Improving compressed air network efficiency in South African PGM mines through continual monitoring and reporting

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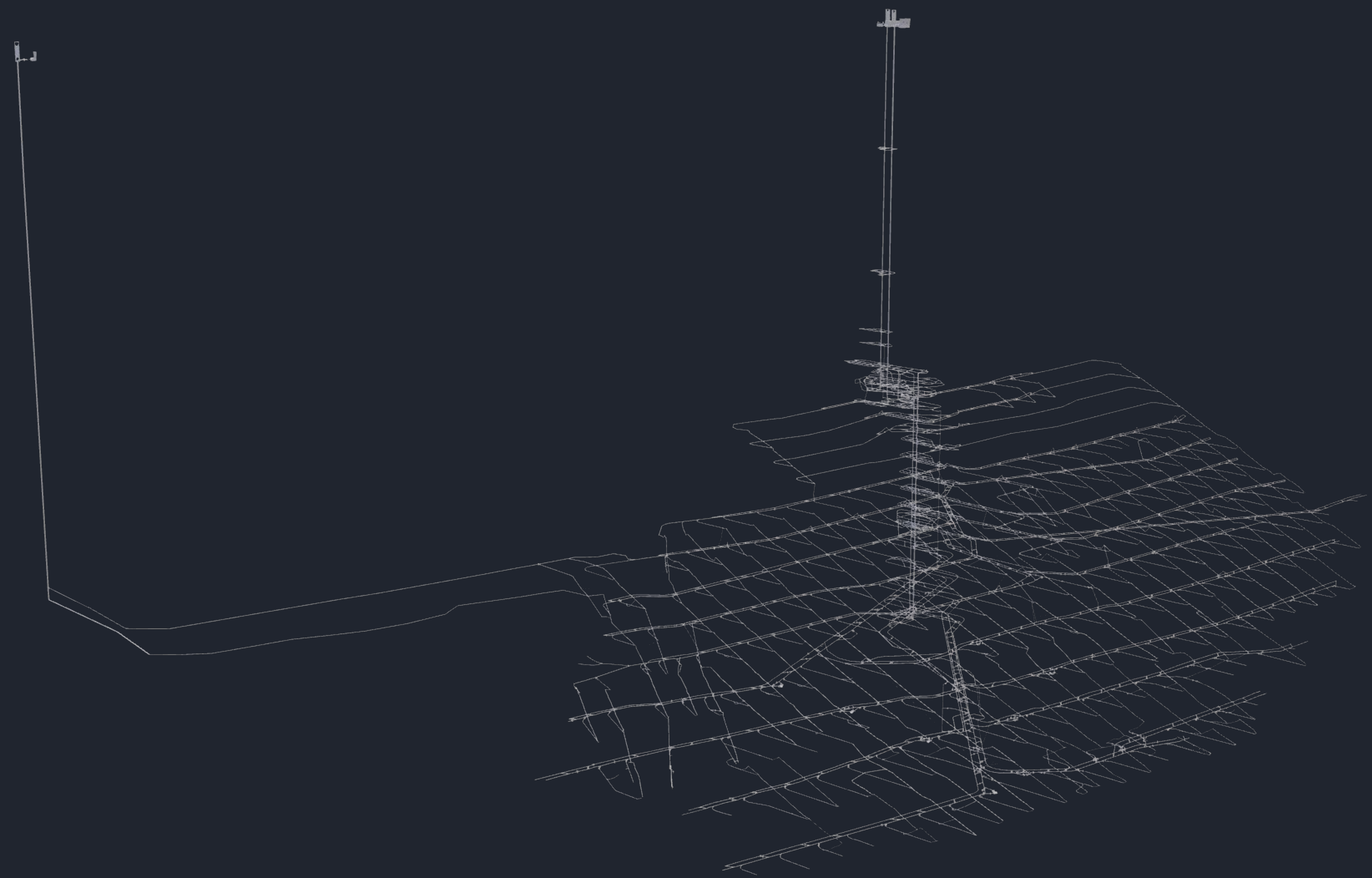

