Getting Control for Optimal Plant Control

QUARRY ACADEMY

Improving Processes. Instilling Expertise.

Dyno Nobel

SANDVIK


• SUSTAINABILITY •
• PROFITABILITY •
• PRODUCTIVITY •
BREAK ROCK
Chemical Crushing
MOVE ROCK
Load and Haul
SIZE ROCK
Mechanical Crushing and Screening
• PLANNING AND METRICS •
• SAFETY CULTURE •
QUARRY ACADEMY

Agenda

- Feeding the crusher
- Automation

Feeding Arrangements

- The negative effects of poor feeding---how poor feeds cause extra costs to the operation and reduce productivity
- Some ideas how we can determine the source.
- Some ideas how to prevent and cure, reduce costs, increase plant and equipment utilisation and generally increase profitability.

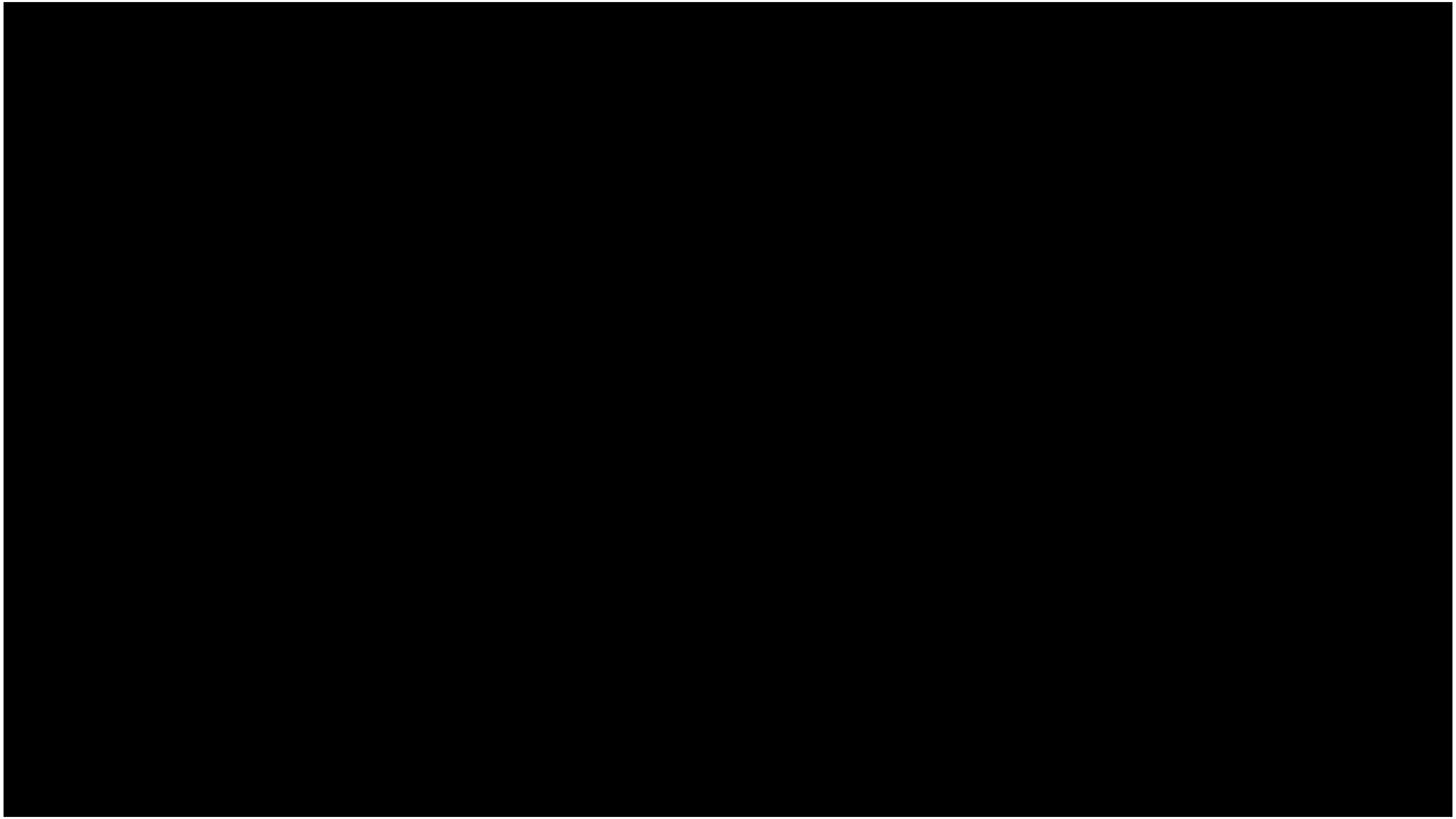
QUARRY ACADEMY

Cone Crusher Function

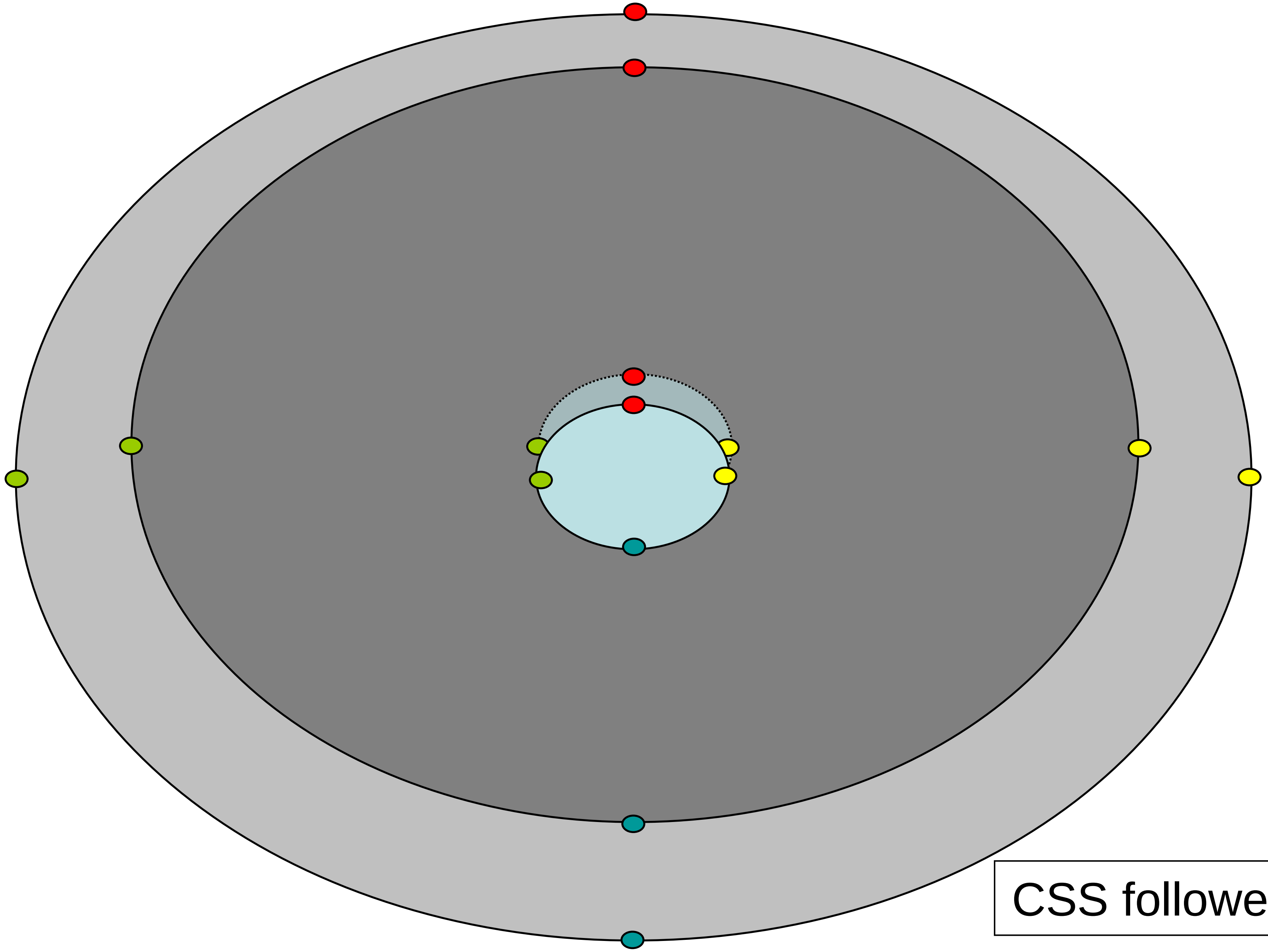
- The CSS runs around the chamber so the action is basically rotational.
- Raw material enters the chamber on the OSS and is crushed one half revolution later by the CSS.
- This cycle takes place in most cone crushers 5 to 6 times per second.
- Cone crushers have volumetric capacities.

QUARRY ACADEMY

Function sc.



Function



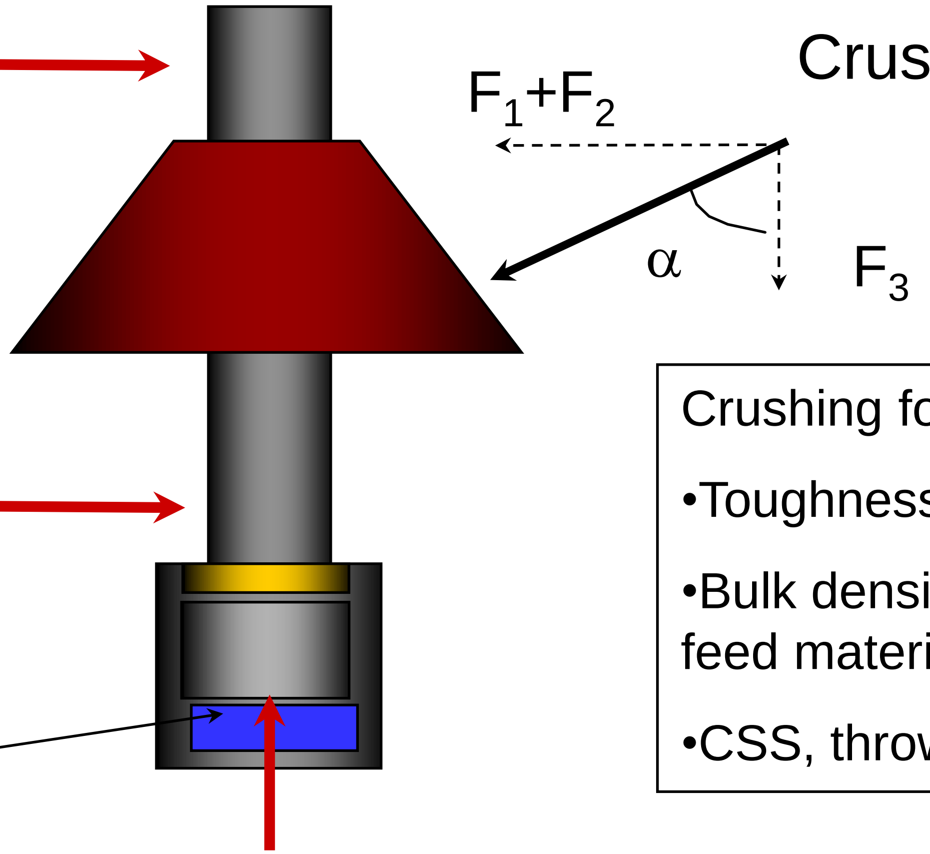
Concave

CSS followed 180^0 later by OSS

QUARRY ACADEMY

Reaction to well distributed, unsegregated feed

A similar crushing force will be seen throughout each and every revolution



Reaction forces seen as

Power, hp (kW)---- F_1+F_2

Pressure, psi (mPa)--- F_3

Crushing force affected by

- Toughness of rock
- Bulk density/particle size distribution of the feed material
- CSS, throw and chamber profile

$$p = \frac{F_3}{A} = \frac{F \cdot \cos\alpha}{A}$$

QUARRY ACADEMY

Segregation

Possibly the greatest single factor in destroying crusher performance and process control.

