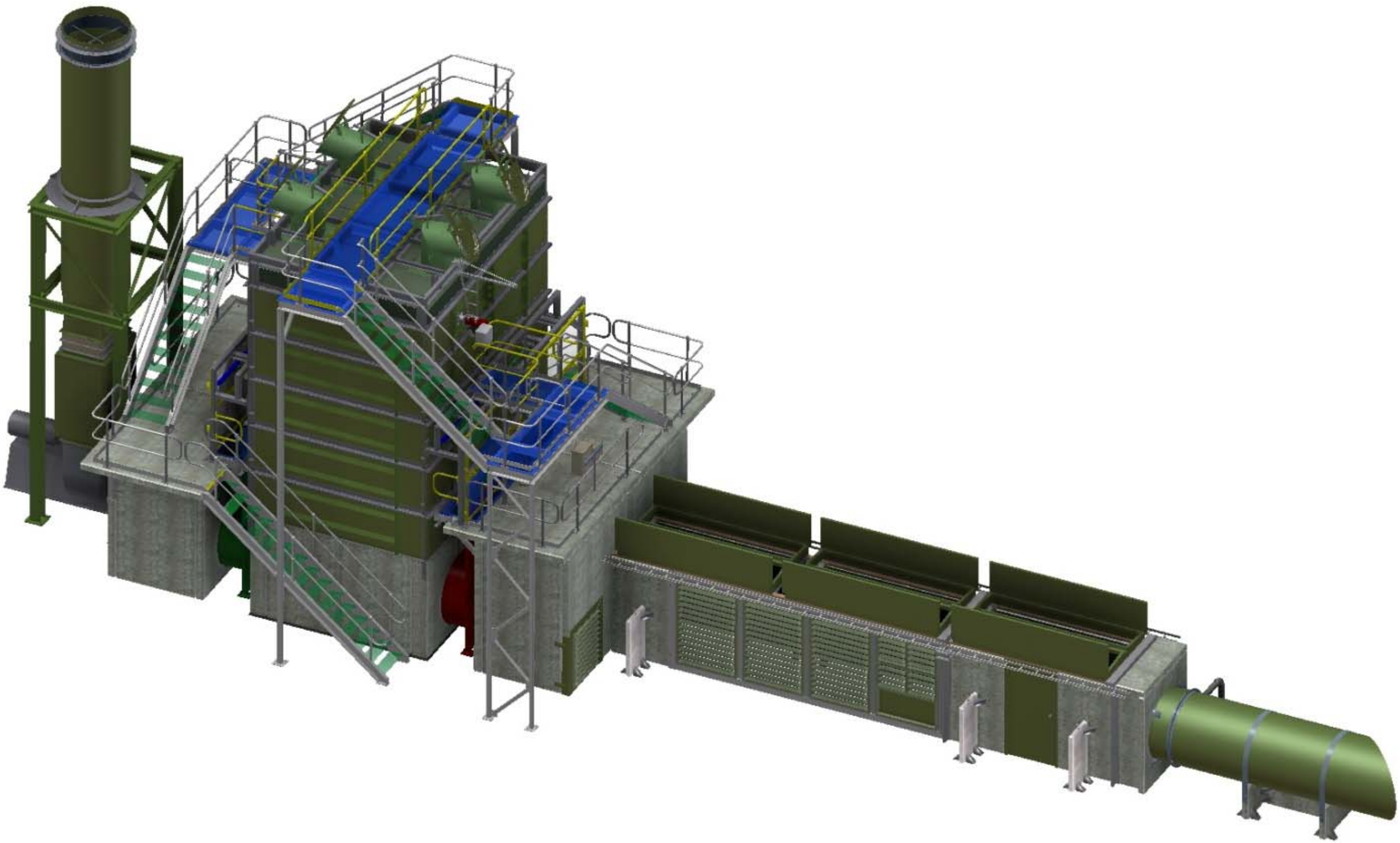
VAM RAB



Solving Unique Technical Problems

If VAM is such a large issue why has it not been solved before?

