Robertson Technology
UK and Australia

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Continuous monitoring of pump performance – case studies

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"How to get the best out of your pumps?"

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Robertson Technology

- Manufacturer, with equipment and services in 22 countries on 5 continents

- Offices in Australia and UK

- Latest design thermodynamic continuous monitoring equipment is in use in the USA, Australia, the UK, and Hong Kong

- Our particular expertise is accurate differential temperature measurement, to better than 1 mK, with long-term stability of calibration (> 10 years)

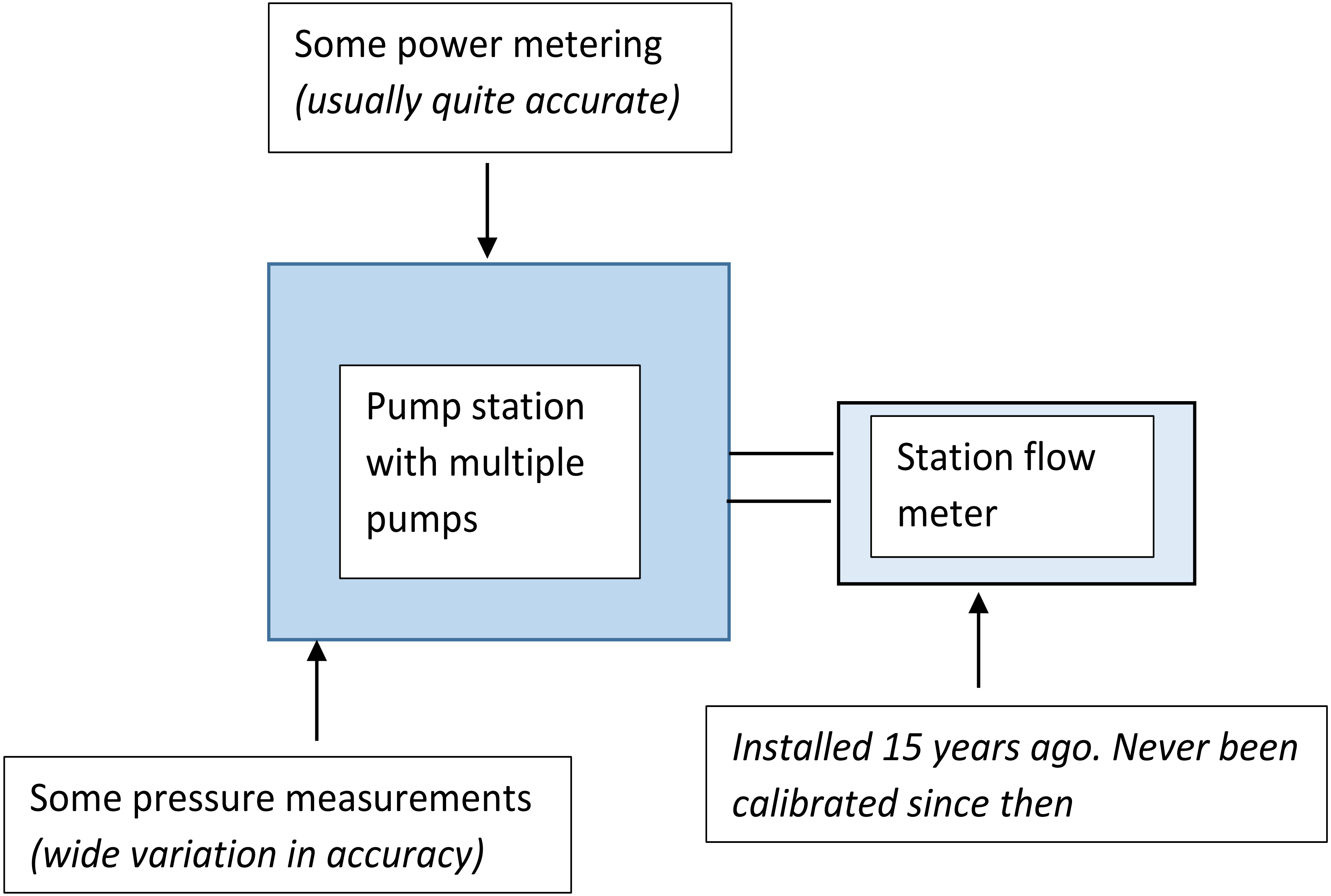
Continuous thermodynamic pump performance monitoring

- Real time and accurate pump performance data for every pump in a system, for all operational conditions
  - Flow rate
  - Pump efficiency
  - Total head
  - Electrical power
  - NPSHa
  - Operating point of the pump relative to BEP