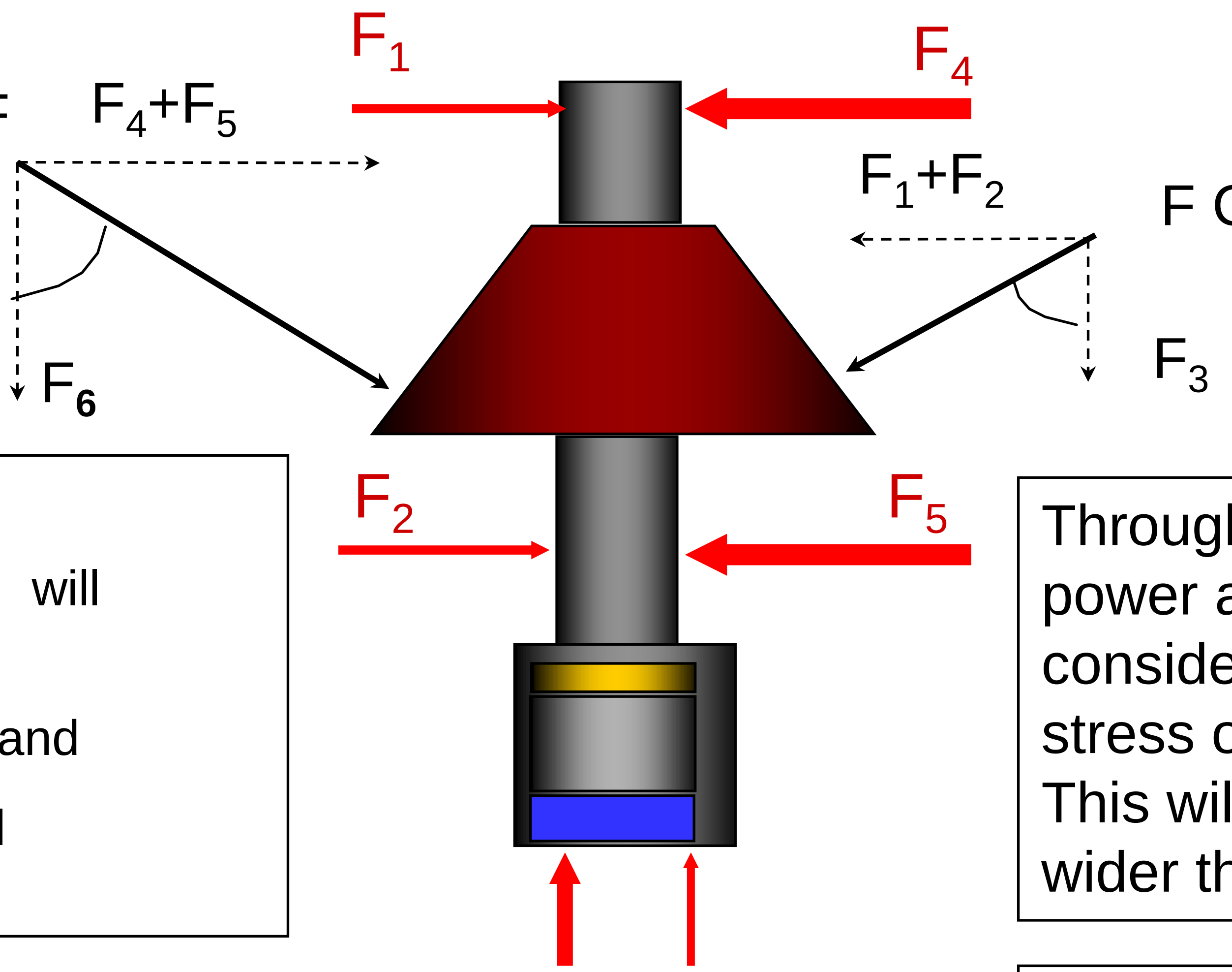
QUARRY ACADEMY

Reaction to uneven,segregated feed

Crushing Force F

F4 +F5 > F1+F2

F6 > F3



As wear becomes uneven

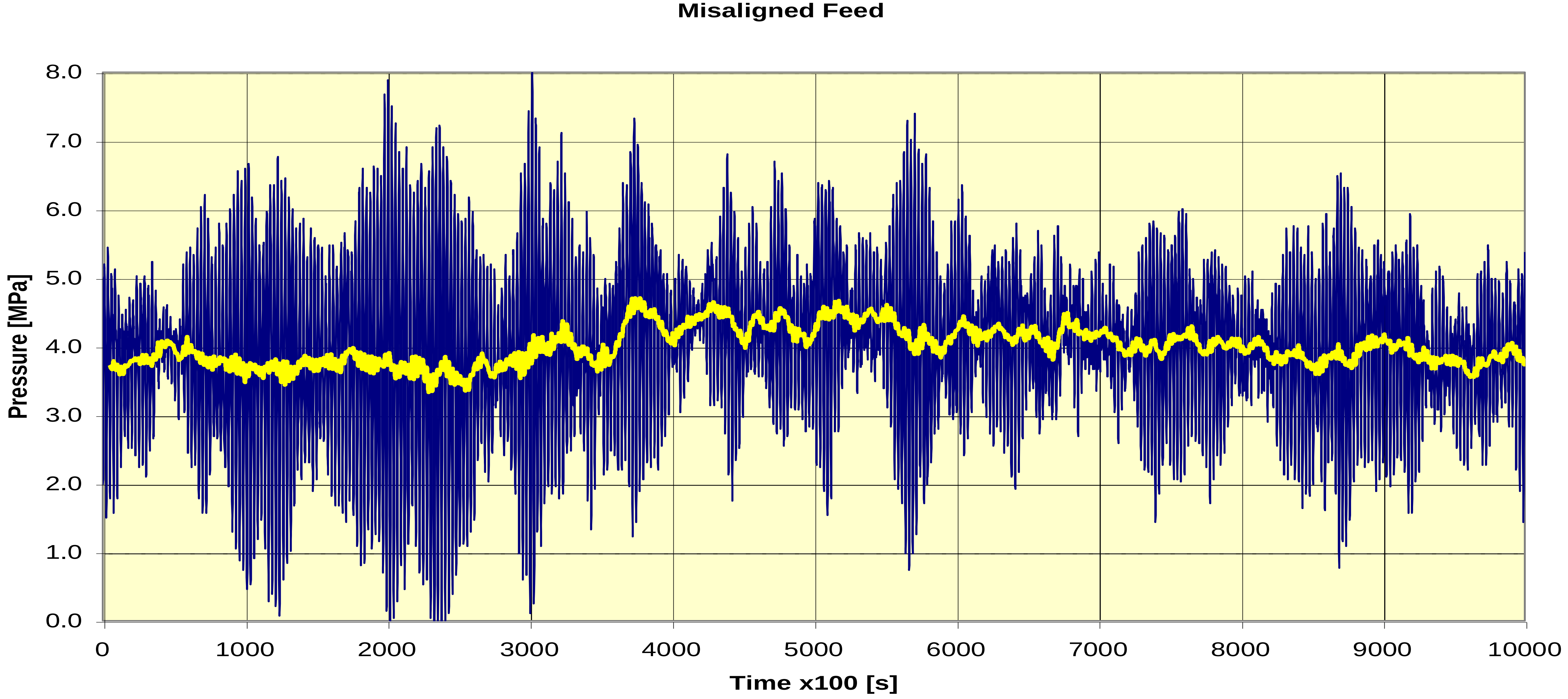
- the power and pressure fluctuation will become exaggerated,
- the setting more difficult to control and
- the product grading and quality will deteriorate.

Throughout every revolution both power and pressure will fluctuate considerably, causing extreme cyclic stress on machine component parts. This will require the setting to be run wider than necessary

Zero reaction at any point during the revolution will suggest a portion of the chamber is empty

CH880, tertiary application

Misaligned/segregated feed - High pressure amplitudes

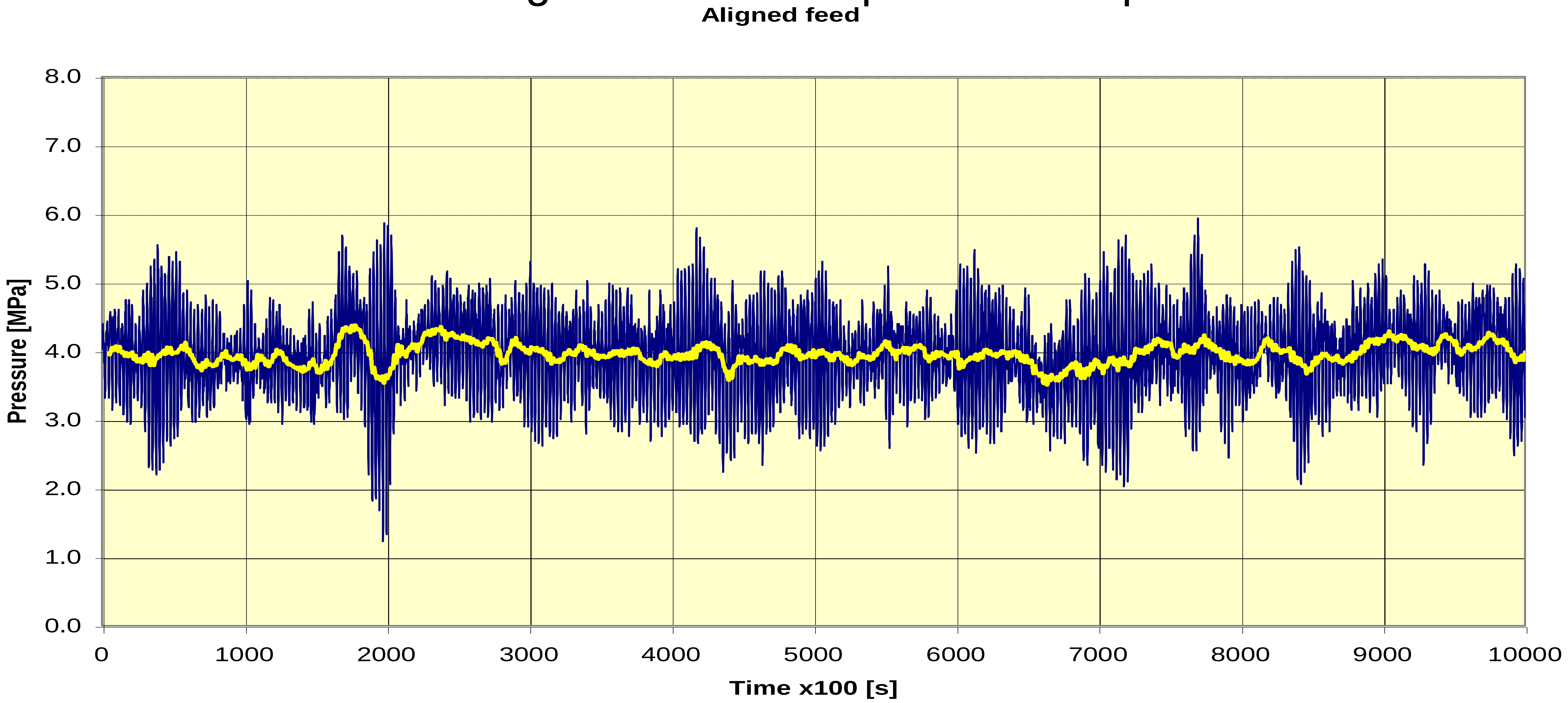


4mpa=580psi

QUARRY ACADEMY

Improved segregation

Aligned feed- Low pressure amplitudes



4mpa=580psi

QUARRY ACADEMY

What are the negative effects?

High power and pressure will cause the crusher to be run at wider than necessary settings resulting in coarser product therefore higher recirculating loads with increased conveying, wear and crushing Costs.

Higher circulating loads leads to lower system feed, less product on the ground.

Occasionally the necessity for increased crushing will demand increased capital investment.

Segregated and poorly distributed feeds will cause the crusher liners to wear unevenly, again with deteriorating performance and associated Costs.

Product will become coarser and less cubical. Costs??

QUARRY ACADEMY

What are the negative effects?

Segregation and uneven wear will cause reduction in liner life through premature exchange. Costs??

Segregation and uneven wear will cause reduction in mechanical component life, often leading to traumatic failure and the costs of unplanned stoppages.

ALL IN ALL CONSIDERABLE COST TO THE OPERATION.