Unique technical restraints on technology:

- Safety – must manage the system so there is no flame path between the reactor and the mine
- Mine dust may react with bricks
- Maintaining reactor temperature, VAM does not sustain oxidation easily, which is good for safety but poor for abatement
- Cost of safely deploying "new technology"
- Footprint

Corky's aims to demonstrate the answers to the first three questions with their current VAM RAB project . The 4th and 5th question will be answered in a further scale up project which is currently being contemplated.

Perceived Barriers to VAM Abatement

- Safety

  "It will be a candle at one end of the mine"

- Fluxing

  "Mine dusts react with brick"

- Temperature control

  "VAM is highly variable. A 600% upswing is likely at times"

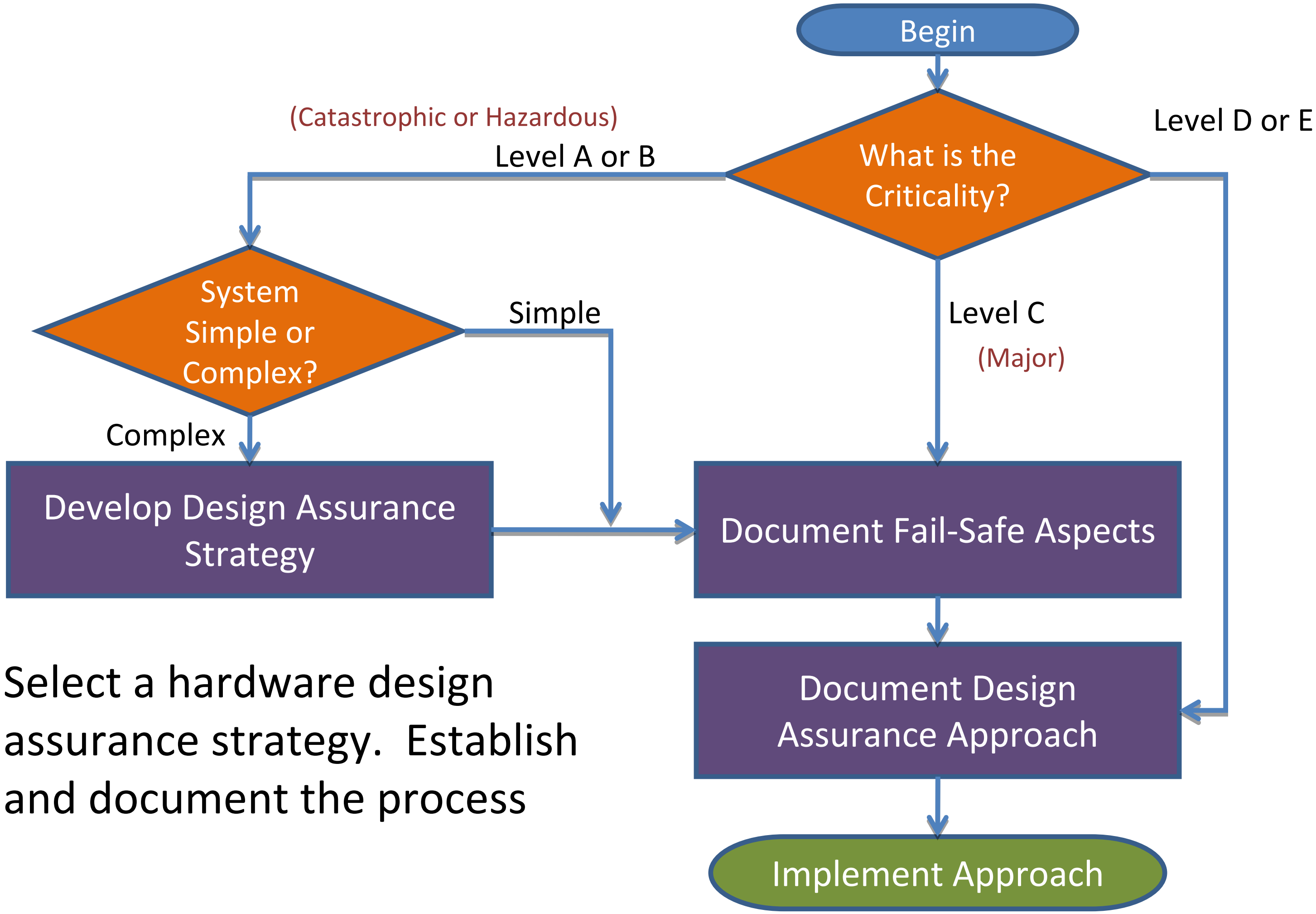
- Cost and footprint of new technology

  "No safe mine connection yet proven"