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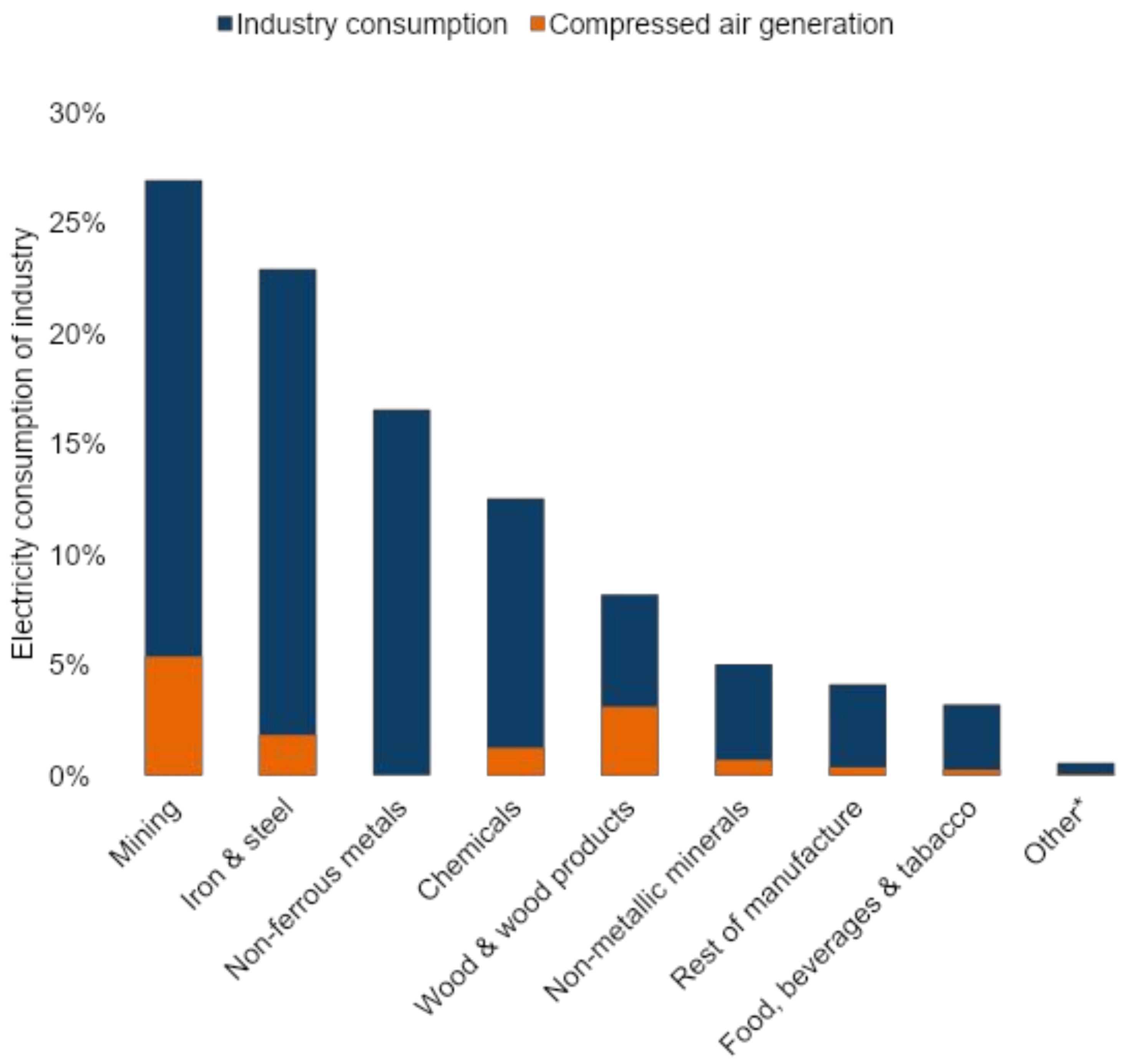
Introduction

- Compressed air is an essential utility in the South African mining sector [1]
- Accounts for approximately 21% of a typical mine's electricity usage [2-3].
- Wastage of this utility is widespread in the mining industry.
- Typical sources of inefficiency on the demand side [3-6]:
  - Leakages;
  - Misappropriation;
  - Supply to inactive mining sections.