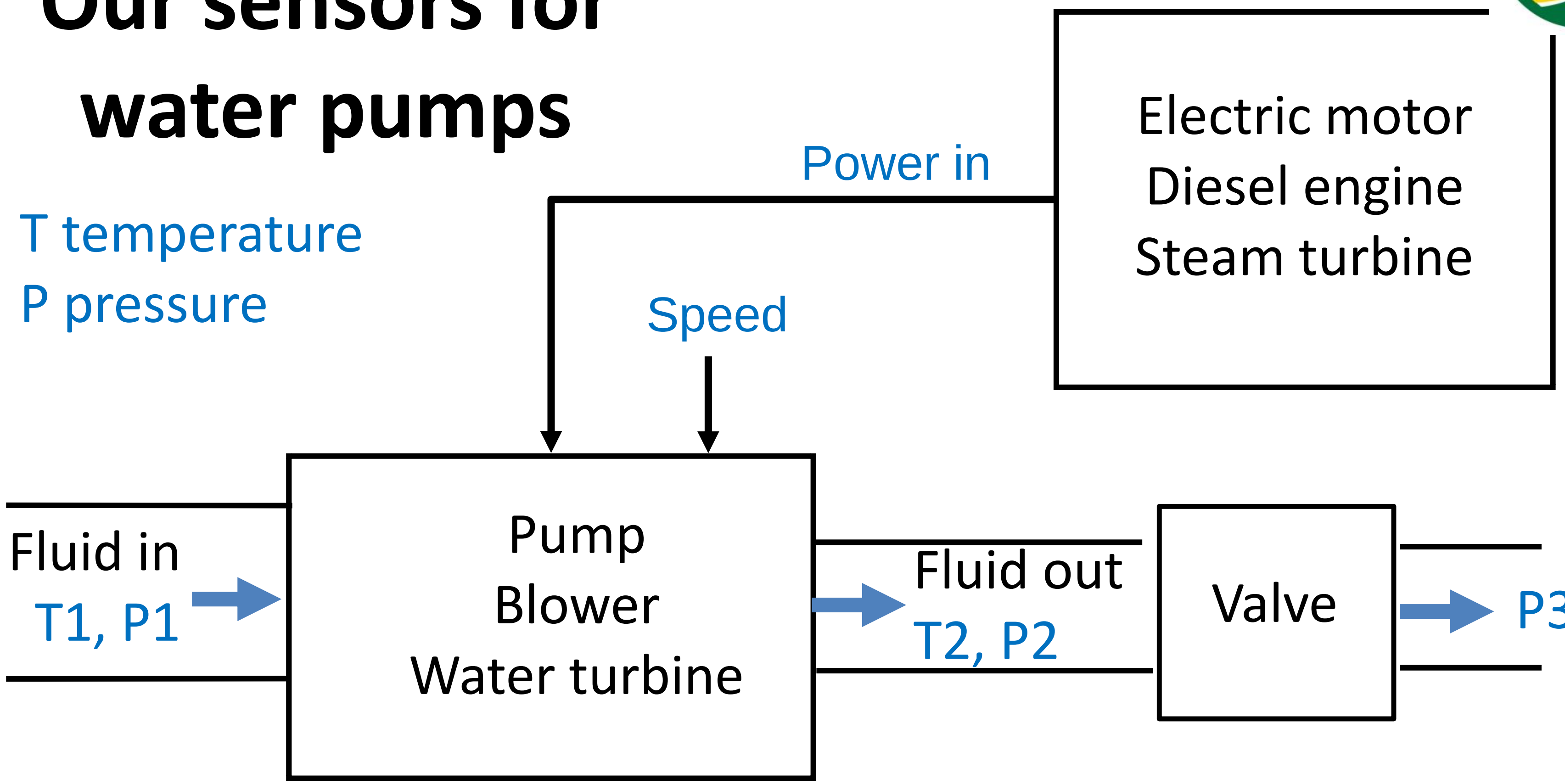
- Information is readily communicated and displayed, e.g. via SCADA and / or HMI

- The technology is also applicable to blowers and turbines

What we typically find in a water utility pump station



Our sensors for water pumps



Differential temperature dT = T2 – T1

Differential pressure dP = P2 – P1

Water is compressed in the pump and has a higher internal energy per unit mass at discharge (T2 > T1 ; P2 > P1)

Main pump parameters measured or derived

- Pump efficiency (a function of dT and dP)
- Suction pressure
- Discharge pressure
- Total head
- Flow Rate (a function of dT, dP, and Power)
- Electrical Motor Power
- Motor speed
- NPSHa
- Operating point

Typical locations for temperature and pressure probes

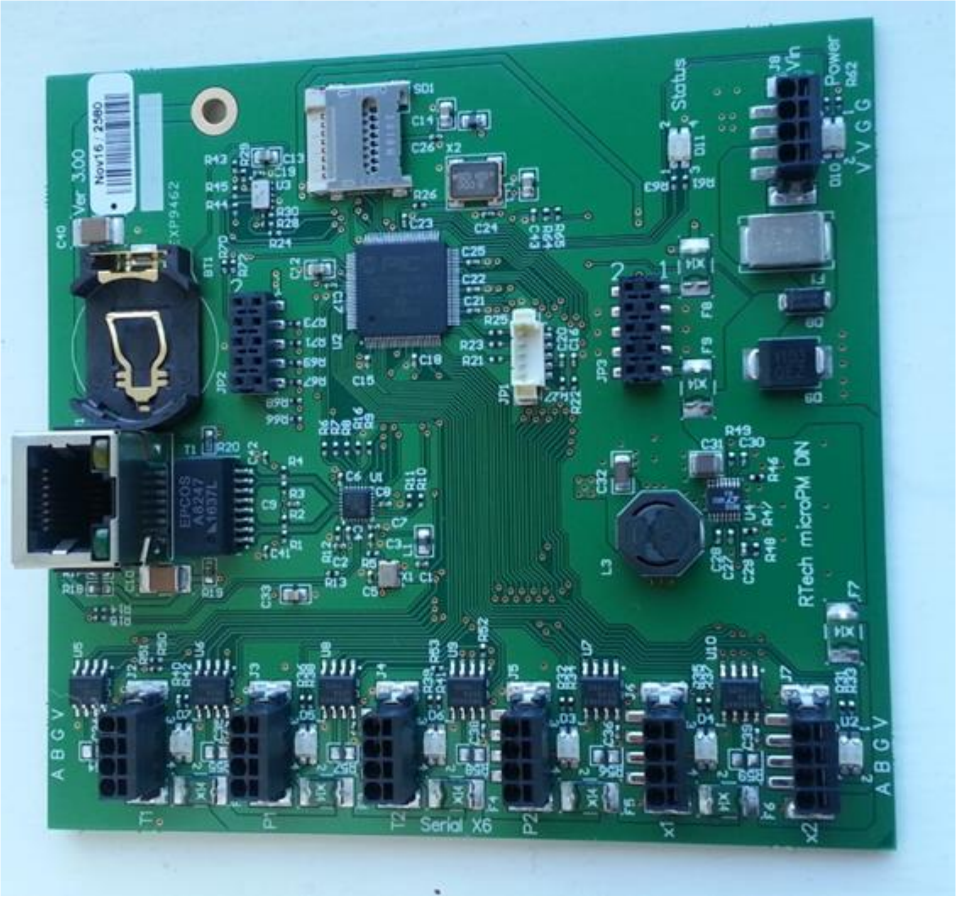
- T1 – suction temperature
- T2 – discharge temperature
- P1 – suction pressure
- P2 – discharge pressure

Also measured

- Electrical power to motor
- Motor speed (for variable speed drives)
- Delivery manifold pressure P3