- Design Assurance Process

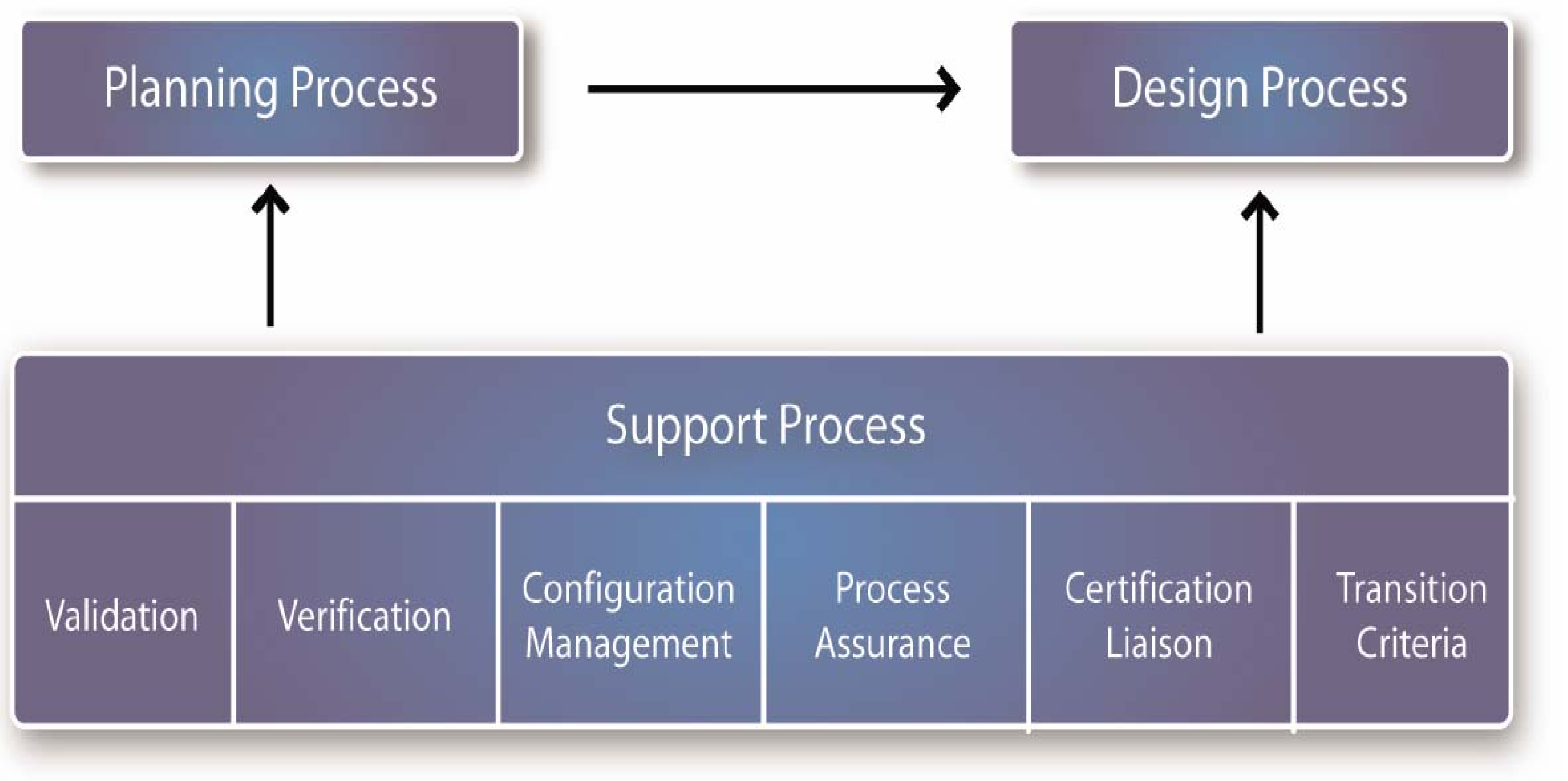
  "No safety standards are available for this technology"