*Other: Textile, cloth & leather, and the remainder of basic metals

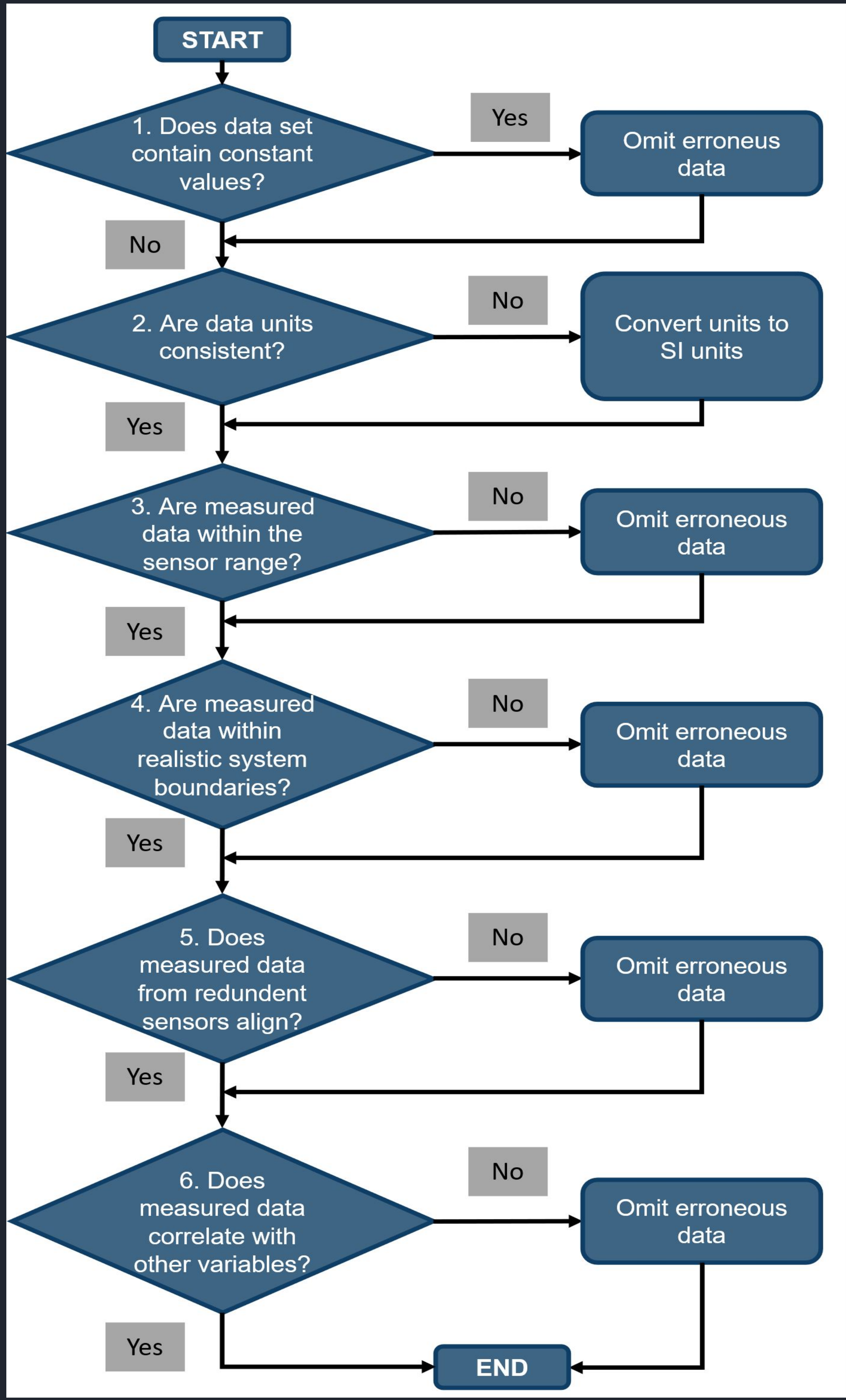
References are listed at the end of the presentation.

Problem statement

- Compressed air accounts for approximately 21% (and in some cases up to 35%) of a typical mine's electricity consumption [2-3].
- Compressed air wastage is widespread in the mining industry [3-6].
- Rising electricity prices threaten the operation's profitability [7].
- **There is a need to address compressed air demand-side mismanagement, widespread leakages and unauthorised use.**
- Previous studies identify and aim to address these problems, **but lack a framework for sustained performance management, through continual monitoring and reporting.**
- The aim is to create a systematic approach that:
  - Identifies, validates and analyses performance data;
  - Creates automated hierarchical reports for various stakeholders;
  - Establishes a procedural workflow for acting on inefficiencies.