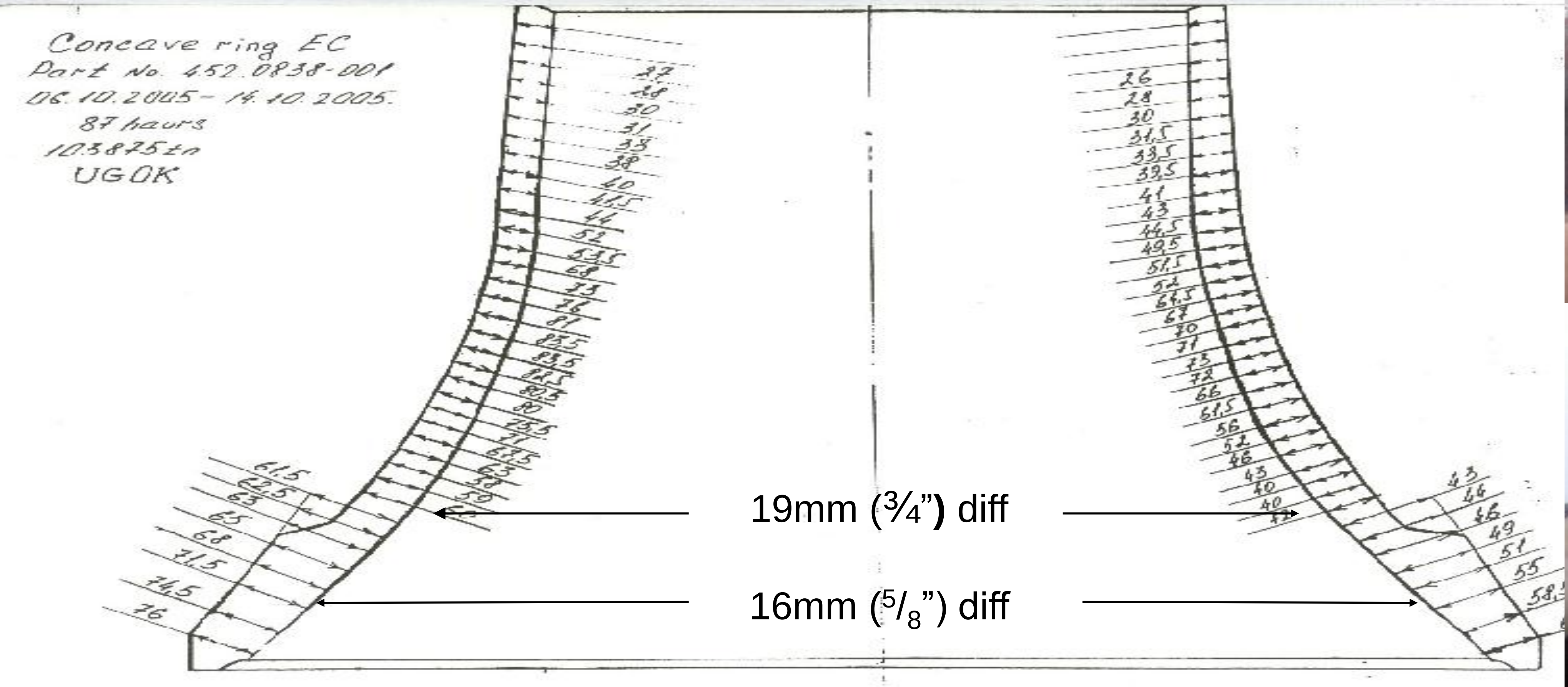
QUARRY ACADEMY

Case study
Segregation

CH870 EC Iron ore

QUARRY ACADEMY

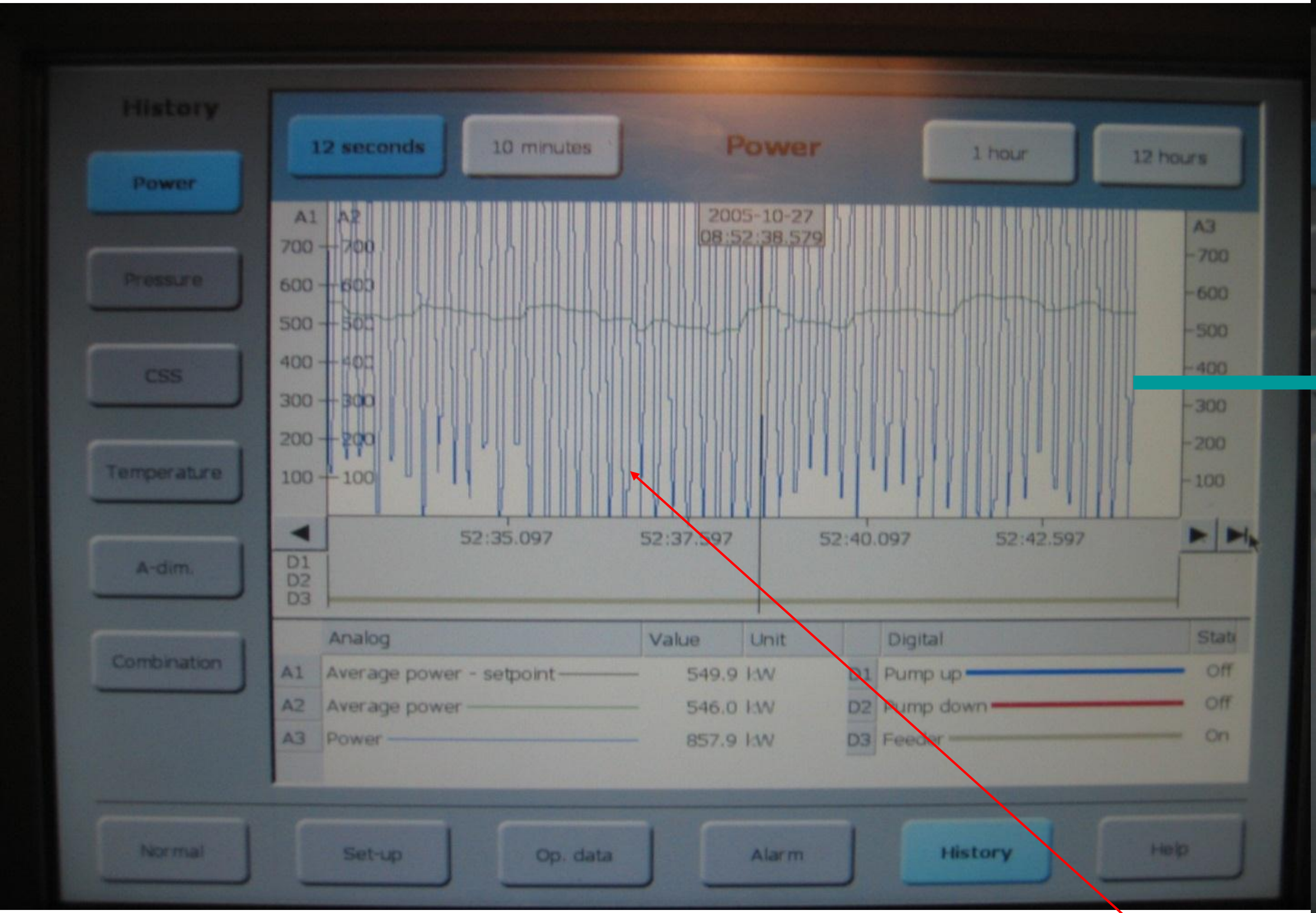
Negative effect of uneven wear

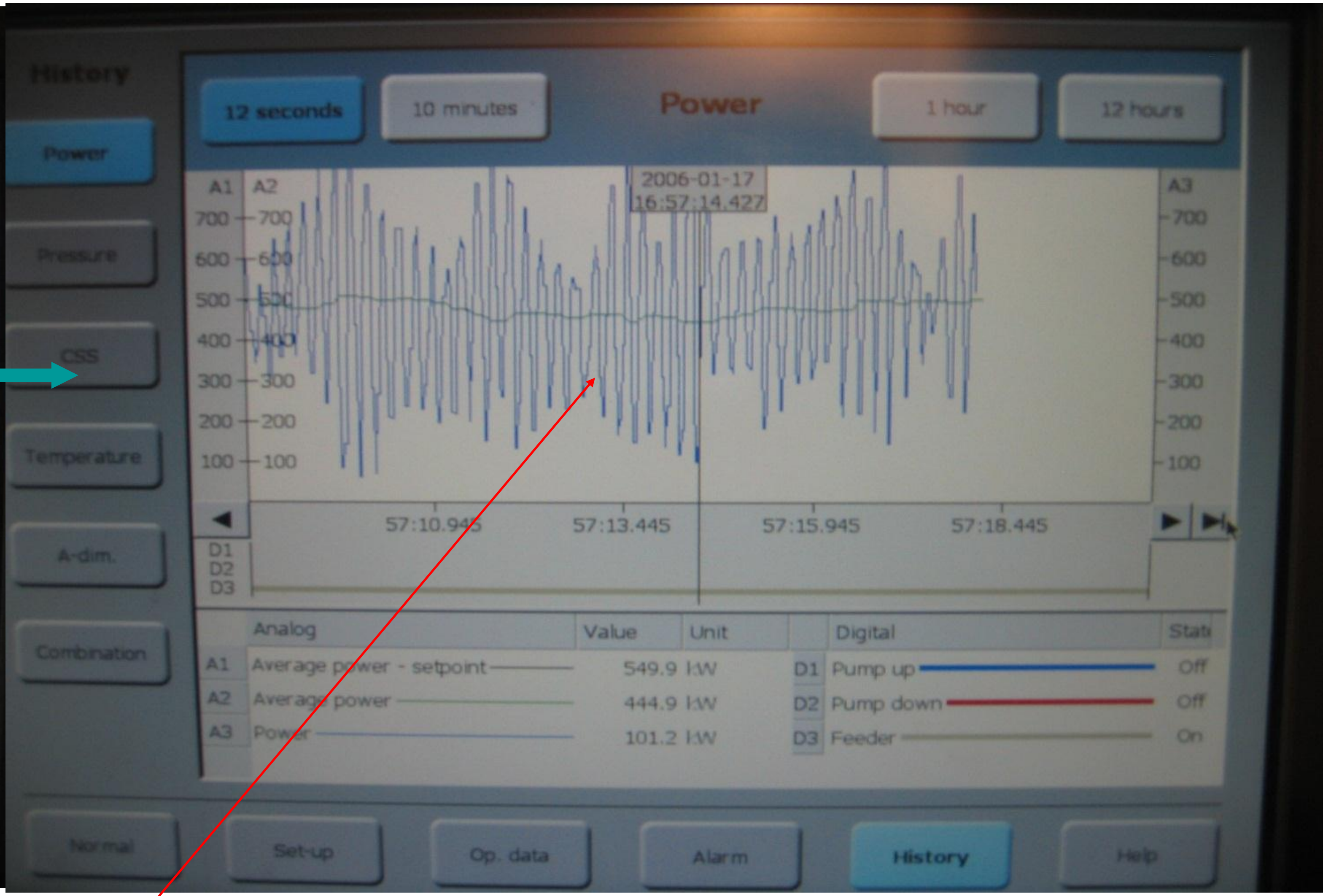


Demands much higher scrap weight----increased operating costs

QUARRY ACADEMY

Improvements after fitting an RFD





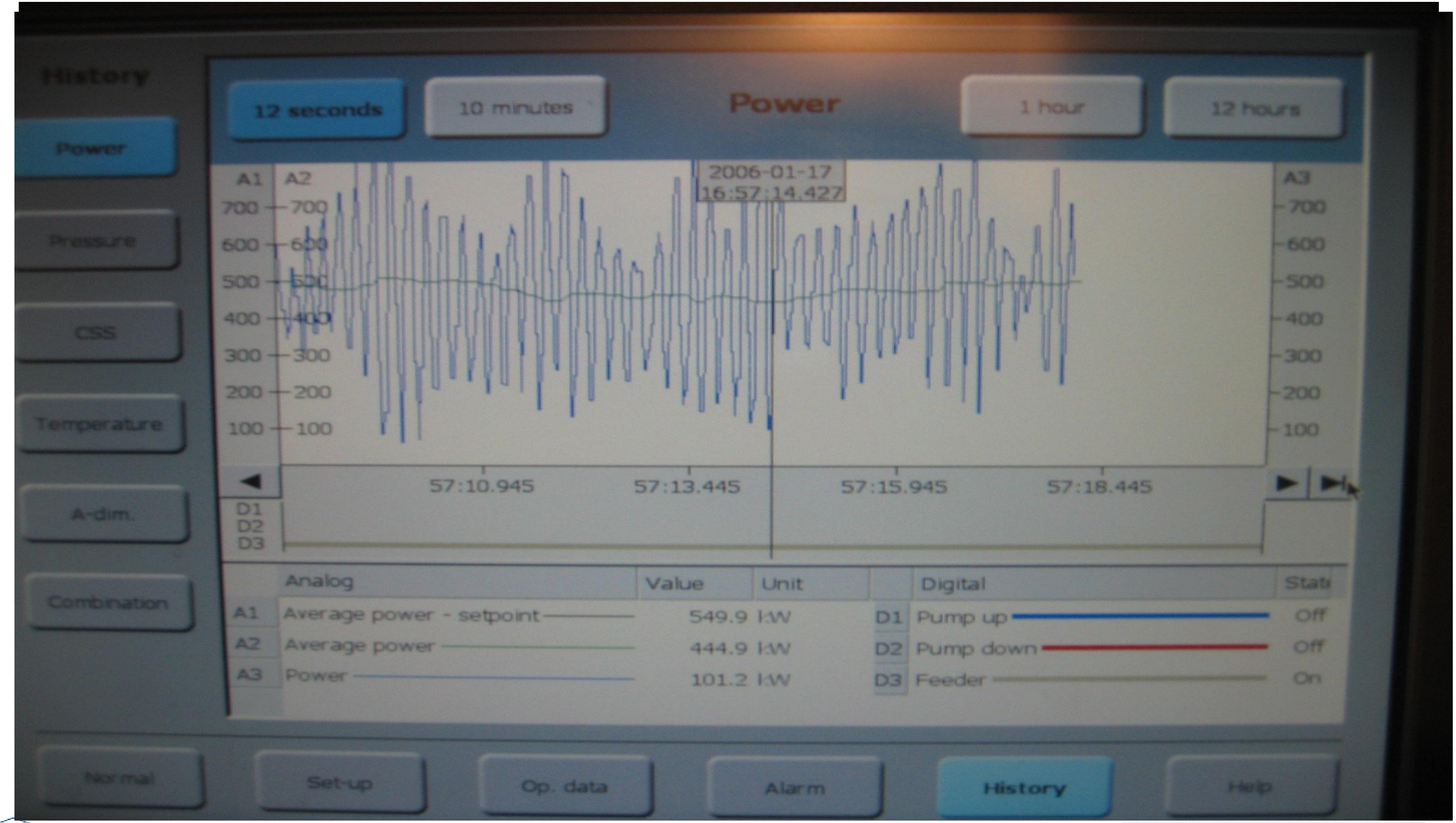
27. 10. 05

Each amplitude represents 1 cycle

17. 01. 06

500kW=670hp

QUARRY ACADEMY


History
Power
Pressure
CSS
Temperature
A-dim.
Combination
12 seconds
10 minutes
Power
1 hour
12 hours
2006-01-17
16:57:14.427
57:10.945
57:13.445
57:15.945
57:18.445
Analog
Value
Unit
Digital
A1 Average power - setpoint 549.9 kW
A2 Average power 444.9 kW
A3 Power 101.2 kW
D1 Pump up Off
D2 Pump down Off
D3 Feeder On
Normal
Set-up
Op. data
Alarm
History
Help

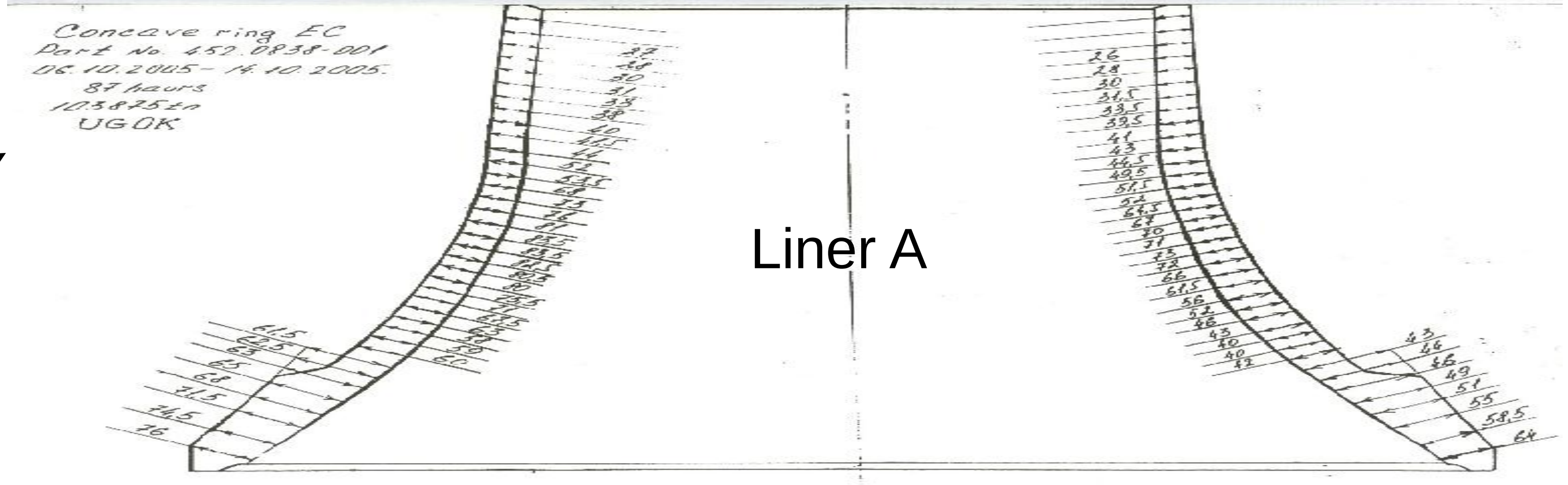
500kW=670hp

Wear life improvement after fitting RFD

87 hours

103875 tonnes (114470stons)

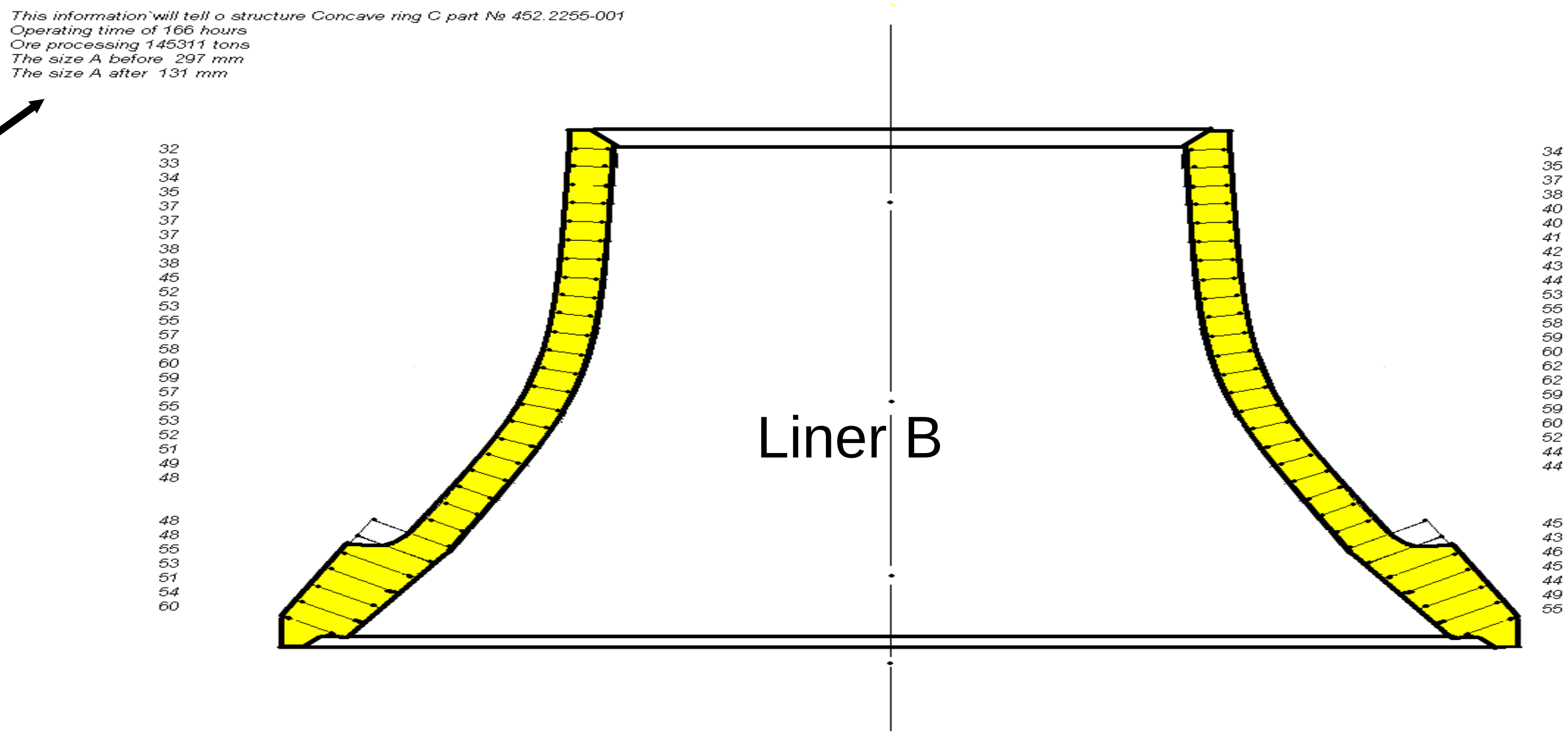
1194 mtph (1316stph)



166hours

145311 tonnes (160133stons)

875 mtph (965stph)



QUARRY ACADEMY

Cost comparison

	Liner A	Liner B
Hours	87	166
Tons	114470	160133
Tons/hr	1316	965
Average setting over liner lifetime	$3^{3}/_{16}$" (80mm)	$2^{3}/_{8}$" (60mm)
Differential wear	¾" (19mm)	$^{3}/_{16}$" (5mm)