Design Assurance – DO-254



Select a hardware design assurance strategy. Establish and document the process

Design Assurance – DO-254



Design Assurance – DO-254

— Define how the hardware requirements trace to functionality. **How do we prove assurance?**

- Define the lifecycle process
- Select and document:
  - Standards
  - Codes
  - Regulations
  - Independent reviews
- Determine where there are gaps and deviations from prescribed standards
- Define the hardware development and verification environment (where and how will we qualify)
- Define the hardware design assurance strategy (the minimum compliance framework to be met)

Design Assurance – DO-254

- **Requirements capture is the key.**
- Documents and processes used can be **closely audited** for certification.
- All system requirements implemented in hardware should be documented. For example, architecture, test structures, interfaces, and power characteristics.
- Any **safety requirements** related to the hardware should be documented. For example, requirements for loss of function or damage.
- Design constraints should be identified. For example, standards and technology processes.

Safe Connection to Mine - Concepts

Combustion above the Lower Explosive Limit (LEL) does not necessarily lead to a deflagration or explosion.

A gas BBQ uses combustion above the LEL and we happily stand next to it to cook our sausages.

VAM RAB and gas BBQs are safe if the heat and pressure can be controlled. That is; they are safe if the heat and pressure do not build up.

Above ground we can control heat and pressure by bypassing methane spikes to atmosphere and venting excess heat and pressure.

Functional Safety

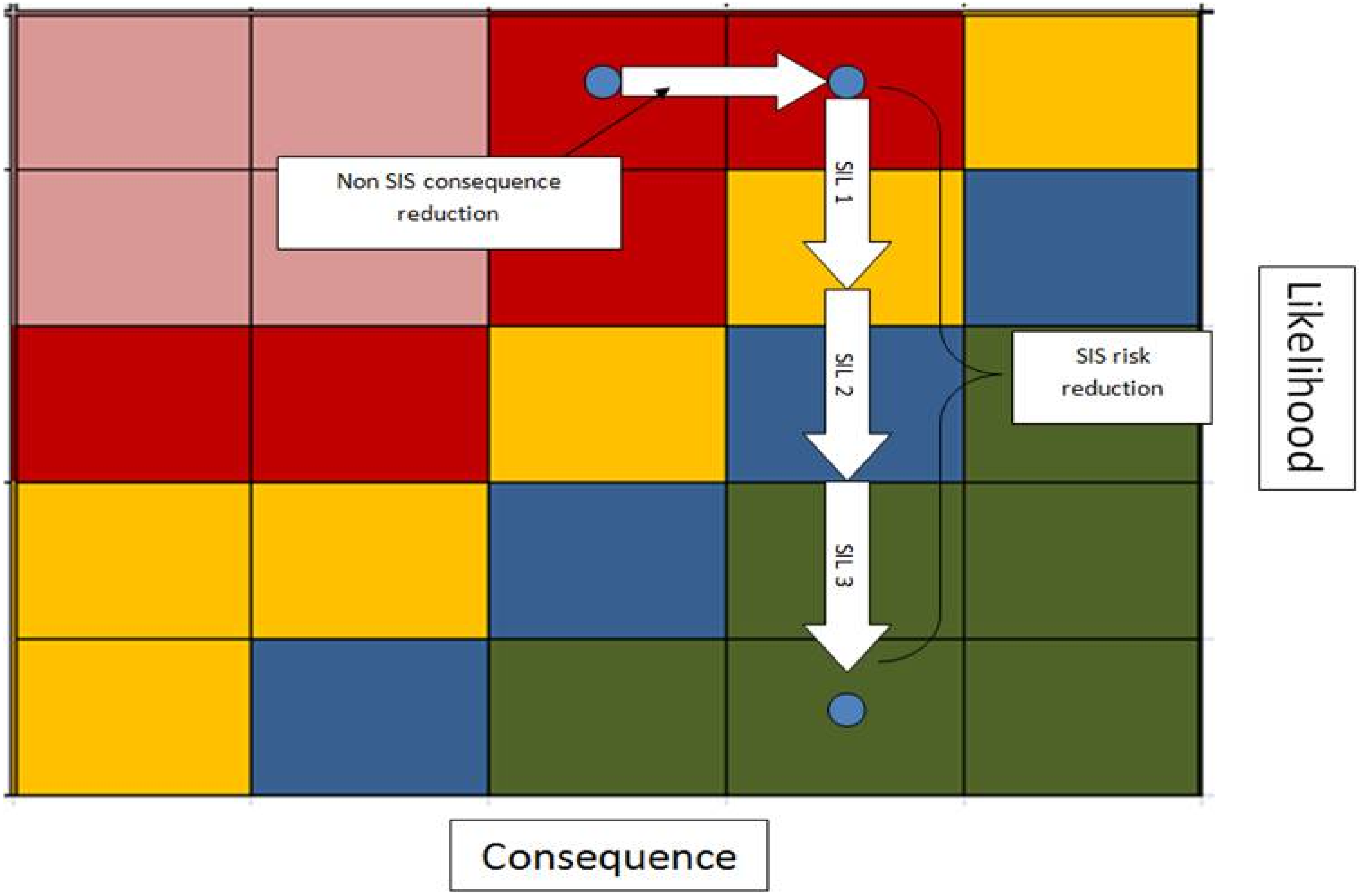
NSW Coal Mine Health and Safety Regulation 2006, Clause 13:

Clause 13(1)(e)(v)…. to provide electrical safeguards for electrical and non-electrical hazards, with a probability of failure appropriate to the degree of risk posed by the hazard.

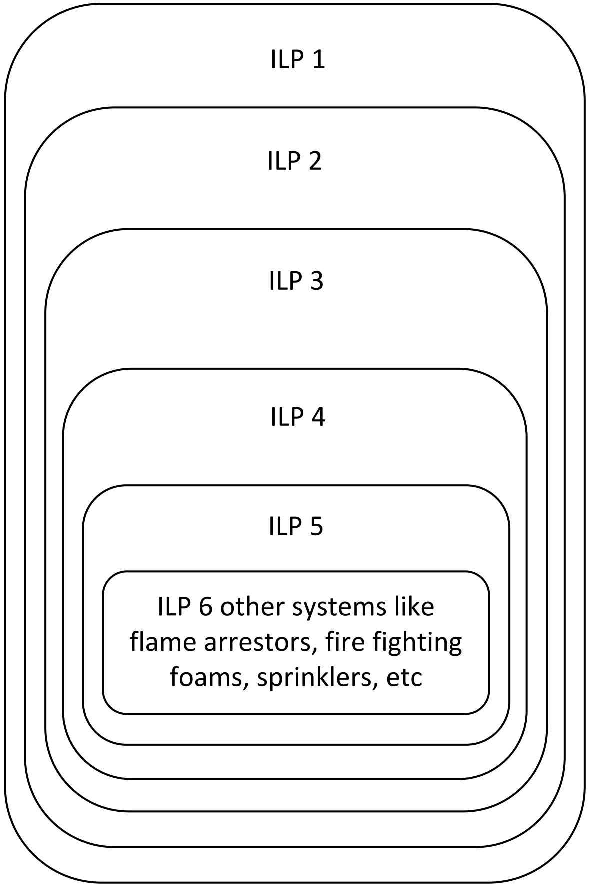
Clause 13(1)(f) (viii)…. to provide safeguards for mechanical plant and installations, with a probability of failure appropriate to the degree of risk posed by the hazard.