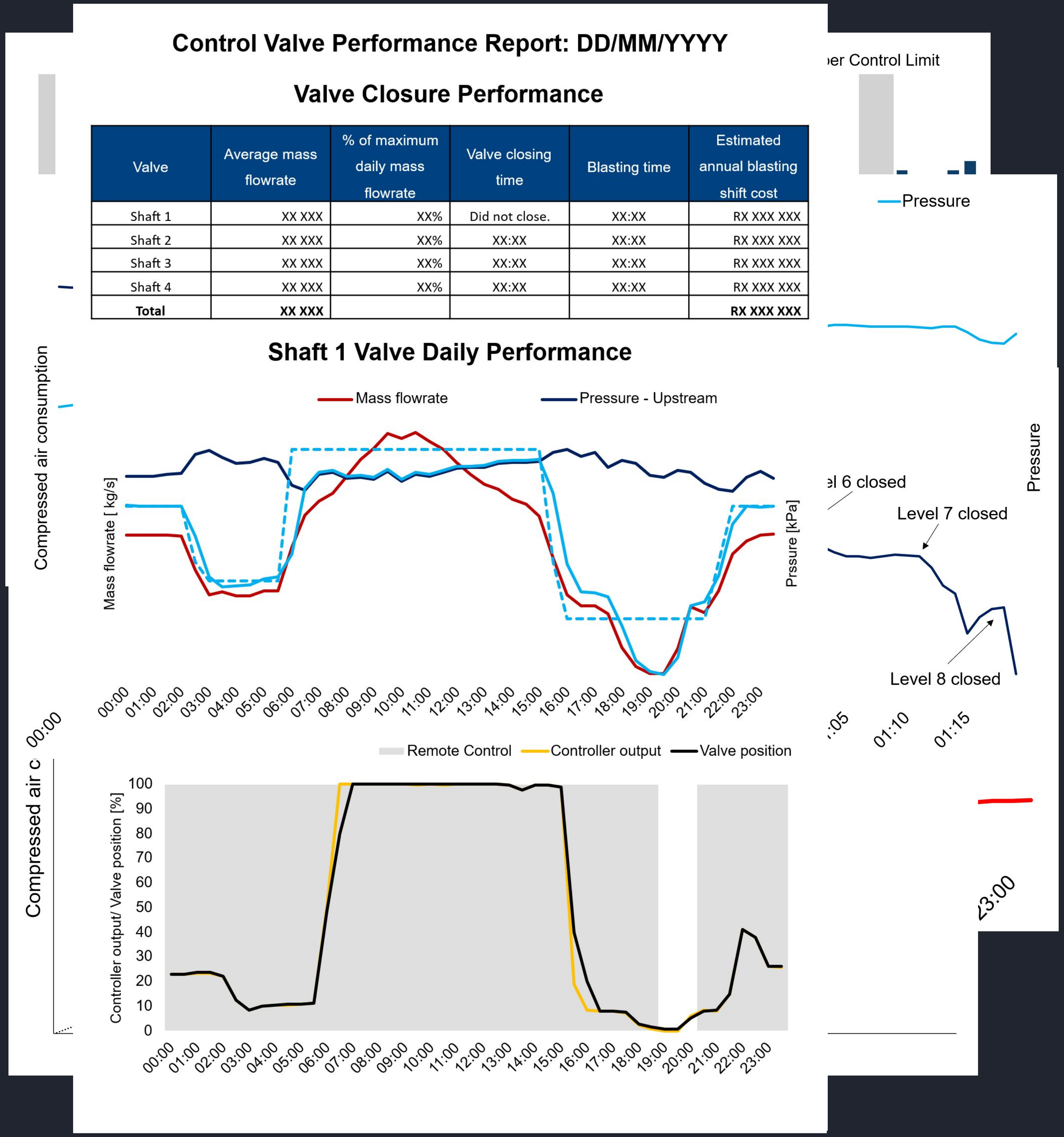
Methodology overview

- Data
  - Identify required data
  - Acquire data (set up automated flows/pipelines)
  - Validate data
- Report development
  - Investigate analysis techniques
  - Identify KPIs and develop visualisations for insights
  - Develop automated reports
- Continual monitoring and reporting
  - Monitor reports
  - Identify inefficiencies and anomalies
  - Report findings
- Act
  - Identify responsible personnel
  - Develop an action plan
  - Track progress



Data

1. Identify and acquire
   - Process data
     - Electricity consumption
     - Flow rate
     - Pressure
     - Control equipment performance indicators
   - Production data
   - Organisation hierarchy
   - Layouts
     - Physical
     - Services
2. Validate [3]
   a. Apply multiple checks to ensure the data is trustworthy and accurate (Refer to image)