% oversize	47	22
Tons/hr oversize	619	212
Tons/hr product	697	753
Additional cost assuming $0.5/ton	$310/hour	$106/hour
Wear cost (assuming $10000 per set)	10000/(697 x 87) =$0.165/ton of product	10000/(753 x 166) =$0.08/ton of product

Costings are for comparitive purposes only

QUARRY ACADEMY

Early Prevention

- **During the design stage, whether a <u>new plant</u> or <u>plant extension</u> or <u>replacement crusher</u> is being planned, careful consideration is required to the design of the feeding arrangement.**

- **Material normally arrives in a stream, from a conveyor, feeder or chute—the need is for even full width distribution with no segregation.**

- **Height can be an ally when available and employed to constrain material, change flow direction, combat segregation and remove impact, but a deadly enemy when working against us--too little height gives no opportunity.**

QUARRY ACADEMY

Early Prevention

- Flexibility in design---e.g.... the opportunity to alter the position and speed of the material discharge point and trajectory.

- Each feed arrangement design is unique, can be complex and may require several compromises

- **THE OPERATIONAL SUCCESS AND OVERALL OPERATING COST OF THE INSTALLATION WILL DEPEND ON A SATISFACTORY DESIGN.**

QUARRY ACADEMY

Late cure

WHY segregation?