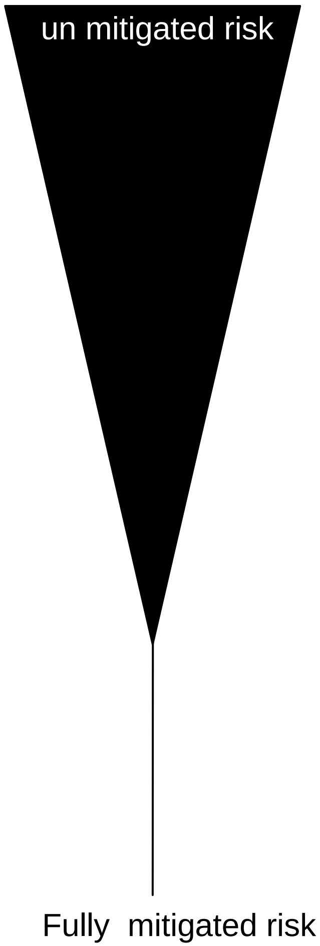
NSW DPI Legislation Update LU07-05 (CMH&SR 2006):
Mandates the use of AS61508, AS62061 and/or AS4024 to fulfill these requirements.

Functional Safety



Connection to Mine – LOPA

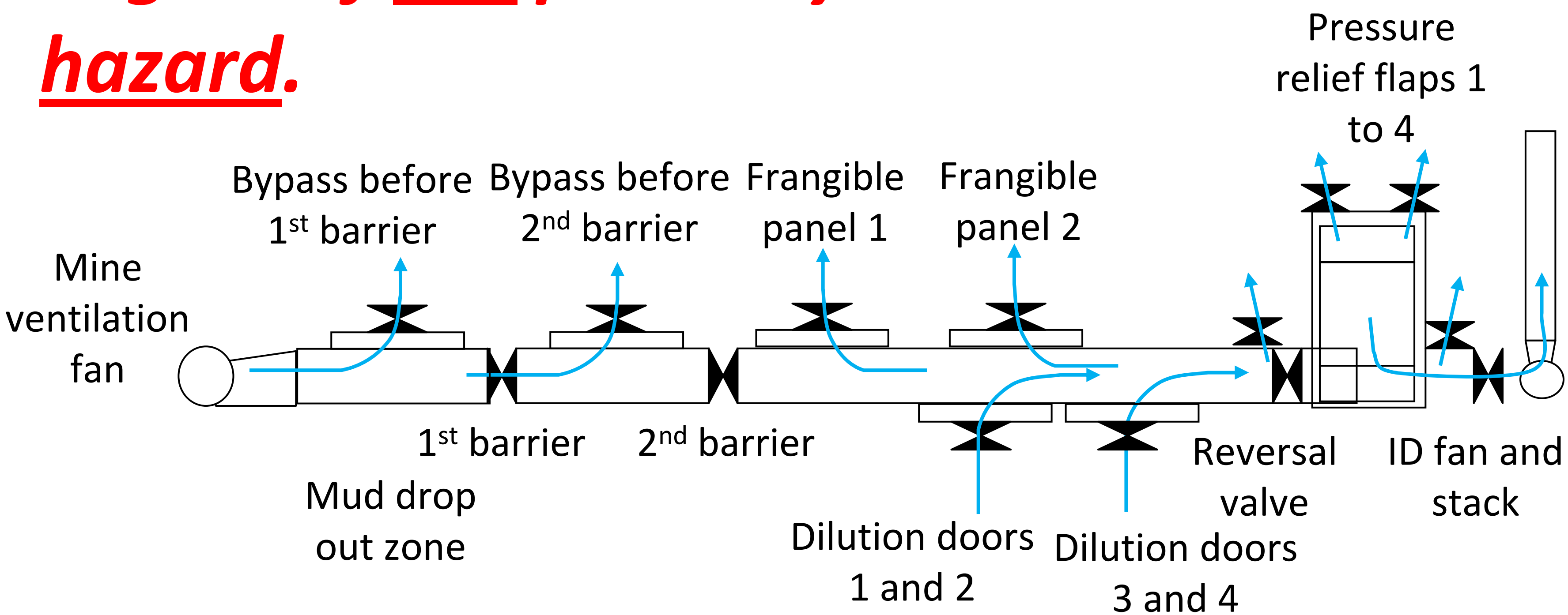




LOP	VAMRAB
ILP1	SIL rated bypass
ILP2	SIL rated dilution doors
ILP3	Intrinsically safe by design
ILP4	SIL rated isolation
ILP 5	SIL rated frangible design