Expert firmware within a microprocessor

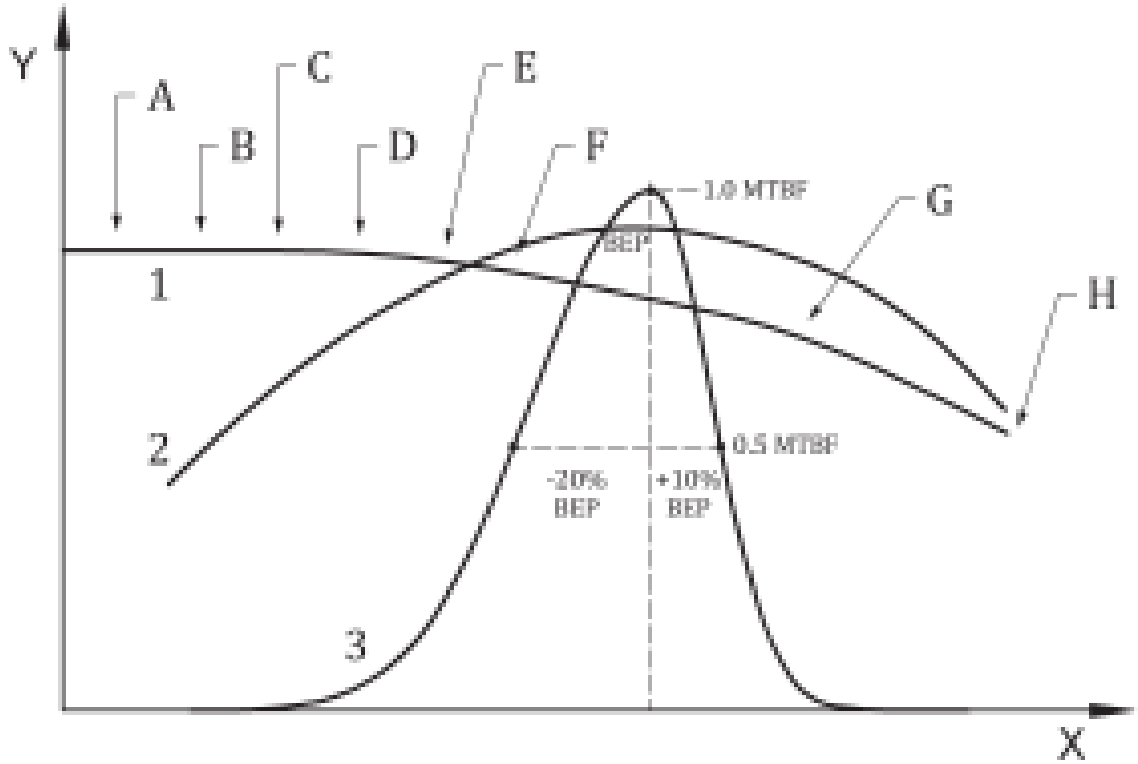
- Sensor data analysed on-board
- Connects via Ethernet, with TCP Modbus protocol
- Embedded webpages for initial set-up and configuration
- Information held in specific registers
- Live data monitoring and self-testing
- Minimal SCADA / HMI development and maintenance costs
- DIN rail mounting



For both lower energy and maintenance costs:

- Operate pumps near BEP (Best Efficiency Point) and within pump manufacturer's POR (Preferred Operating Region)
- Preferentially operate the most efficient pumps
- Identify excessive wear, valve problems, and cavitation
- Identify problems without delay

Operate near the Best Efficiency Point to minimise both energy and maintenance costs