- In general conveyor belts.
- Narrow high speed belts.
- Elevated material fed with a trajectory.
- Transfer points discharging at angles
- Conveyors to bins

QUARRY ACADEMY

Belt width and speed

Belt width and speed

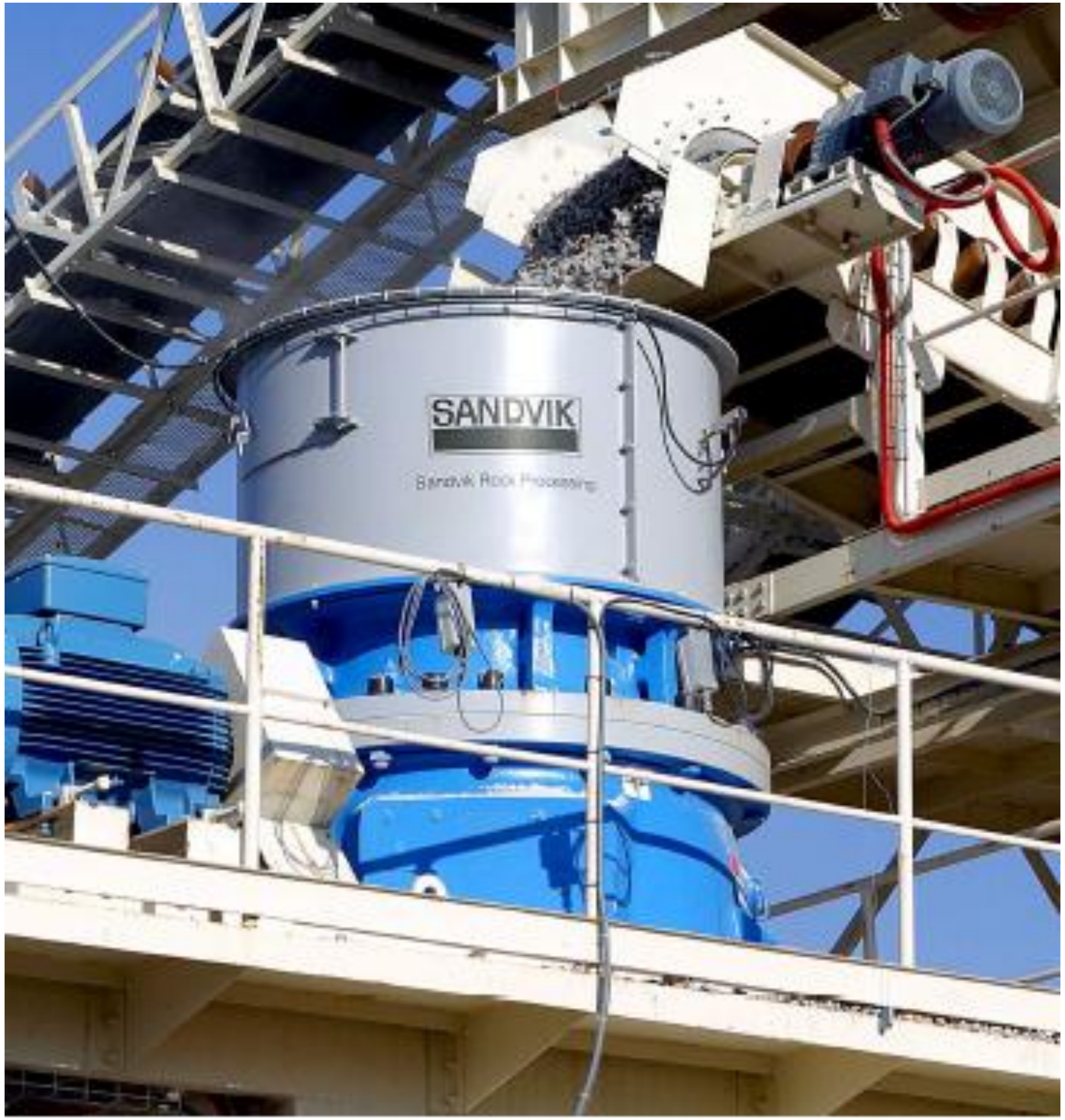
Static distributors and splitters

QUARRY ACADEMY

QUARRY
ACADEMY

QUARRY
ACADEMY

QUARRY
ACADEMY


SANDVIK
Sandvik Rock Processing

Summary

Poorly designed crusher feeds leading to segregation or uneven distribution are extremely costly and often remain so for the life of the operation. These costs result from:

1. Re-crushing oversize through running crushers wider than necessary.
2. Detrimental effects on product quality.
3. In serious cases increased capital expenditure
4. Energy and wear costs as oversize is transported around the plant.

QUARRY ACADEMY

Summary

5. Poor utilisation of manganese liners through uneven wear.

6. Poor utilisation of component parts through extreme cyclic overloading.

7. In serious case traumatic unplanned mechanical failures.

8. Lost business opportunities.

QUARRY ACADEMY

Improved feeding

I hope we have given an insight into some causes, consequences and possible solutions to poor feeding.

Segregation and /or poor distribution, if they already exist can and should be improved.

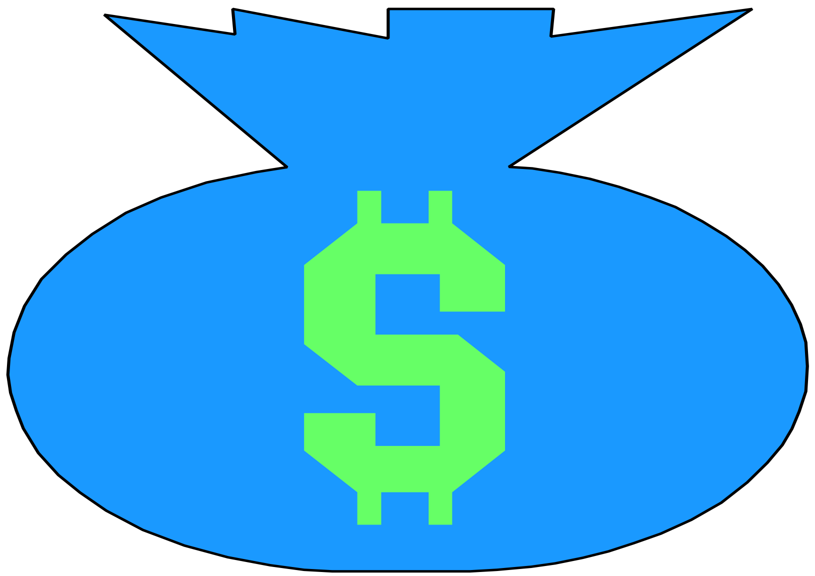
Automation - Control

Audience Survey

- How many of you have some form of automation in your plants today?
- How many of you have some form of automation on your cone crushers today?

Why Automation Control ?

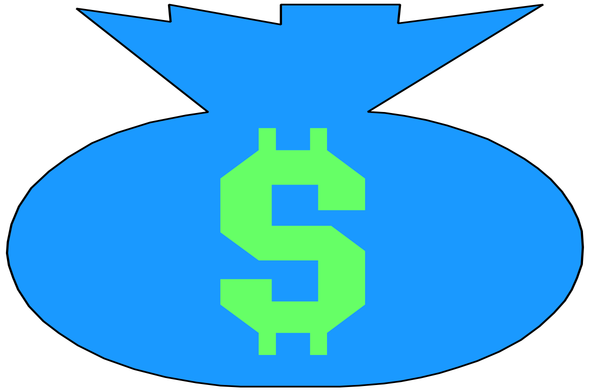
- Repetitive conditions
- Free up man power
- Increase reaction time
- Control a system remotely
- Increase efficiency of a system
- Maximize efficiency of a piece of equipment
- Increase product quality
- Protect capital investment
- Optimize a particular product
- Monitoring operation
- Data gathering




CAUTION

WHY AUTOMATE YOUR CONE CRUSHER ?

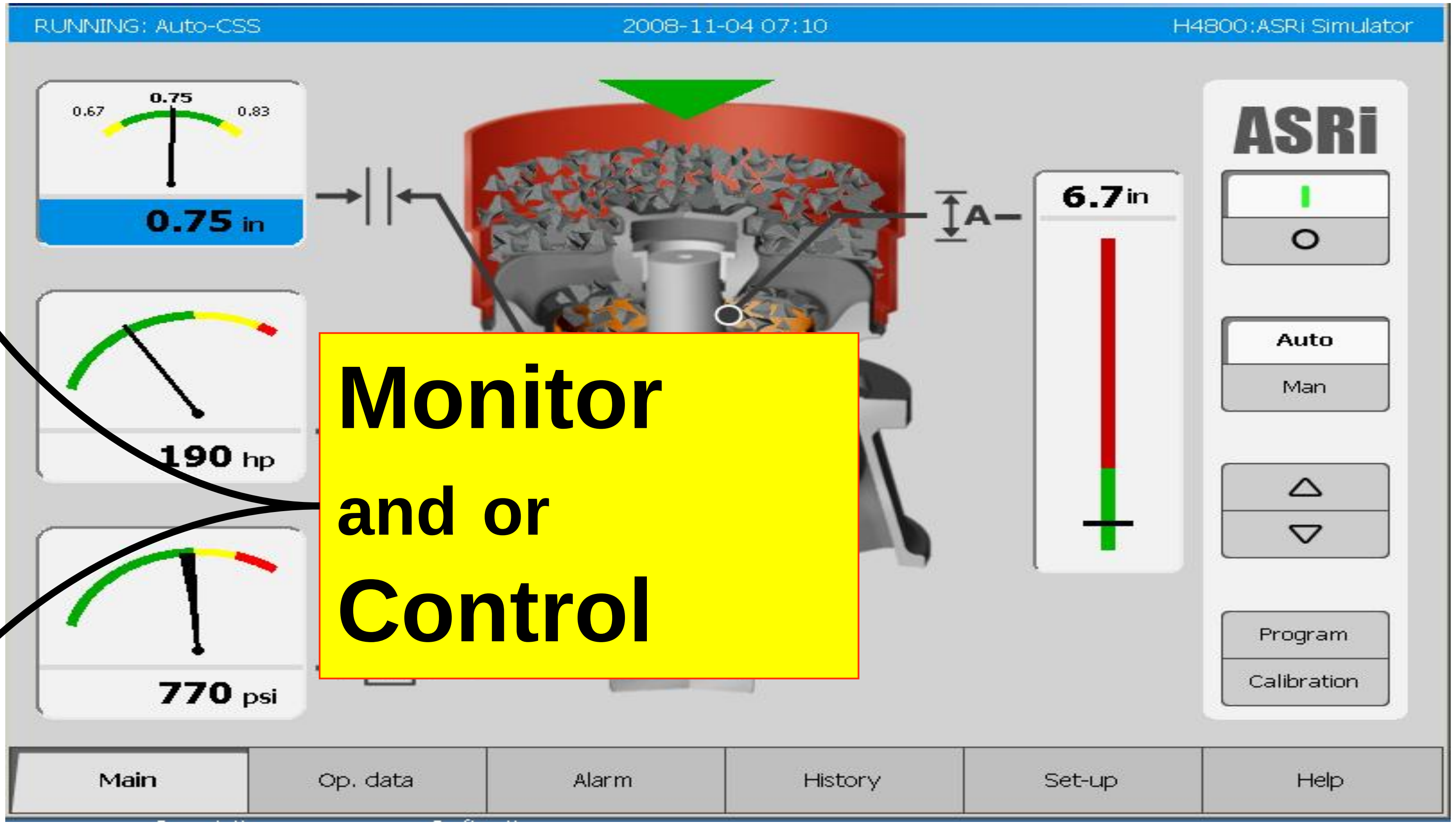
- Realize a higher return on your investment.
  - Higher net production of desired products
  - Optimum power utilization
  - Continuous generation of quality products
- Protection of your investment
  - Constant overload protection
  - Continuous adjustment compensating for changes in material characteristics
  - Ability to analyze operational data



