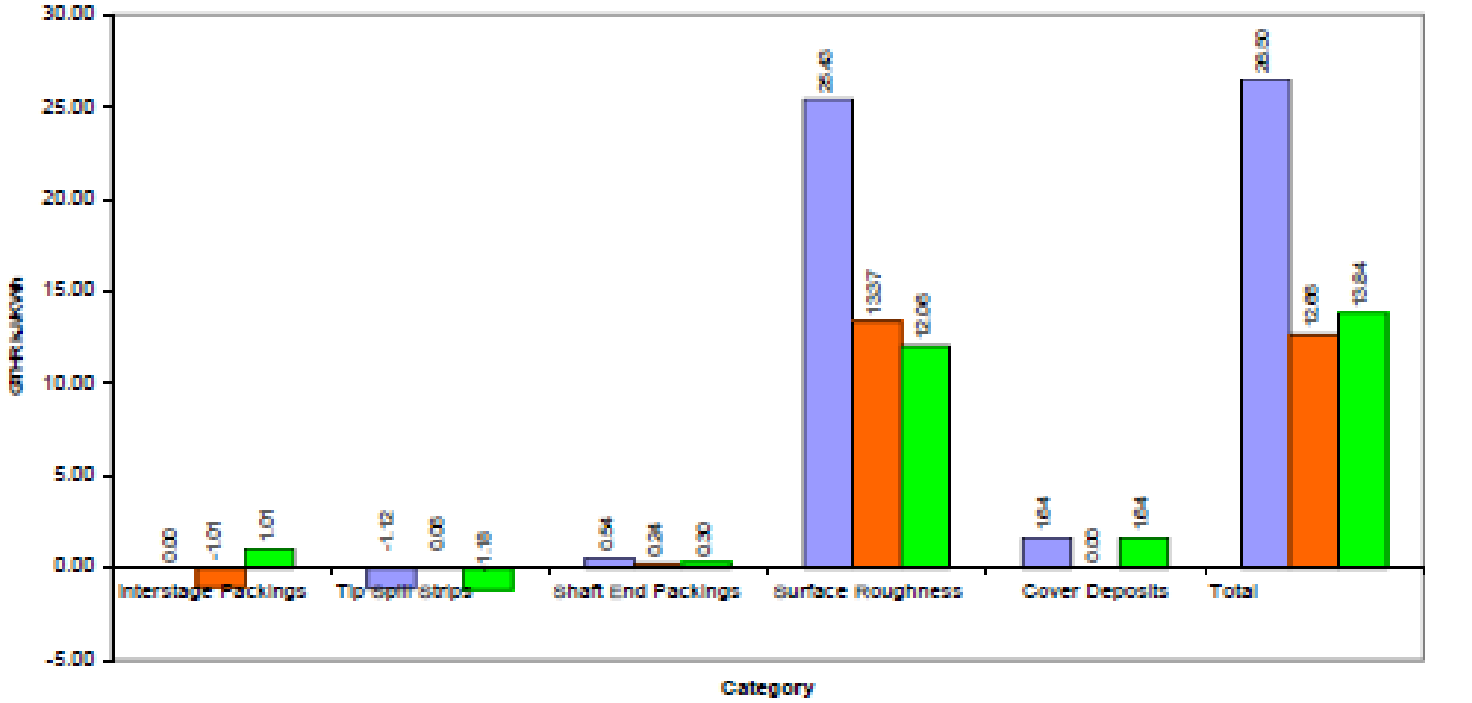
   Clearance, Roughness, Deposit, etc.