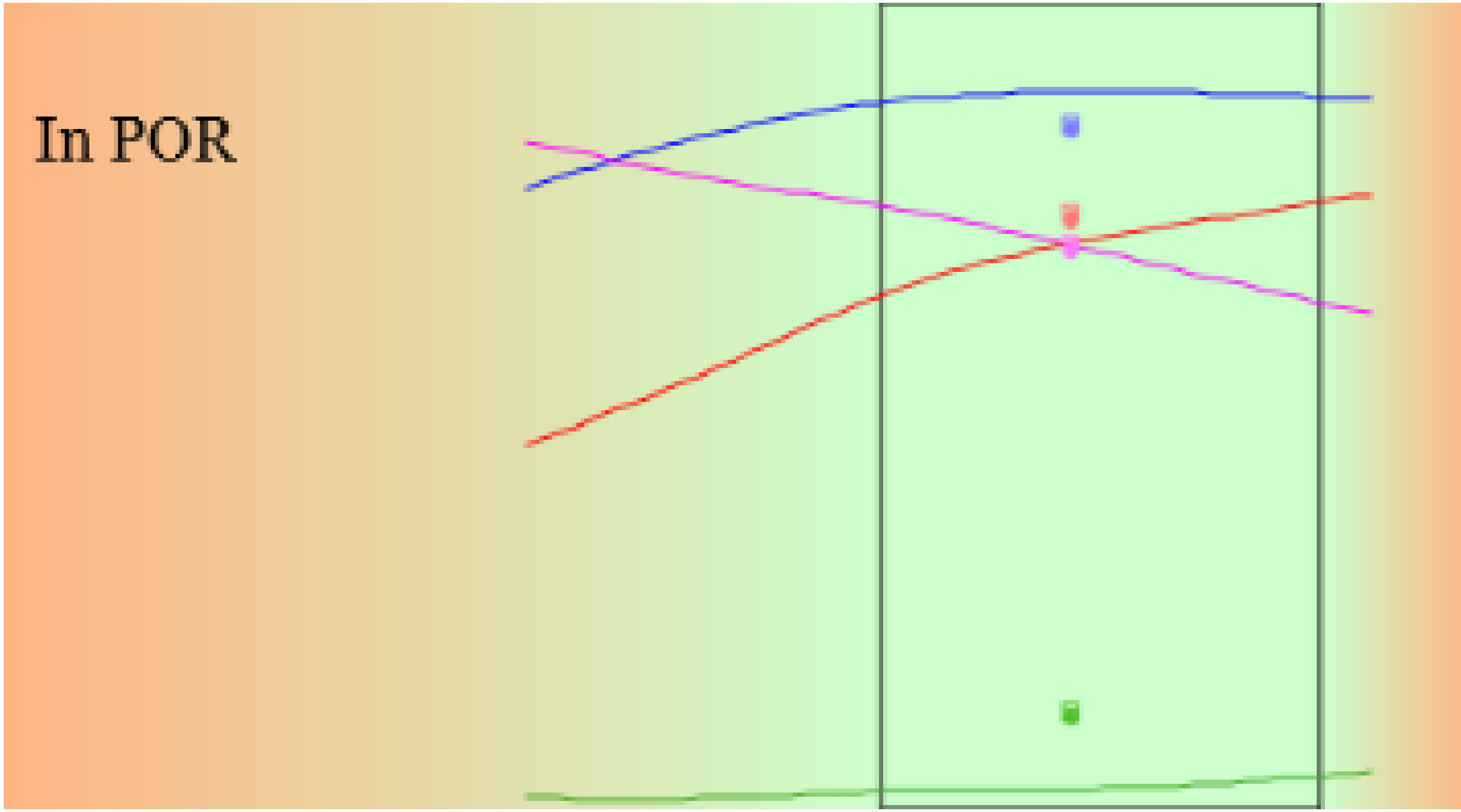
Key

A	high temperature rise	Curve 1	pump curve $H(Q)$
B	low flow cavitation	Curve 2	pump efficiency curve
C	low flow bearing and seal life	Curve 3	reliability curve/MTBF
D	reduced impeller life	X	flow in percent of flow at BEP
E	suction recirculation	Y	head in percent of head at BEP
F	discharge recirculation		
G	low bearing and seal life		
H	cavitation		

Extract from ISO/ASME standard 14414-2015 (Pump System Energy Assessment)

Display of operating point

	Flow	Eff	Head	Power	NPSHa	BEP%
Actual Data	1012.87	85.14	245.88	2962.30	42.93	
Scaled Data	1012.9	85.1	245.9	2962.3	42.9	-2.8



Cursor xxxxx l/s xxxxx % xxxxx m/m xxxxx kW

BEP flow - 1042.40 , POR - 833.92 to 1250.88

Example of recorded data

Units can be metric or US

	average	stdev	units
T1:	79.8747	0.0008	F
T2:	79.9892	0.0008	F
dT:	0.1145	0.0005	F
P1:	11.297	0.279	PSI
P2:	166.967	0.303	PSI
dP:	155.670	0.392	PSI
Head:	363.76		ft
Suction Head:	26.55		ft
Eff:	85.92		%
Overall Eff:	82.66		%
Flow:	20208.89		Gpm
Power:	1671.70	2.61	kW
Speed:	890.0	0.0	RPM

Typically, the averages and standard deviations of 20 samples, counted at 3 second intervals over 1 minute, are transferred to SCADA/ HMI

High standard deviations can give indication of pump problems such as cavitation, wear, or recirculation

Case study 1 -Australia – industrial water pipeline

Two 3 MW pumps at bottom of 40 m deep pit

Provide cooling water to power station

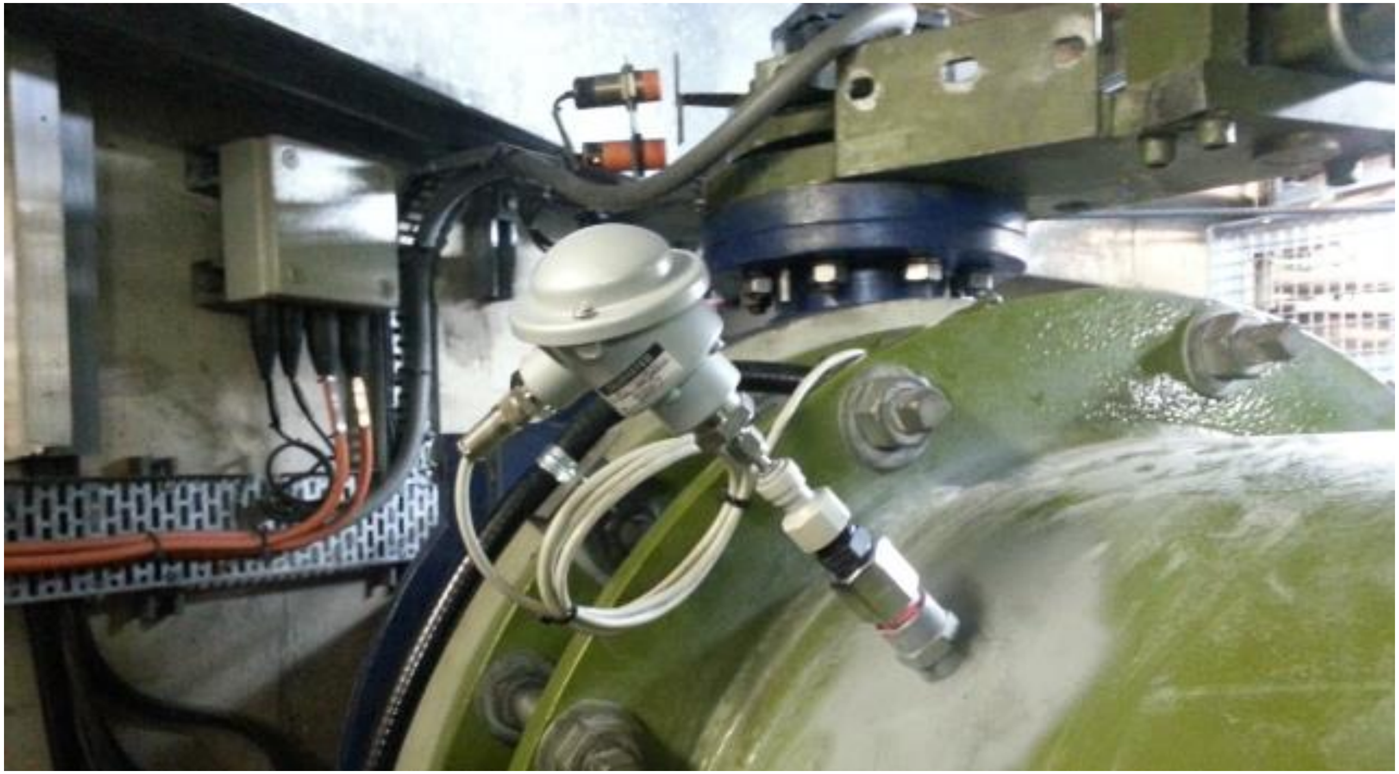
Early warning of potential pump problems essential