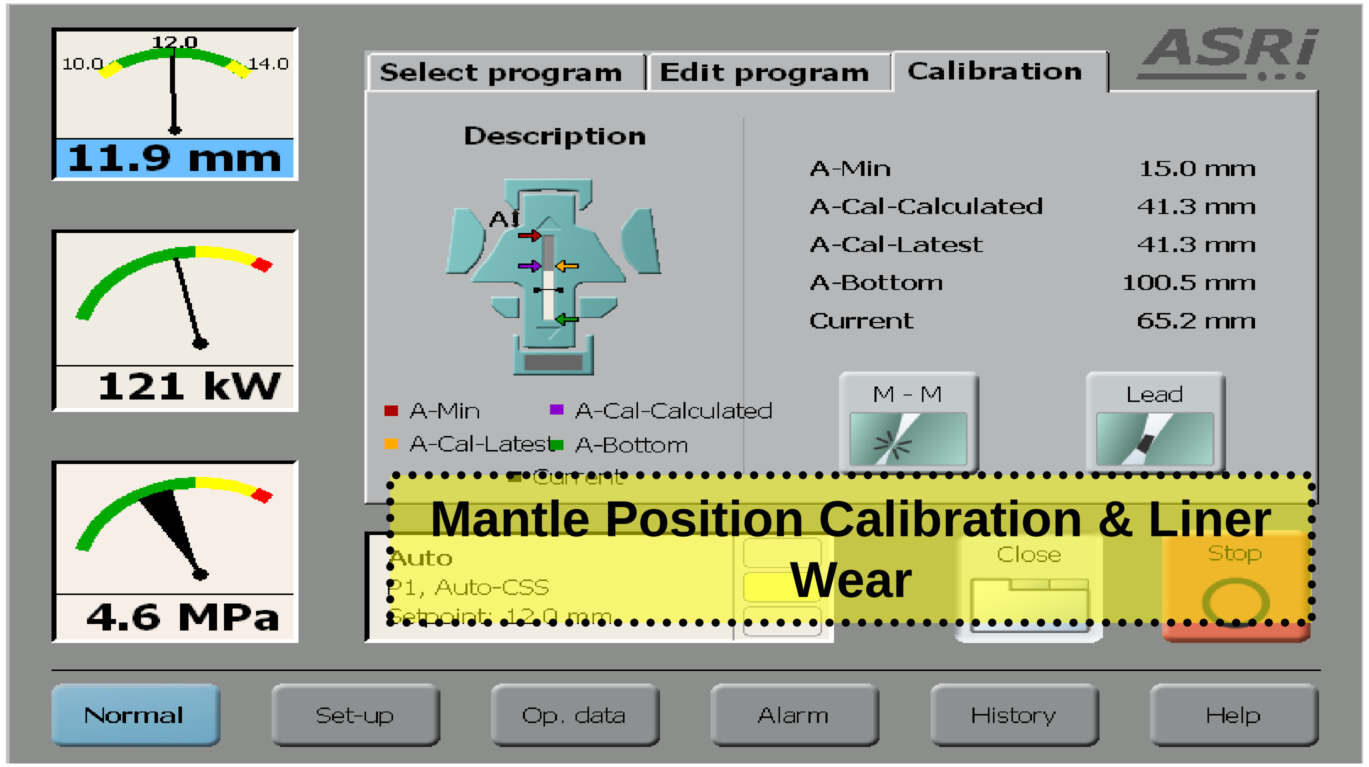
QUARRY ACADEMY

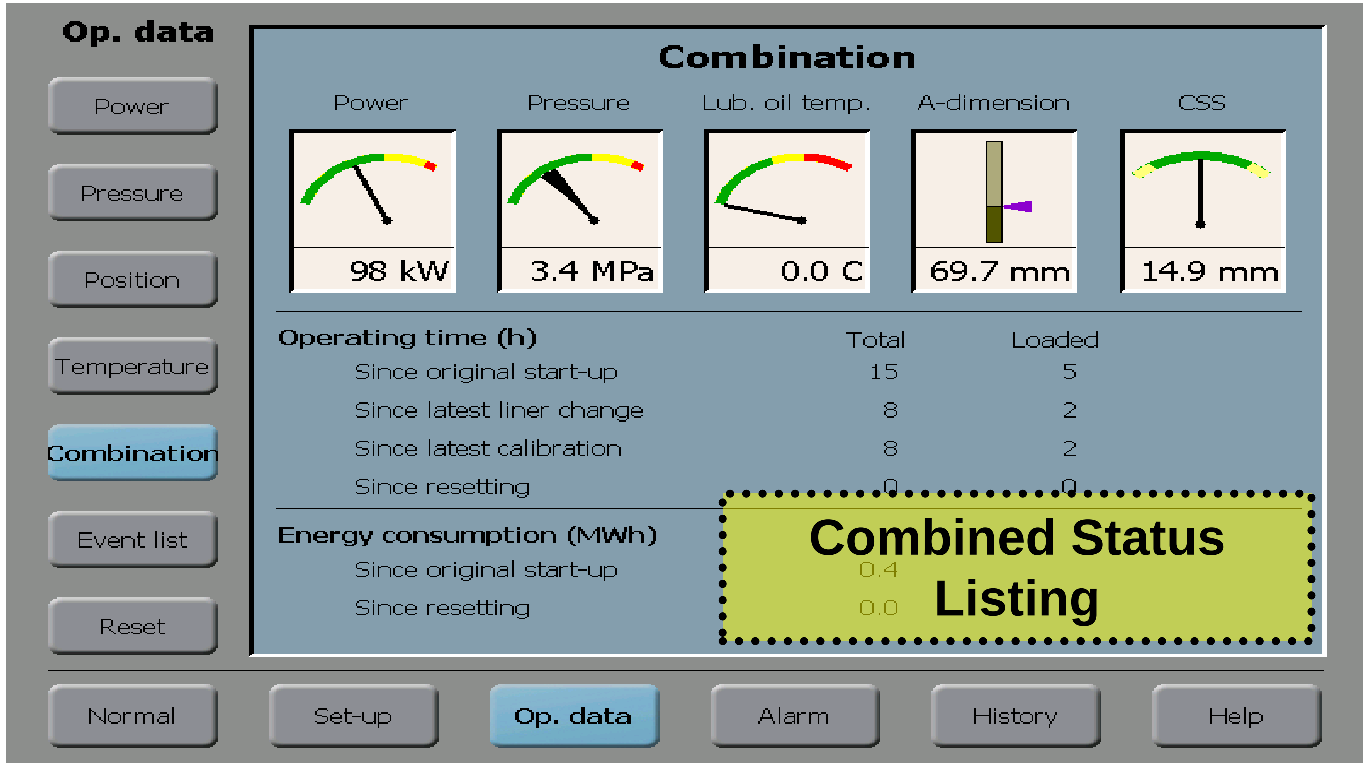
Monitor and Control
Available at a push of a button

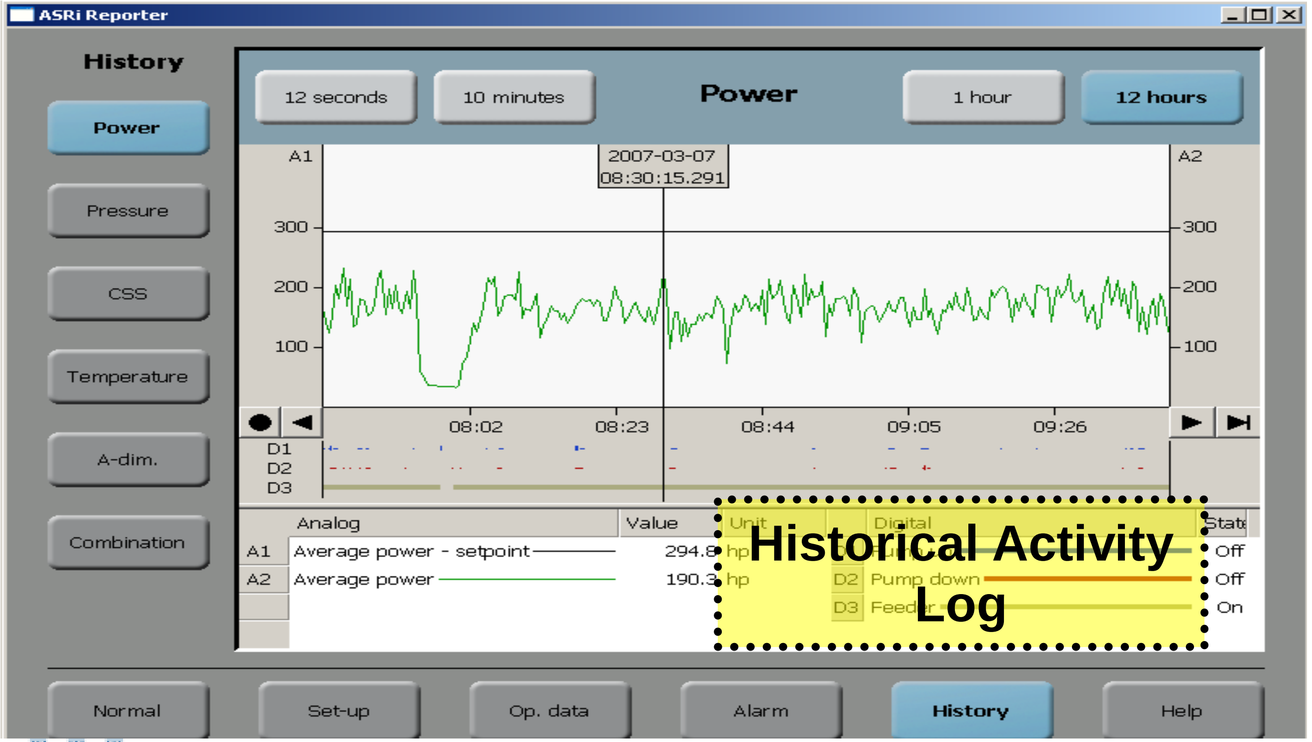
- Closed Side Setting
- Horsepower in use
- Power consumption
- Load Time
- Operating time
- Hydraulic Pressure
- Lubrication Oil temperature
- Liner Wear
- Recorded data
- Graphing data