Control Valve Performance Report: DD/MM/YYYY

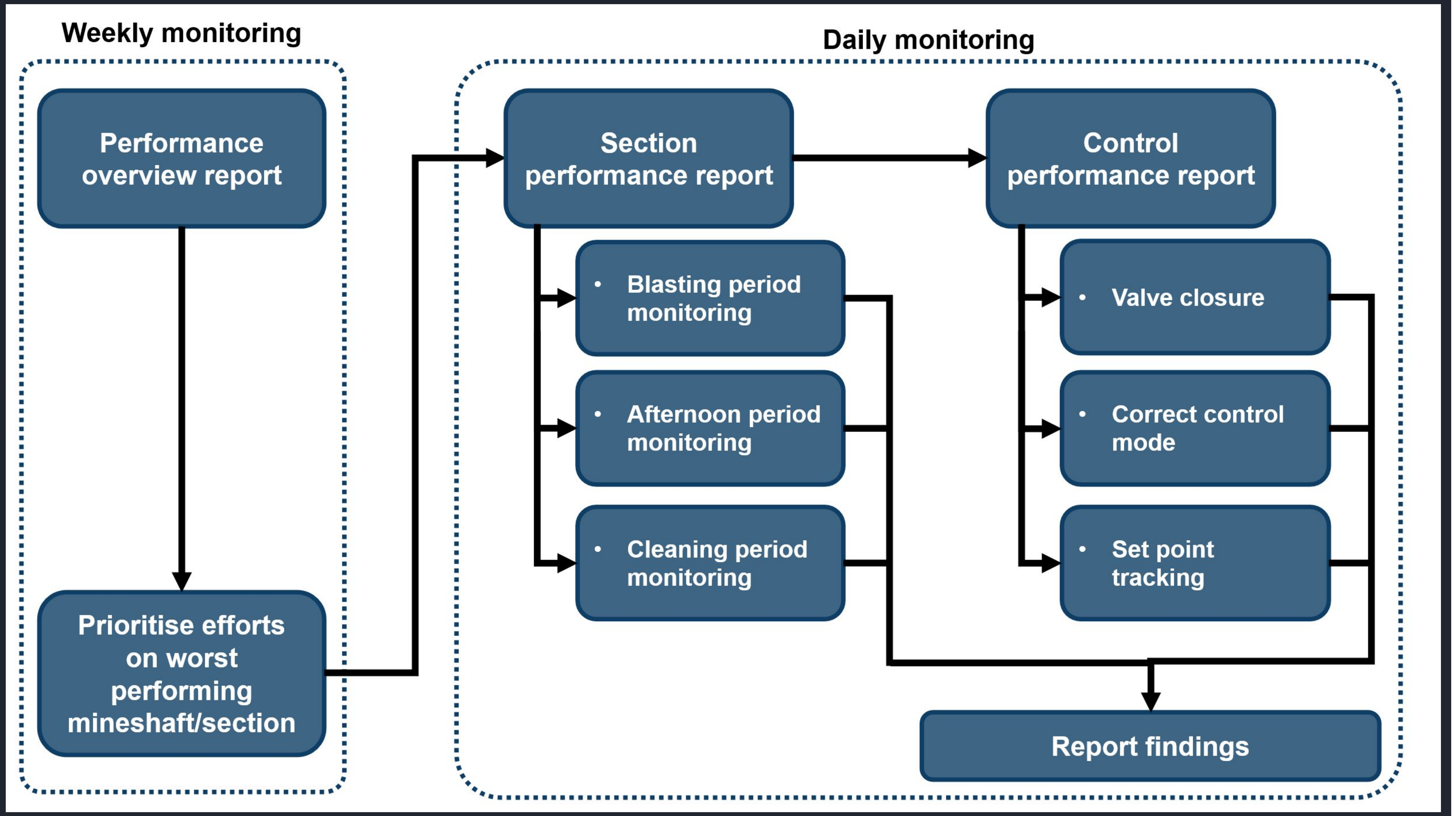
Valve Closure Performance

Valve	Average mass flowrate	% of maximum daily mass flowrate	Valve closing time	Blasting time	Estimated annual blasting shift cost
Shaft 1	XX XXX	XX%	Did not close.	XX:XX	RX XXX XXX
Shaft 2	XX XXX	XX%	XX:XX	XX:XX	RX XXX XXX
Shaft 3	XX XXX	XX%	XX:XX	XX:XX	RX XXX XXX
Shaft 4	XX XXX	XX%	XX:XX	XX:XX	RX XXX XXX
Total	**XX XXX**				**RX XXX XXX**

Shaft 1 Valve Daily Performance

Report development

- Many analysis techniques exist:
  - Daily consumption analysis [8]
  - Profile analysis [8]
  - Intensity analysis (consumption per production unit) [4]
  - Step-test analysis [6]
  - Control equipment performance analysis [9]
- Need to compile into simple reports:
  - Section performance reports (Operational)
  - Performance overview reports (Management)
  - Control performance reports (Technical)
- These reports are developed for specific stakeholders.
- Information should always be conveyed as simple as possible.