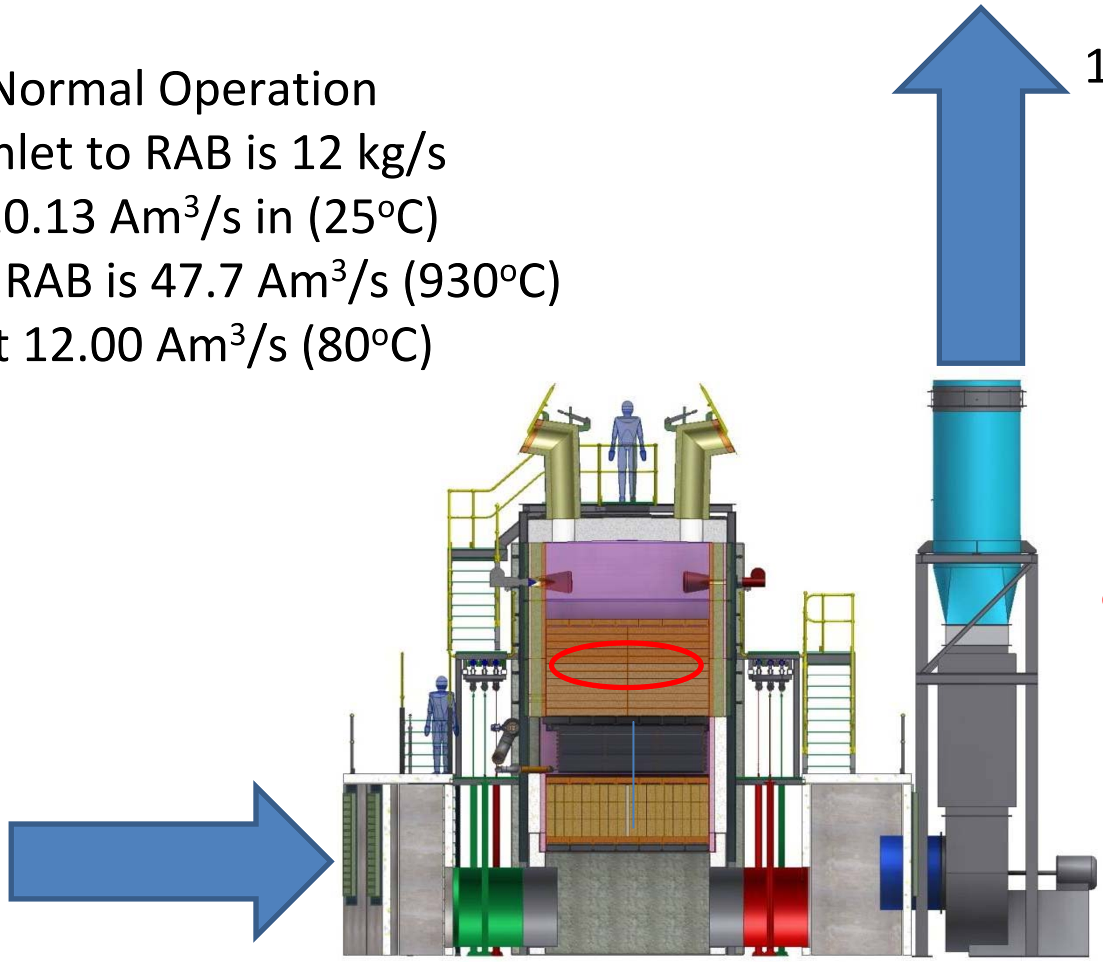
Connection to Mine – Safety Systems

Safeguards .... with a probability of failure appropriate to the degree of risk posed by the hazard.