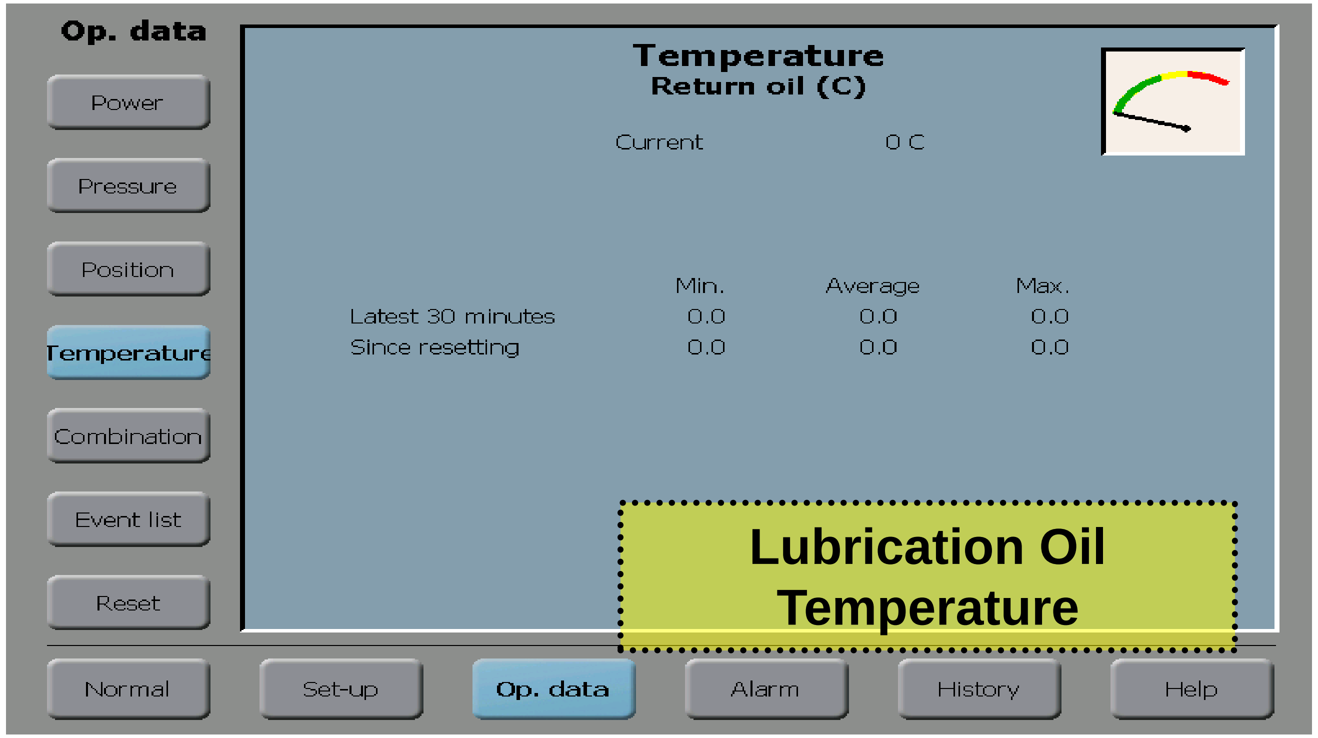


QUARRY ACADEMY



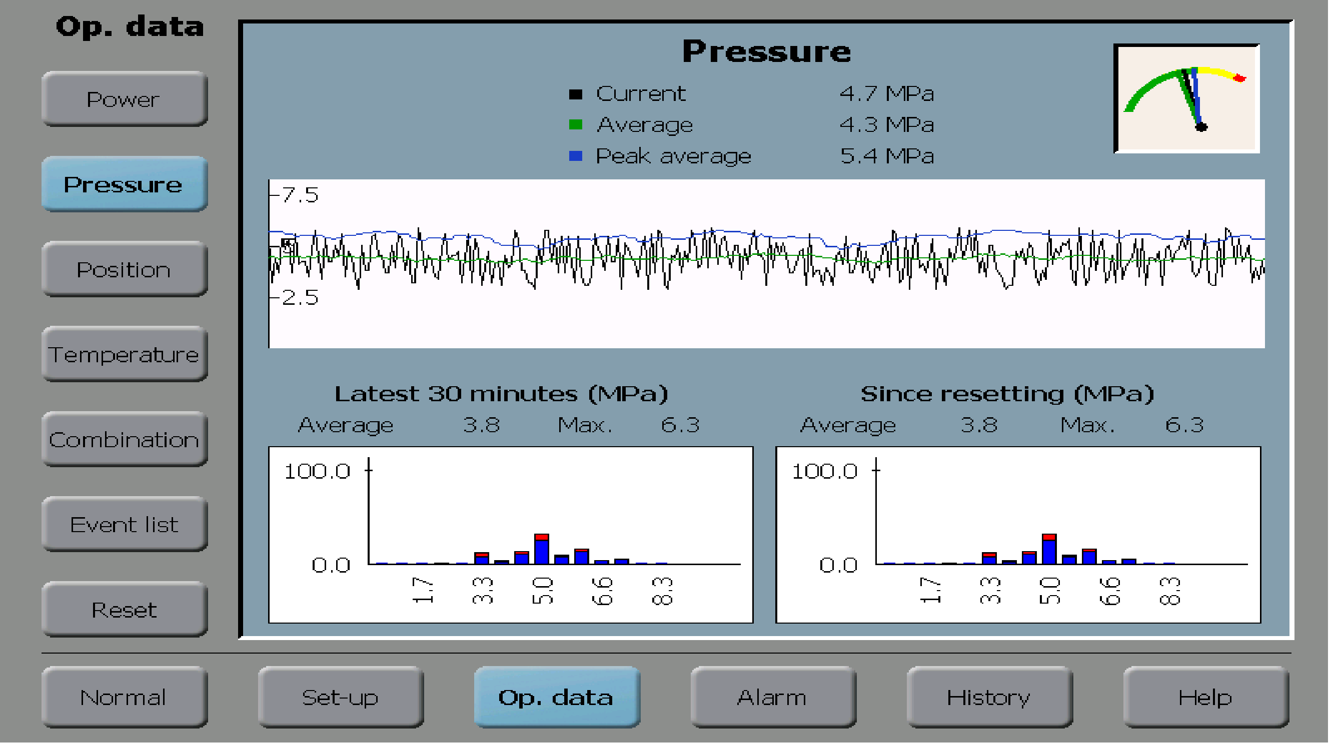


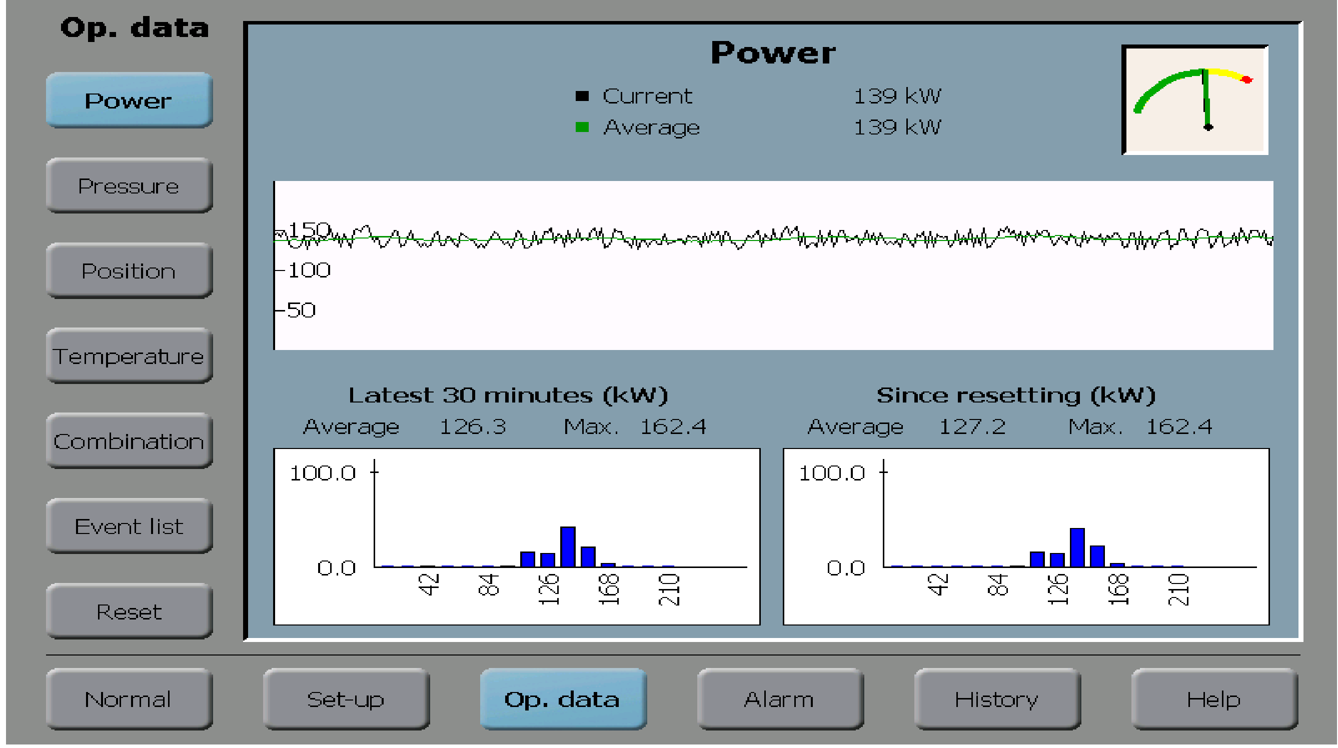


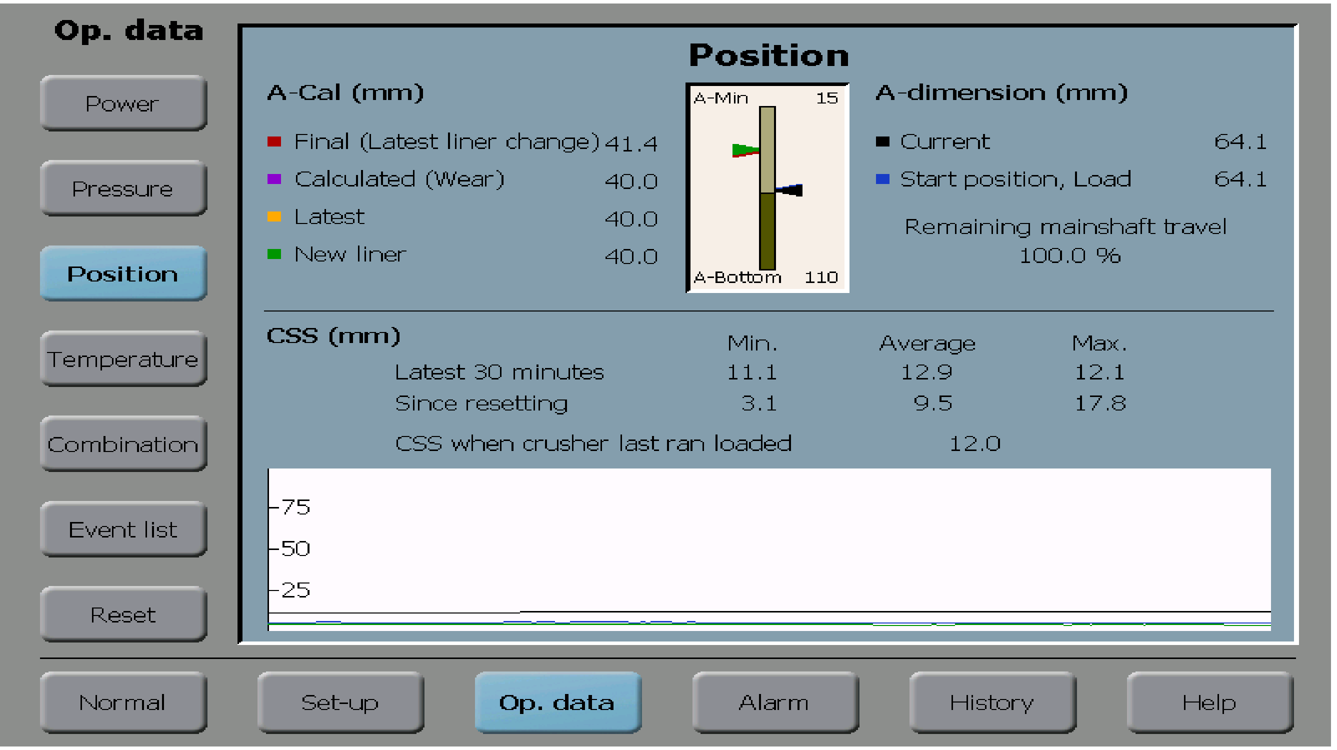


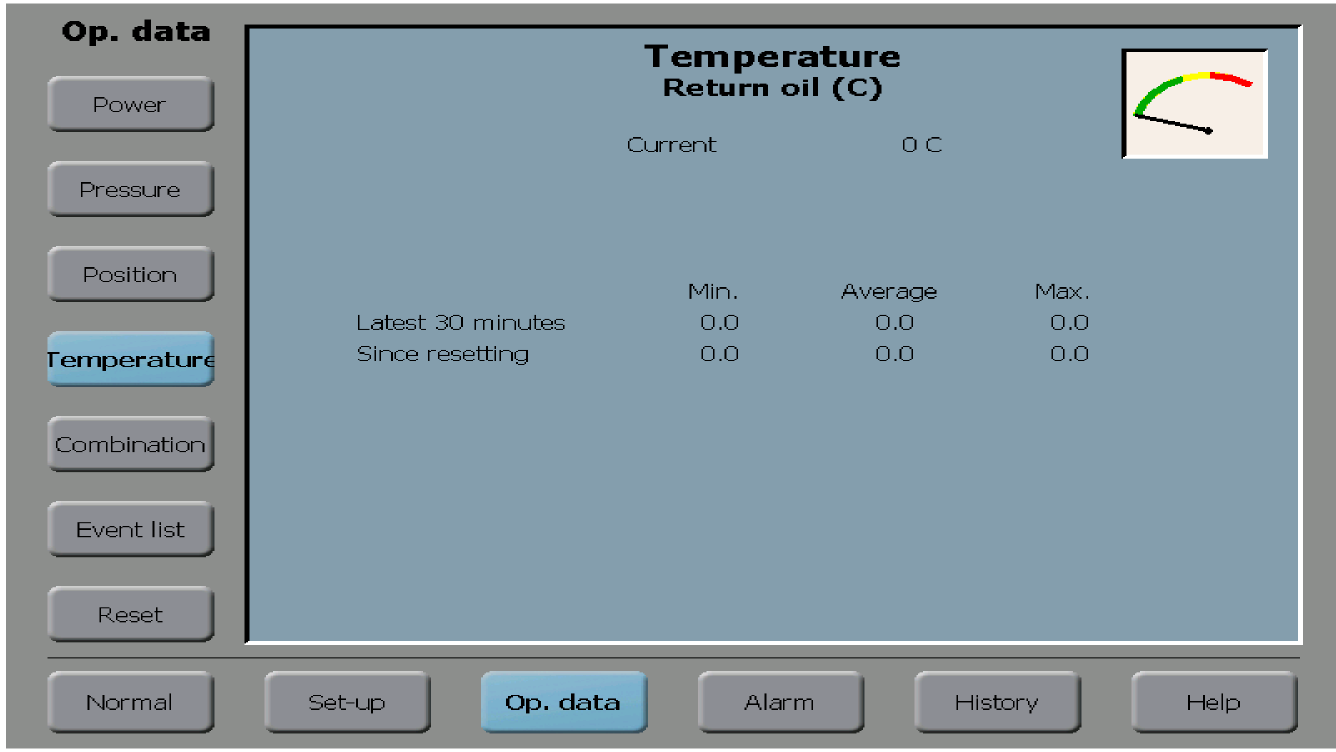
QUARRY ACADEMY

Historical Activity Logs

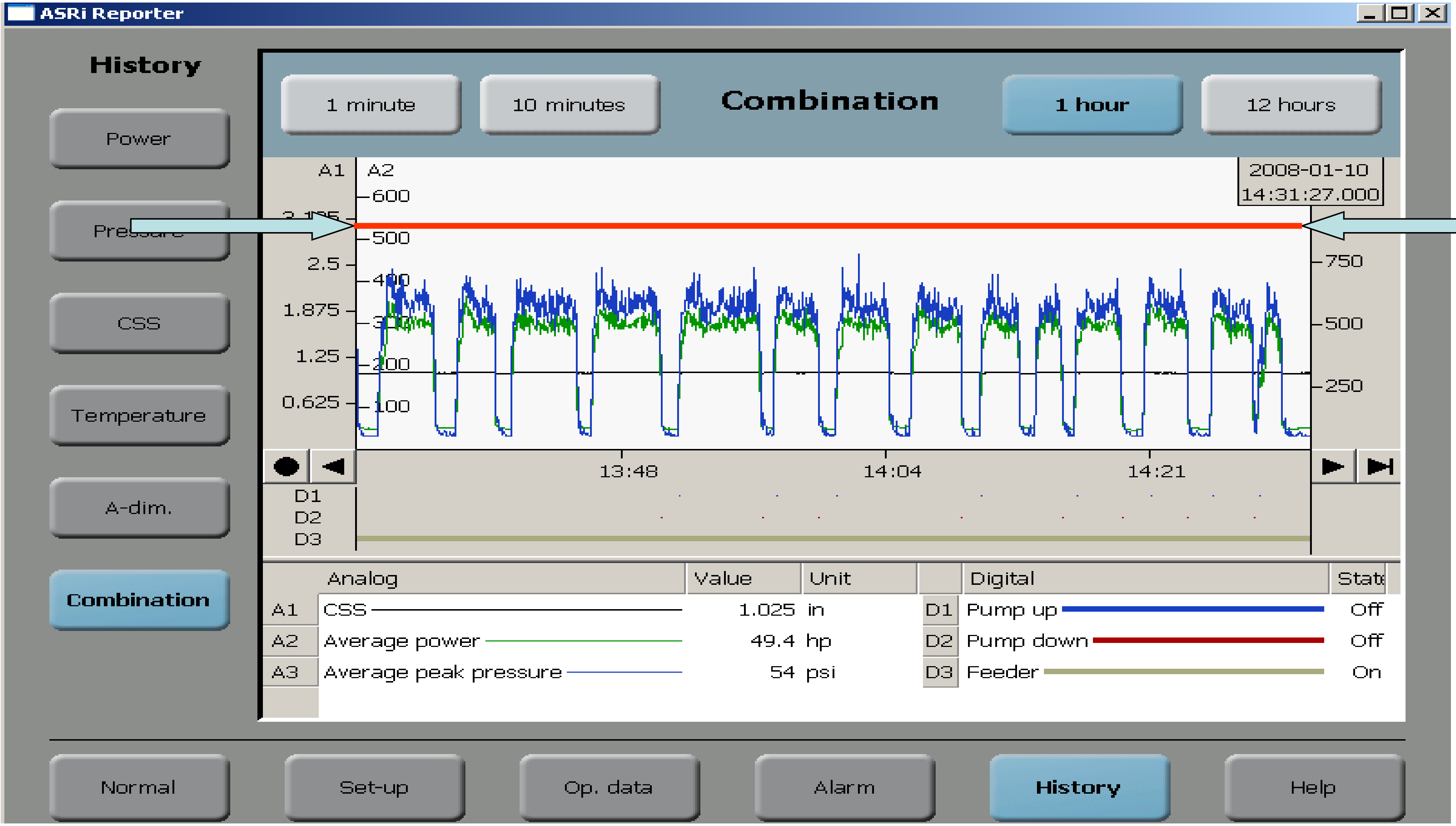






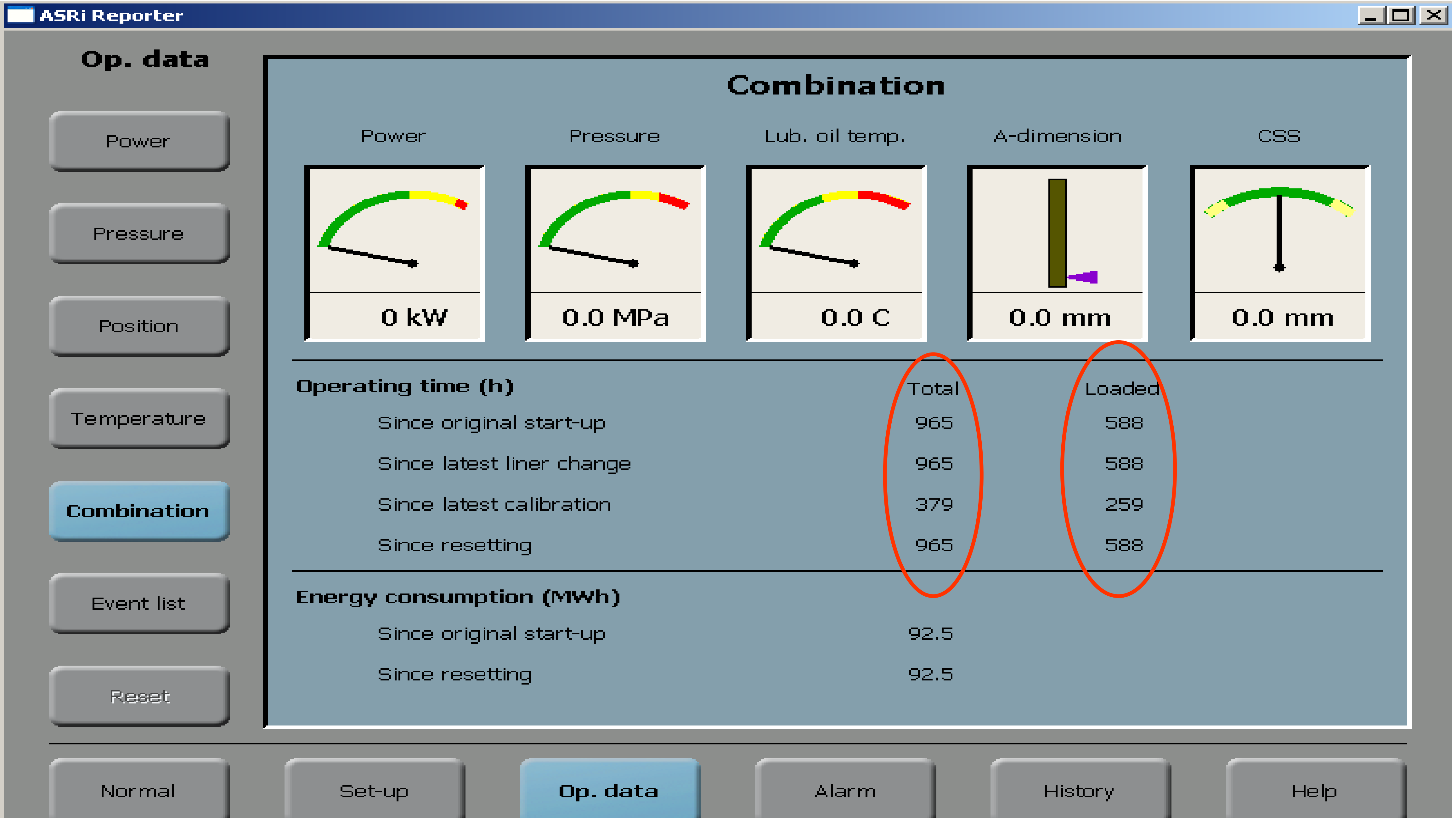


QUARRY ACADEMY



One Hour time span

QUARRY ACADEMY

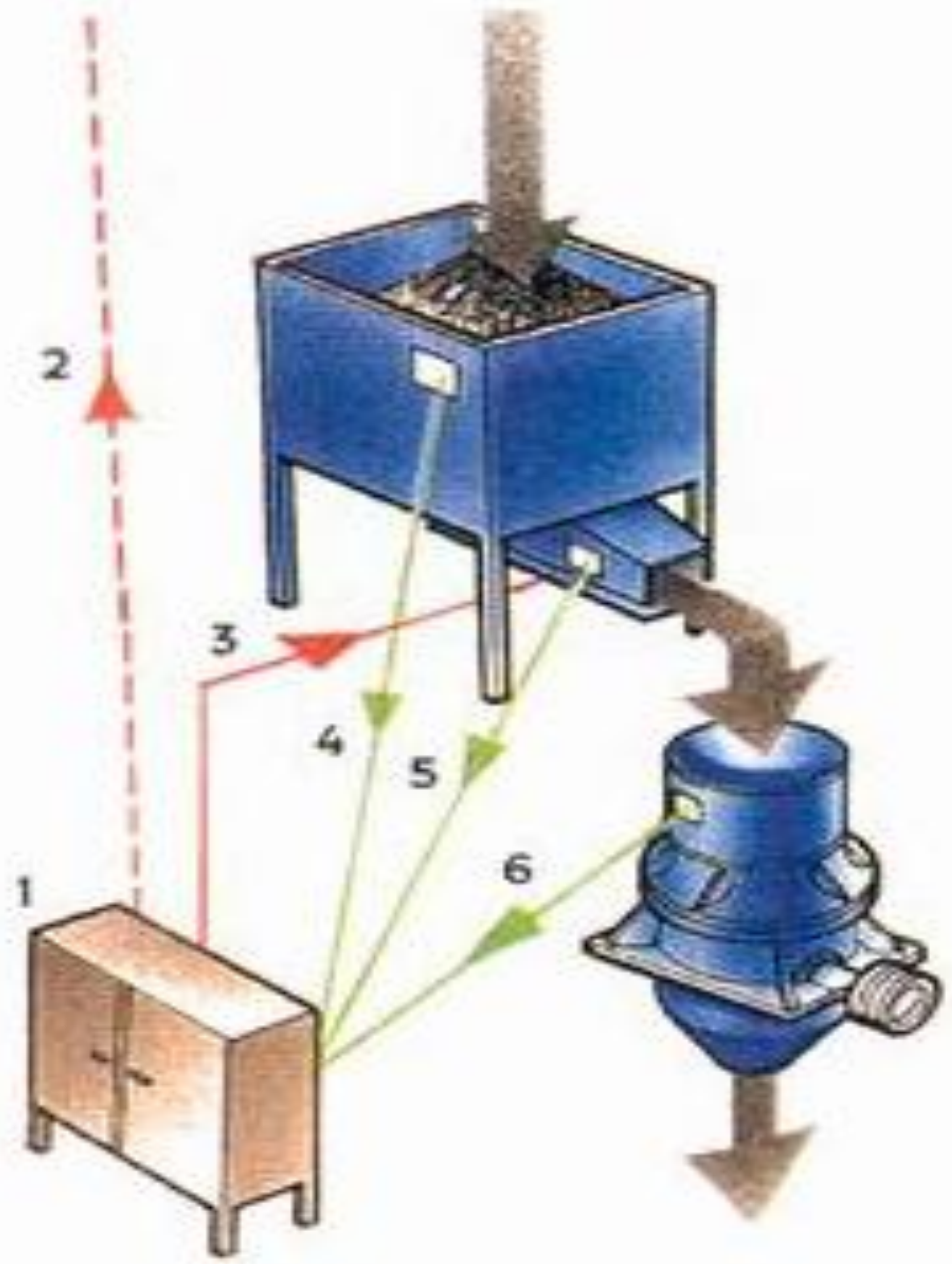


Loaded 66% of an hour

QUARRY ACADEMY

System Automation & Control

1. Switch gear unit
2. Stop signal to feeder
3. Control signal to feeder
4. Max. level in surge bin
5. Min. level in surge bin
6. Max. level in crusher feed hopper



Automation

- Other things to consider
  - Automation mode vs Manual mode
  - Durability of use
  - Is the tool easily used

QUARRY ACADEMY

In summary automation of a compression crusher will provide:

- Higher net production of desired products
- Optimum utilization of motor power
- Continuous adjustment of setting to compensate for feed conditions.
- Full utilization of the units capacity
- Constant overload protection
- The ability to analyze operating data
- The opportunity to monitor the unit from remote location.

QUARRY ACADEMY

www.quarryacademy.com

Thanks for your attention

QUARRY ACADEMY

Improving Processes. Instilling Expertise.

DYNO Dyno Nobel

SANDVIK