Continual monitoring and reporting

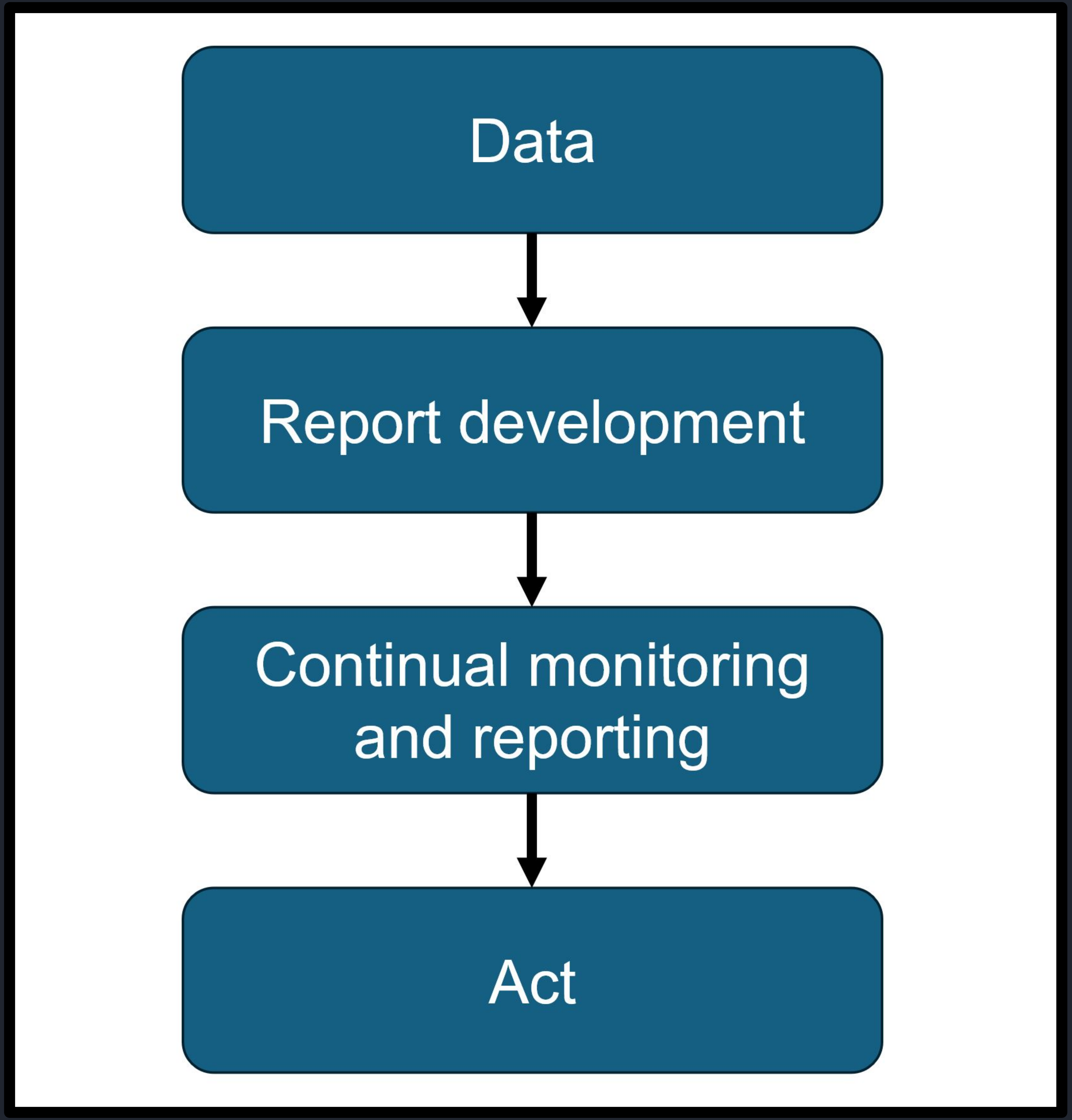
- Weekly:
  – Utilise Performance Overview Report
  – Prioritise efforts on worst performing mineshaft
- Daily:
  – Utilise Section Performance Report:
    - Blasting period monitoring
    - Afternoon period monitoring
    - Cleaning period monitoring
  – Utilise Control Performance Report:
    - Valve closure when no personnel are underground (blasting period)
    - Correct control mode
    - Set point tracking
- Reporting on findings and anomalies.

Act

Shaft	Section	Problem	Action	Photo	Responsible Person	Completion date	Status	Signature
Shaft A	Level 2 Crosscut 6	Open 2'' hose from manifold	Remove 2" hose if it is not being used – take temperature and report to ventilation.					
Shaft A	Level 2 Crosscut 7	4" pipe torn	Replace 4" pipe with new one.					
Shaft A	Level 2 Crosscut 7	Puncture hole in 32" hose	Remove 32 mm hose and replace with new hose.					
Shaft A	Level 2 Crosscut 8	Puncture hole in 32" hose	Remove 32 mm hose and replace with new hose.					