2) Estimation of performance losses

3) Calculation of losses in power and heat rate

4) Opening audit and Closing audit

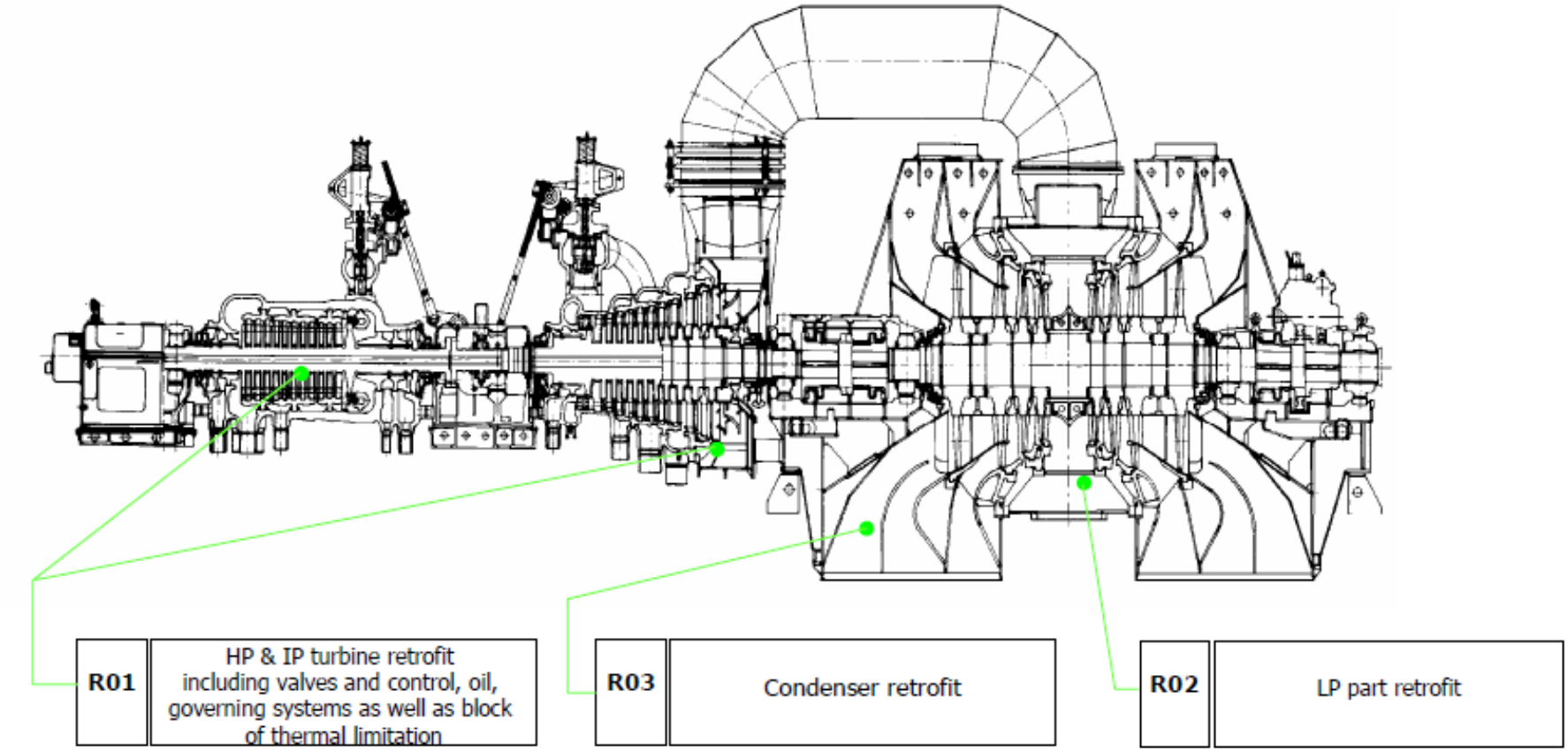
Result of SPA



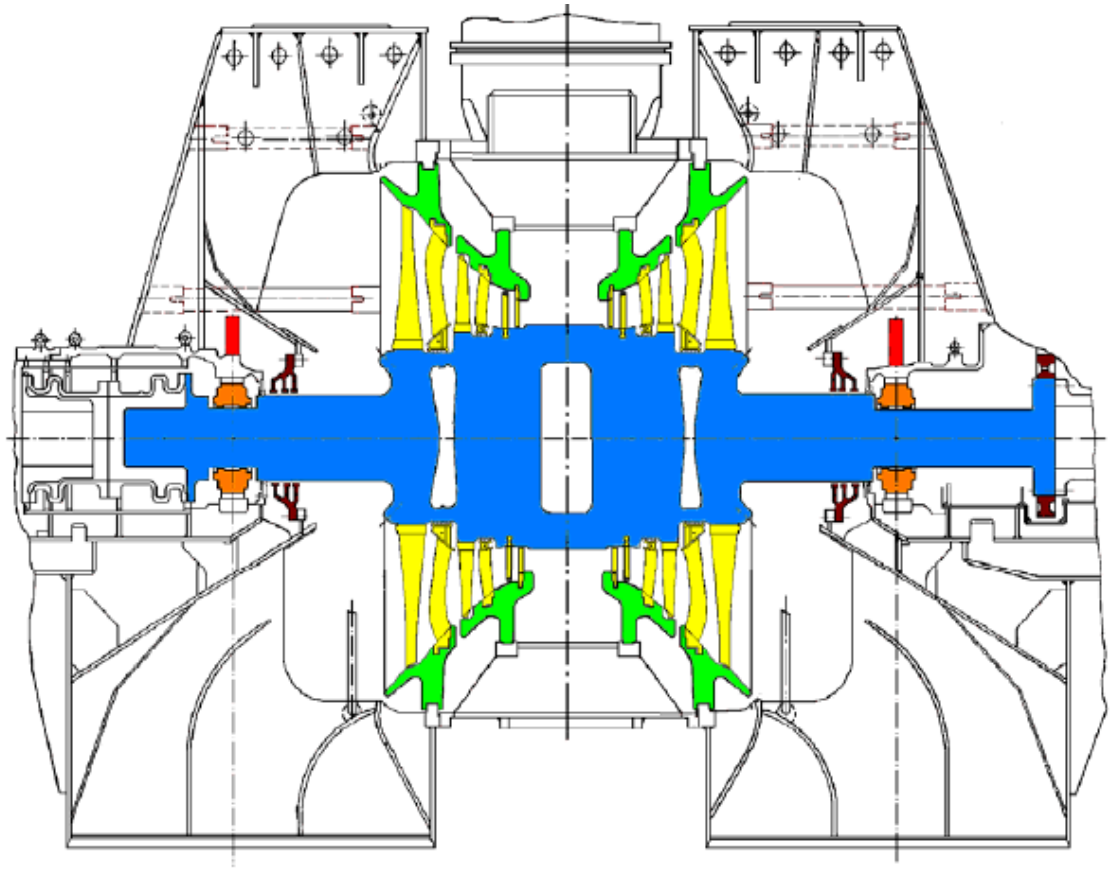
Changes in Heat Rate – IP Turbine

Opening
Closing
Recovery

Retrofit of LMZ Turbine (1/2)



Retrofit of LMZ Turbine (2/2)



Example of Improvement (200MW)

Turbine	Design	Actual	Retrofit	Improvement
HP	82 %	78 %	87 %	5 % (3 MW)
IP	91 %	89 %	92.5 %	1.5 % (1.5 MW)
LP	78 %	65 %	88 %	10 % (7 MW)
Total				11.5 MW

Баярлалаа