Designed to be Safe

Normal Operation
At inlet to RAB is 12 kg/s
In 10.13 Am^3/s in (25^{o}C)
At top of RAB is 47.7 Am^3/s (930^{o}C)
Out 12.00 Am^3/s (80^{o}C)



100% of total flow

12 kg/s cooled from 930^{o}C to 80^{o}C in 0.2 seconds in the chequer pack (aka Regenerators)

Verified by Test

Result from pilot plant deflagrations

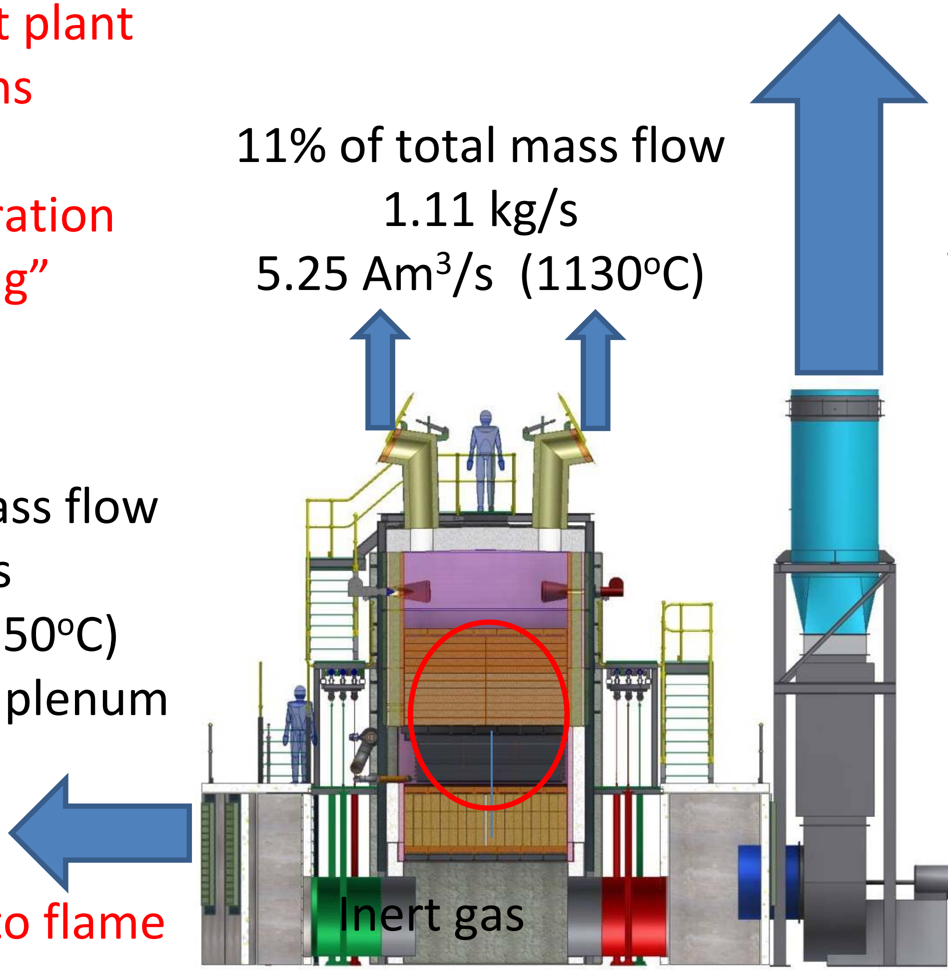
Continued operation with "burping"

11% of total mass flow
1.11 kg/s
5.25 Am^3/s (1130^{o}C)

76% of total mass flow
7.70 kg/s

101% of normal volume flow
12.09 Am^3/s (195^{o}C)

13% of total mass flow
1.32 kg/s
2.53Am^3/s (250^{o}C)
Mostly through plenum vents



Heat loss leads to flame extinction