Track progress

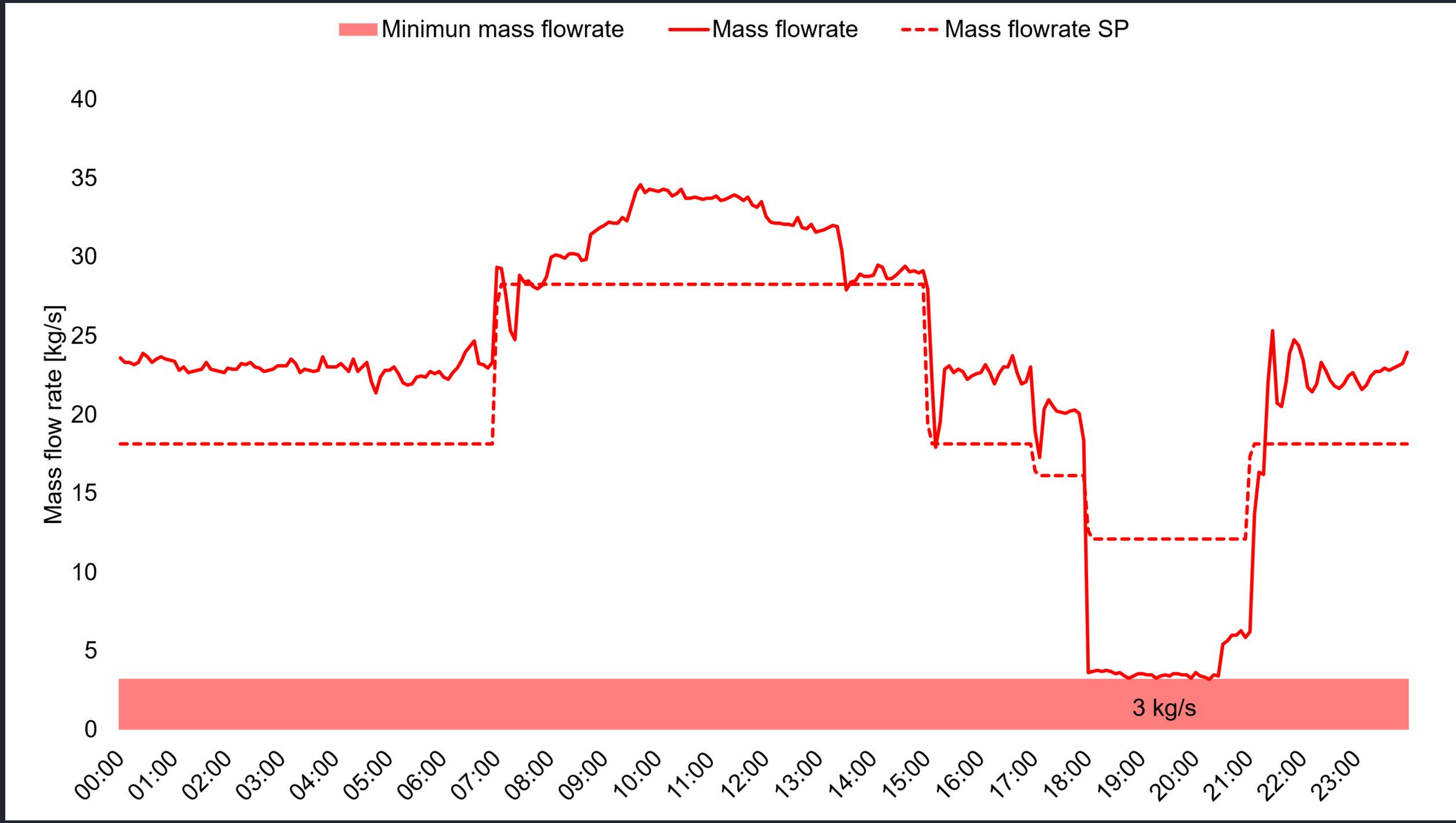
- Identify responsible personnel.
- Develop an action plan, clearly stating [10]:
  - Location of inefficiency
  - Inefficiency description (with an image if possible)
  - Date identified
  - Action required
  - Responsible person
  - Commitment date (to fix)
- Track it on a weekly basis until the inefficiency has been addressed.



Results

- Case Study A
  - Reactive approach to control equipment malfunction.
  - Use of Control Valve Performance Report in monitoring framework.
- Case Study B
  - Proactive approach to drive and sustain an energy savings initiative.
  - Mine-wide monitoring in one simplified report.
- Case Study C
  - Proactive approach to drive and sustain an underground initiative.
  - Performance overview report used to select section.
  - Section performance report used to promote a sustained energy savings from the initiative.