Pumps are currently operating as expected

Pump condition monitored by SCADA, with alert levels

Temperature probes are inserted via low mass thermowells

Minimises vibration heating, mechanical stress, and stem effect



Pressure probe teed off from existing analogue meter

Case study 2 – Water utility pump station in USA – six * 2 MW pumps in parallel

Accurate flow metering for each pump was the initial reason for purchase

Characteristics of thermodynamic flow meters

- Calibration of sensors can be checked on-site
- Each pump has its own flow meter
- Independent of velocity profile, pipe configurations, build-up, cavitation, and air entrainment

- *Lower cost than alternatives for retrofitting to existing pump stations*
- *Low construction and pipe work costs for new pump stations*

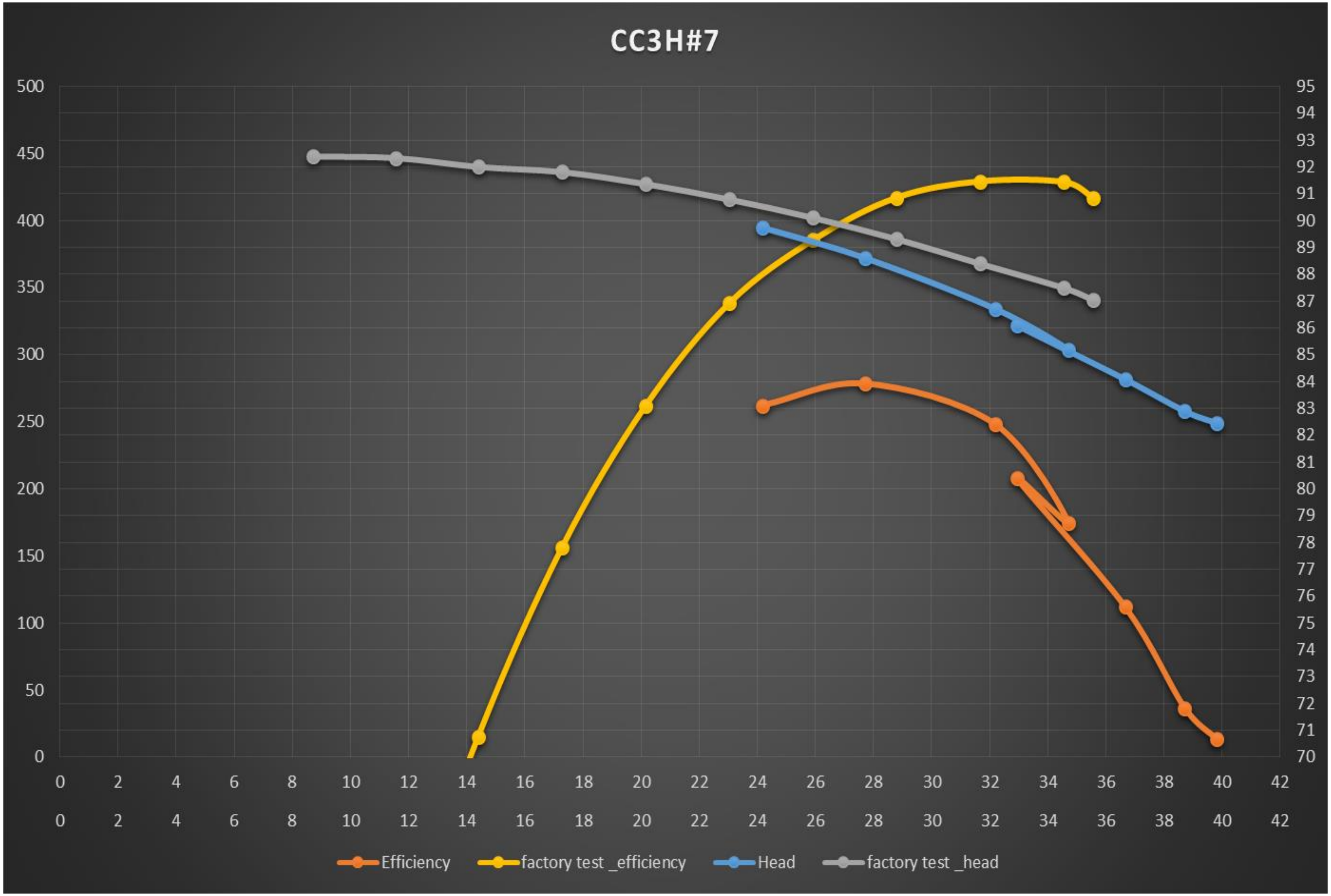
Variation in pump efficiency at the BEP

Costs lowered by operating the most efficient pumps

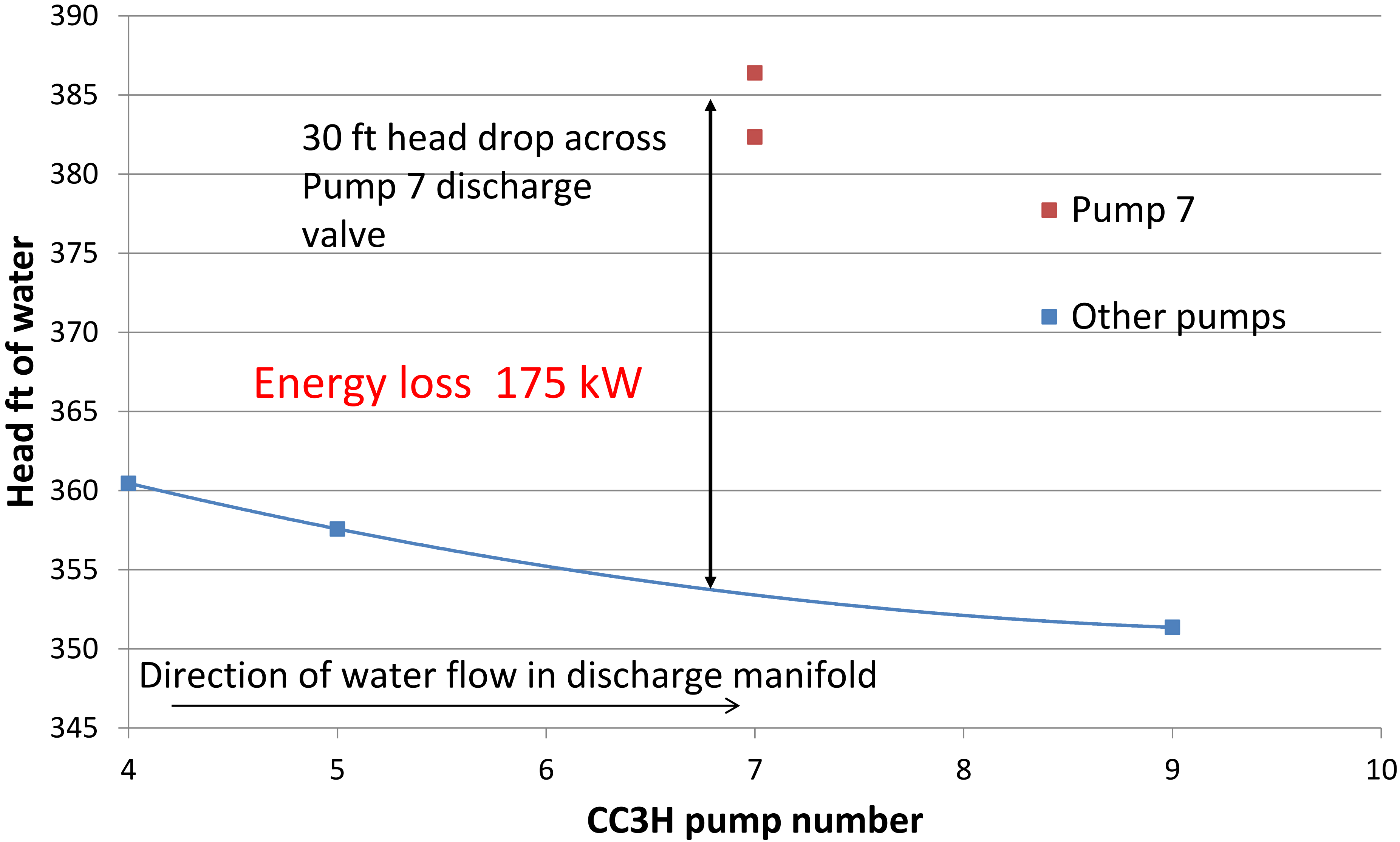
Pump	Efficiency %
1	81.6
2	81.3
3	87.6
4	83.9
5	89.1
6	86.4

7.8 percentage points between best and worst

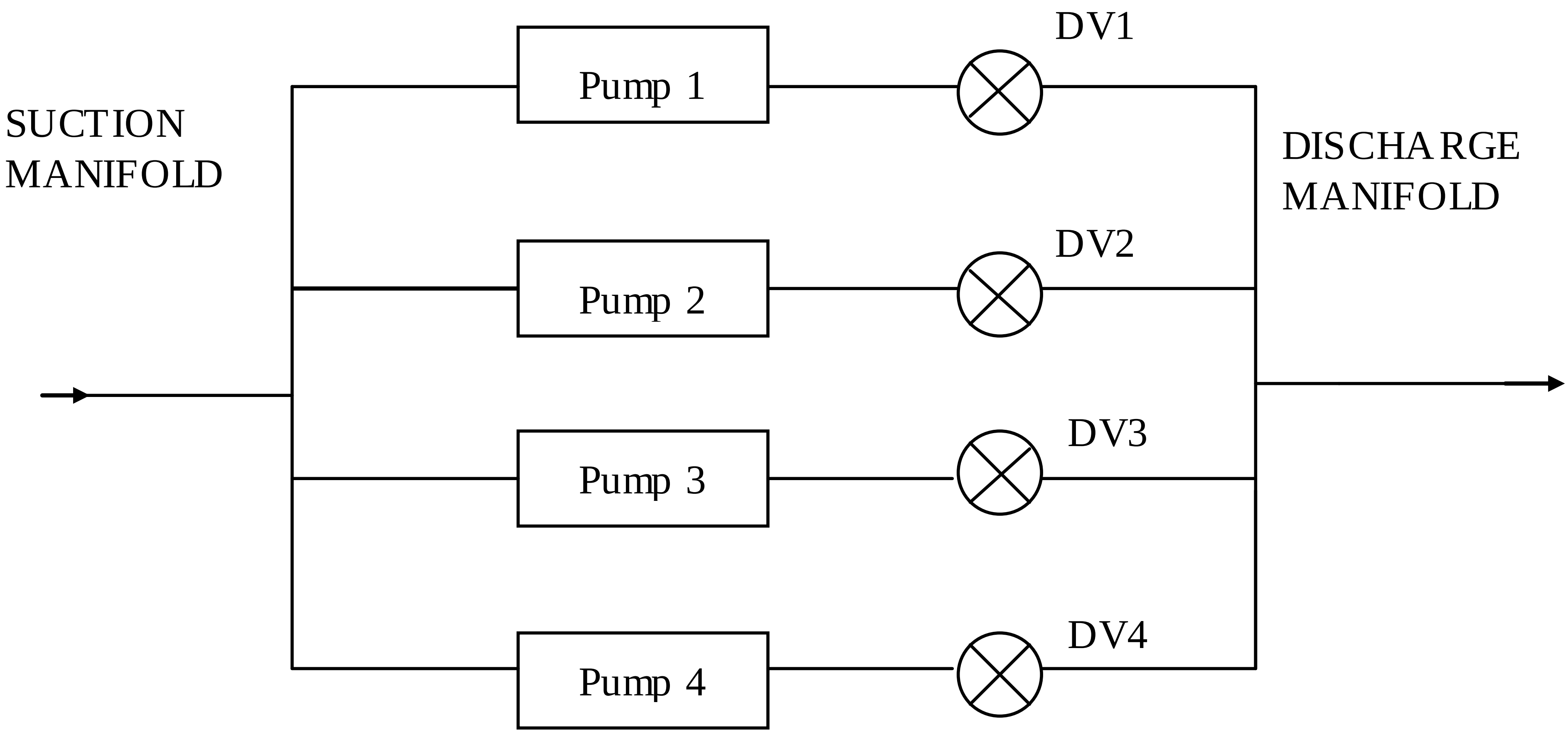
Pumps are over-sized and cavitation can occur at higher flow rates