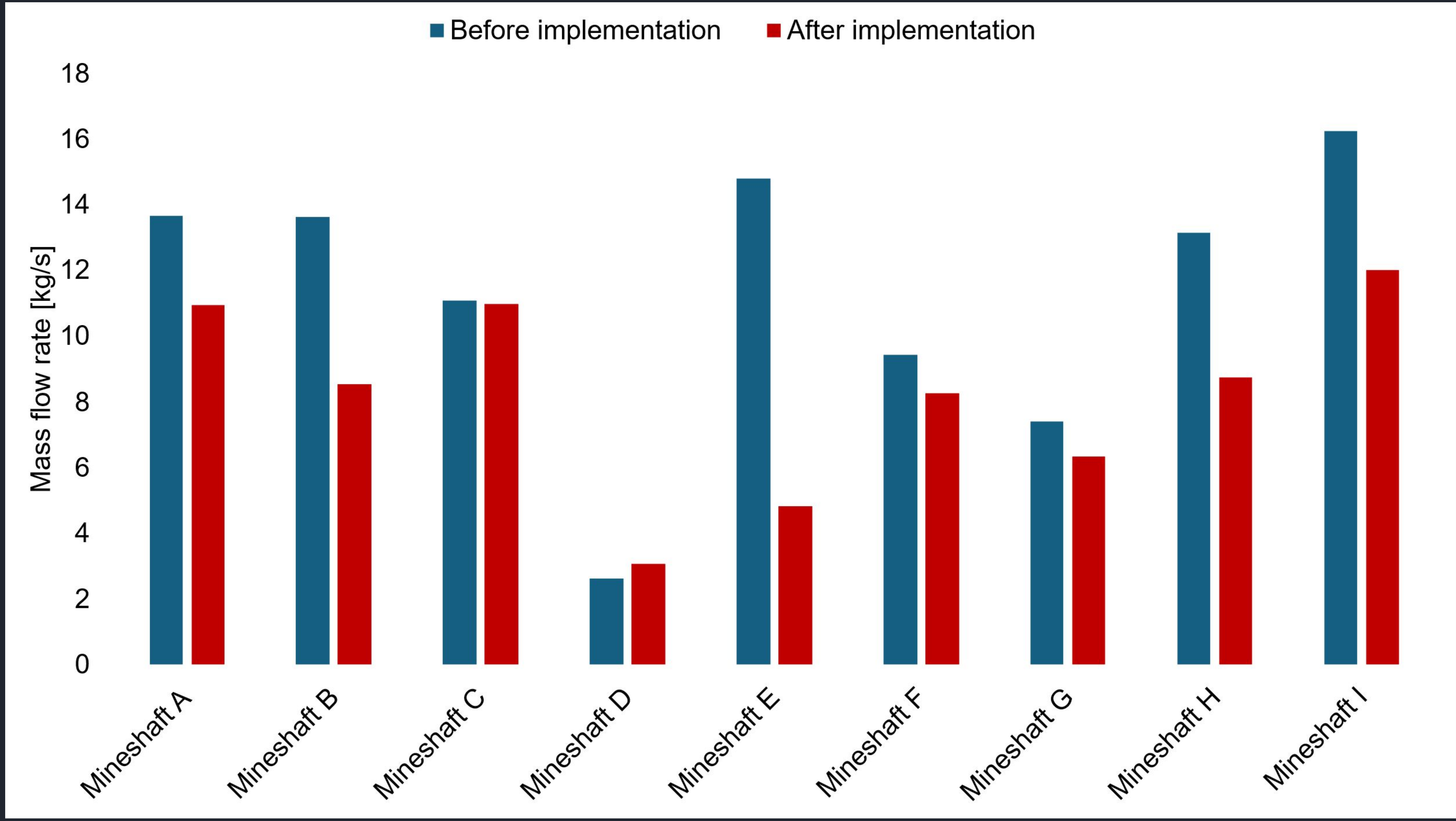
Results:
Case Study A



- Background:
  - Control valve installed on surface at the specific mineshaft.
  - Control philosophy designed to control on both flow rate and downstream pressure.
- Control performance report utilised to monitoring daily performance of control valve.
- Issue identified from Control Performance Report:
  - The mass flow meter registered a constant, non-zero flow rate, even during periods when the control valve was completely closed.

Results: Case Study A

- The issue was identified as a malfunctioning mass flow meter, which also impacted the current control scheme and lead to missed energy savings (wastage).
- Upon identifying the issue, it was escalated to the engineering and instrumentation departments (responsible personnel).
- While awaiting the replacement of the mass flow meter, a temporary control philosophy was implemented, allowing the system to operate using only downstream pressure readings.
- This swift intervention:
  - Restored automated control, and;
  - Averted a potential **energy waste of 116 MWh**, an equivalent **cost increase of R150 000.**



Results:
Case Study B

- Background:
  - Control valves installed on multiple mineshafts.
  - An initiative was launched that focussed on valve closure during blasting period.
  - Blasting period aligns with Eskom Peak Tariff period.
- Control performance report was used to monitor and report on this initiative.
- Initiative monitored over a period of 18 months.
- This initiative resulted in a **21% reduction** in compressed air consumption.
  - Equates to **5.6 GWh** in annual energy savings.
  - Approximately **R10.6-million** in annual cost savings.

Results: Case Study C

- Background:
  - Performance overview report was used to select the specific mineshaft where efforts should be focussed.
  - After investigation, and approval by management, an initiative to address substandard ventilation controls was implemented.

Figure A: Broken ventilation ducting

Figure B: Lack of brattices in a centre gulley

- Approach: Address substandard ventilation controls to lower compressed air wastage.

Results:
Case Study C

- Initiative was monitored for a period of 15 months.
- Through monitoring, reporting and acting on inefficiencies, the following was achieved:
  - Annual energy saving of 3.7 GWh.
  - Annual cost saving of R7.2-million.
- To further verify whether the initiative was implemented successfully, monthly intensity was also considered.

Conclusion

- The problem of compressed air wastage is massive and persistent.
- Mines typically generate a large amount of data, from which useful reports can be generated and insights can be gained.
- A practical solution was developed and implemented on three PGM mining case studies.
- The impact of sustained initiatives leads to major cost reductions (approx. 17.8-million, annually) .
- Considerations for future studies:
  - Adapting the methodology to other major electrical systems.
  - Improving blasting period clearing time through new technology such as Missing Person Locator (MPL) systems.

PGM

MINING

ENERGY

COMPRESSED AIR

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