High pressure drop found across discharge valve on one pump

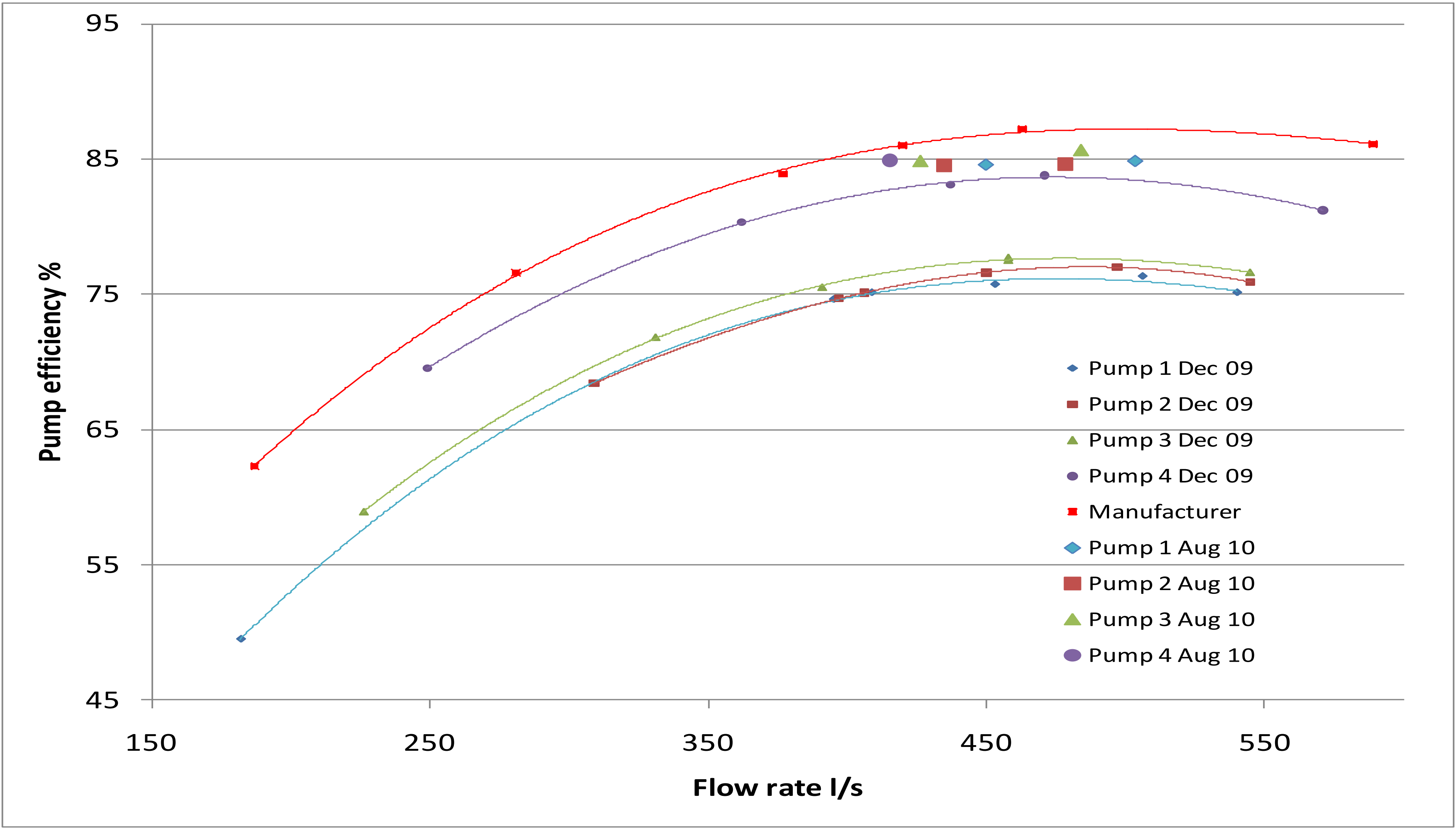


Case study 3: Australian Water Utility: four 600 kW water pumps in parallel

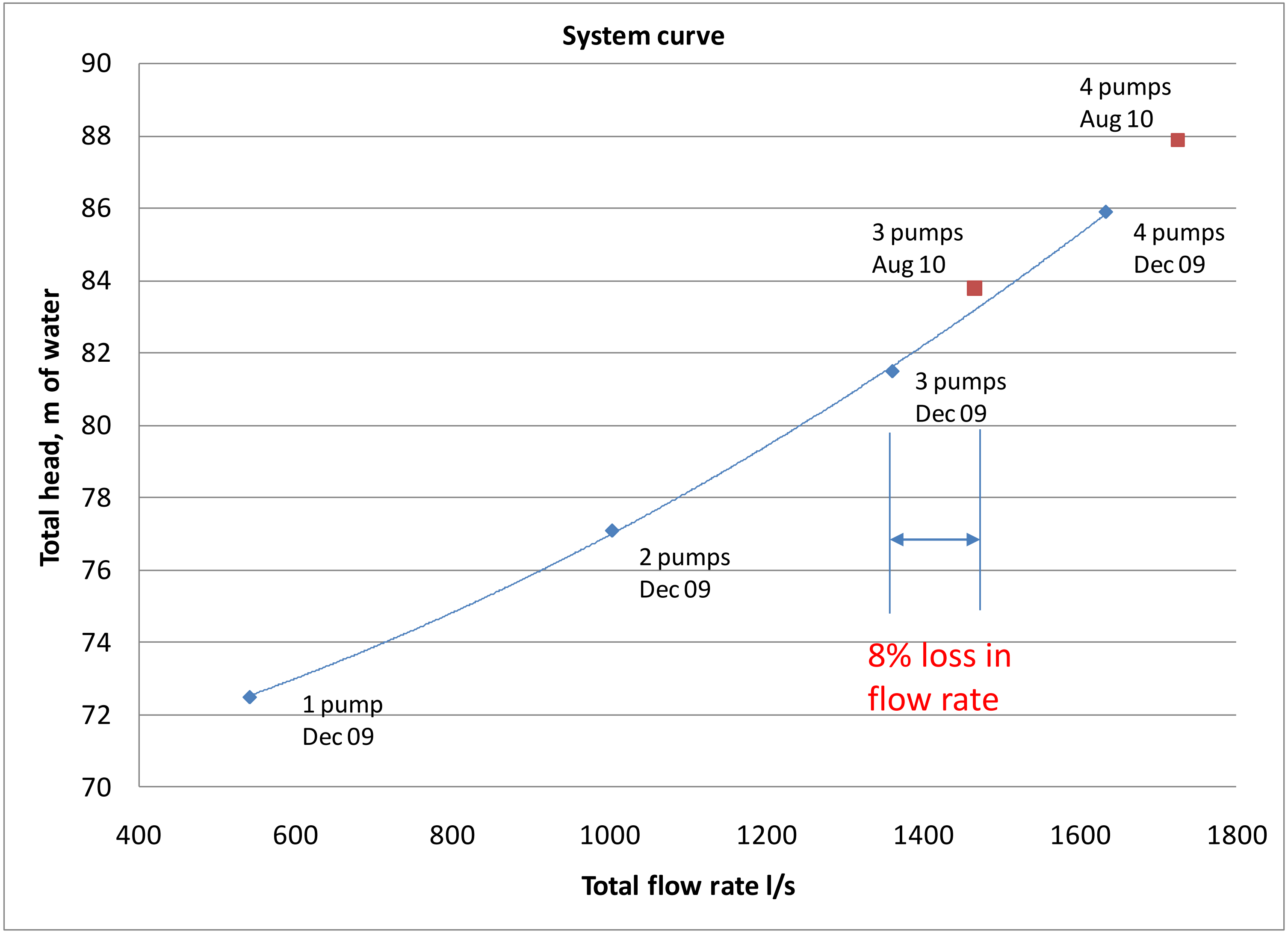


Rapid deterioration in pump efficiency

– 10 months to detect the problem

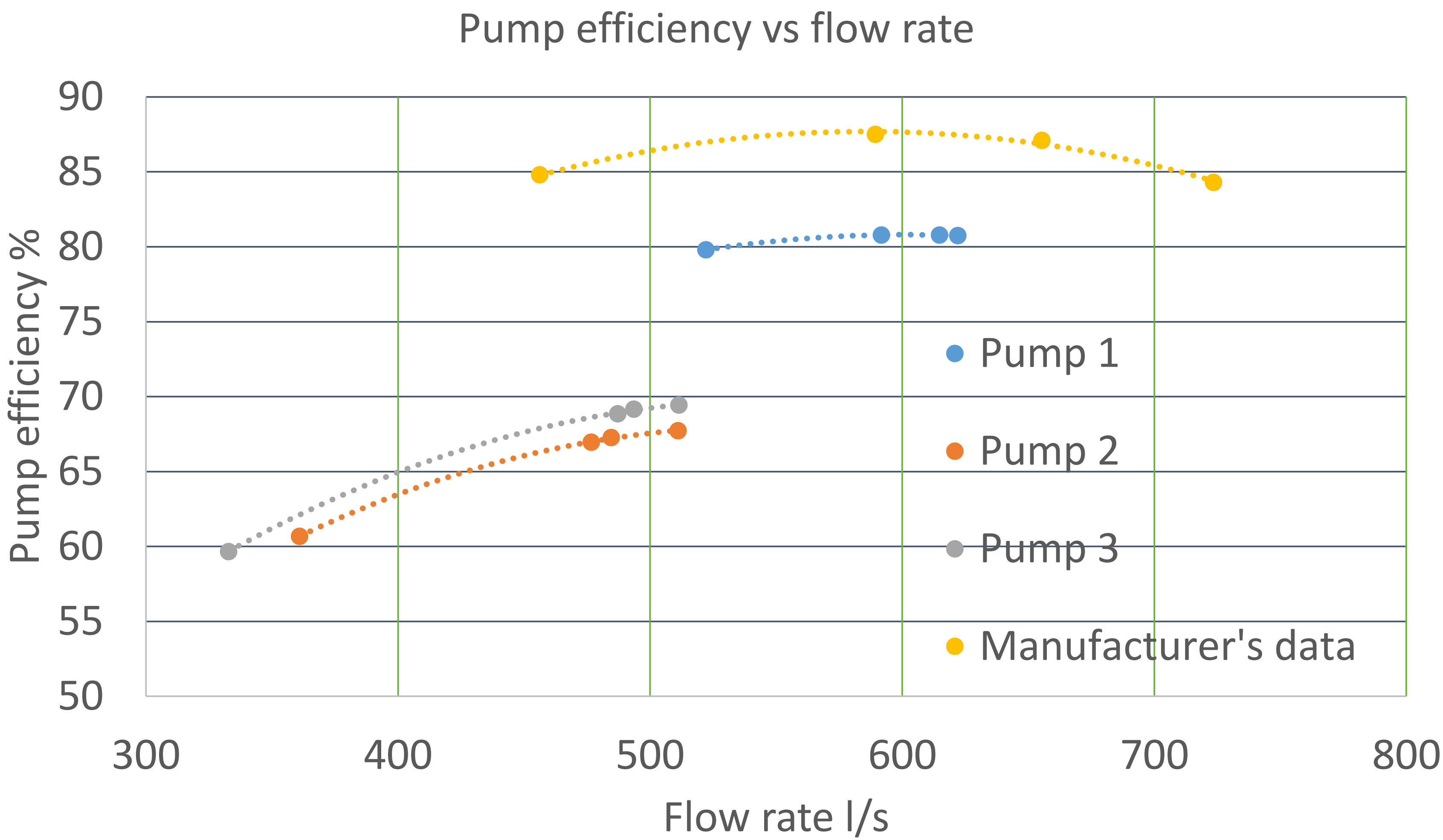


Resultant loss in flow rate



The same problem has occurred twice more since then. The cost of continuous monitoring would be quickly recouped.

Case study 4: Australian water utility: Three * 800 kW pumps in parallel – wear ring problems



Loss in station flow rate was noticed when high productivity became critical. Continuous monitoring to be installed.

Summary – benefits of continuous thermodynamic pump performance monitoring

- See all operational conditions
- Verify that pumps are operating near BEP, and within manufacturer's POR
- Rapidly identify problems
- Preferentially operate the most efficient pumps
- Every pump has an accurate flow meter

- Reduce energy and maintenance costs
- Improve productivity