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Energy-Based Safety

Seeing, Controlling, and Measuring What Matters Most

June 2025

Energy Wheel

EnergyWheel – Why It Matters

Data from 4,800 worker-hours of observation

45%

of hazards
are identified

35%

of hazards are
missed because of
cognitive blind spots

20%

of hazards are missed
because they are not resonably
identifiable before work starts

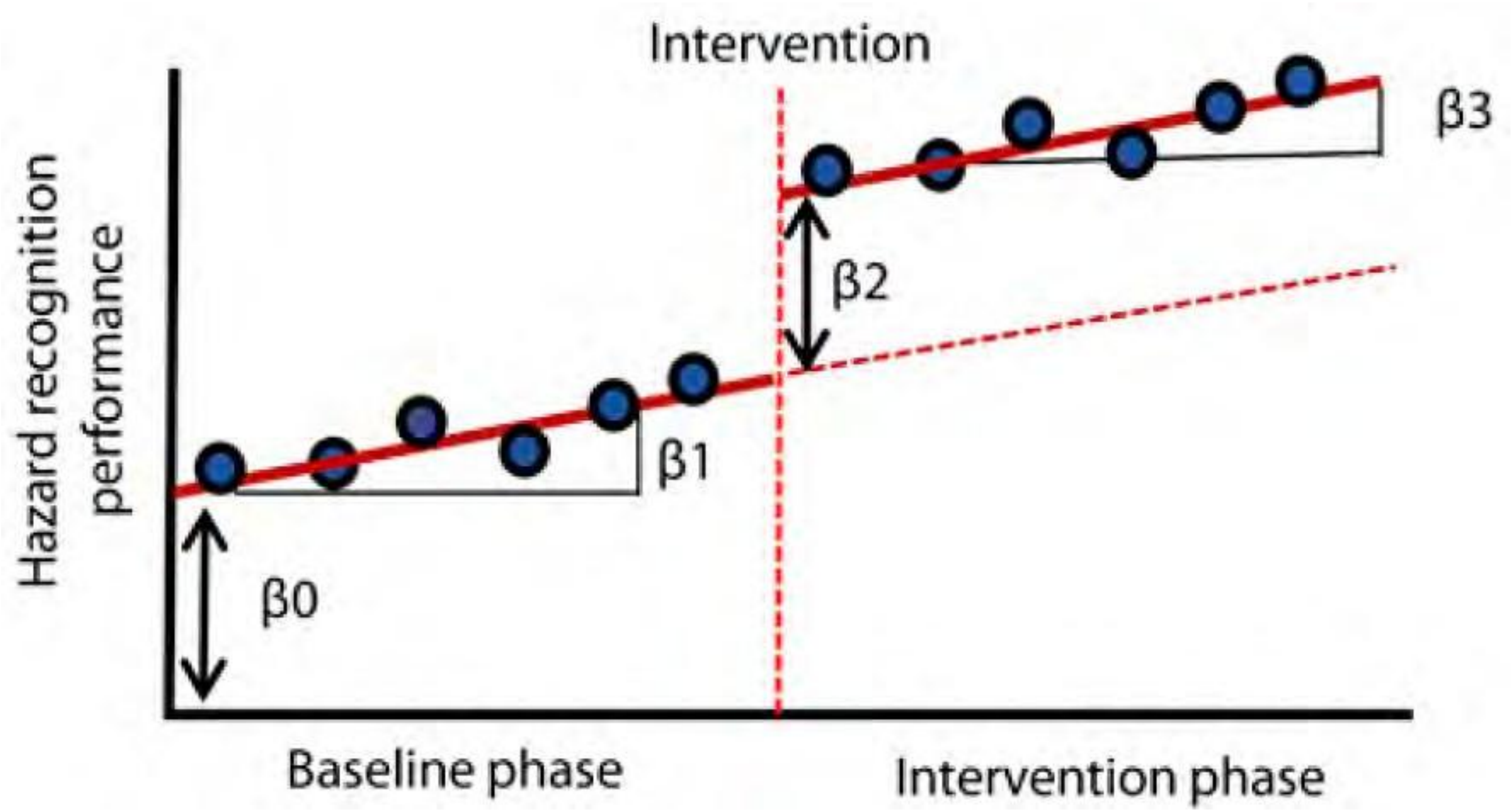
The Energy Wheel – A Simple Tool to See More

Every injury is the result of the unwanted release of and contact with one or more energy sources.

Each of the 10 icons in the energy wheel represents a different type of energy. Although not strictly scientific, the icons represent the most common ways that energy manifests at work.

- Structured way to uncover energy hazards
- Boosts hazard recognition by ~30%
- Supports instinct-based identification, not replaces it
- Simple and scalable across teams

Energy Wheel - testing and scientific validation



The energy wheel improves hazard recognition skills by an average of approximately

30%

Low vs High Energy Hazards

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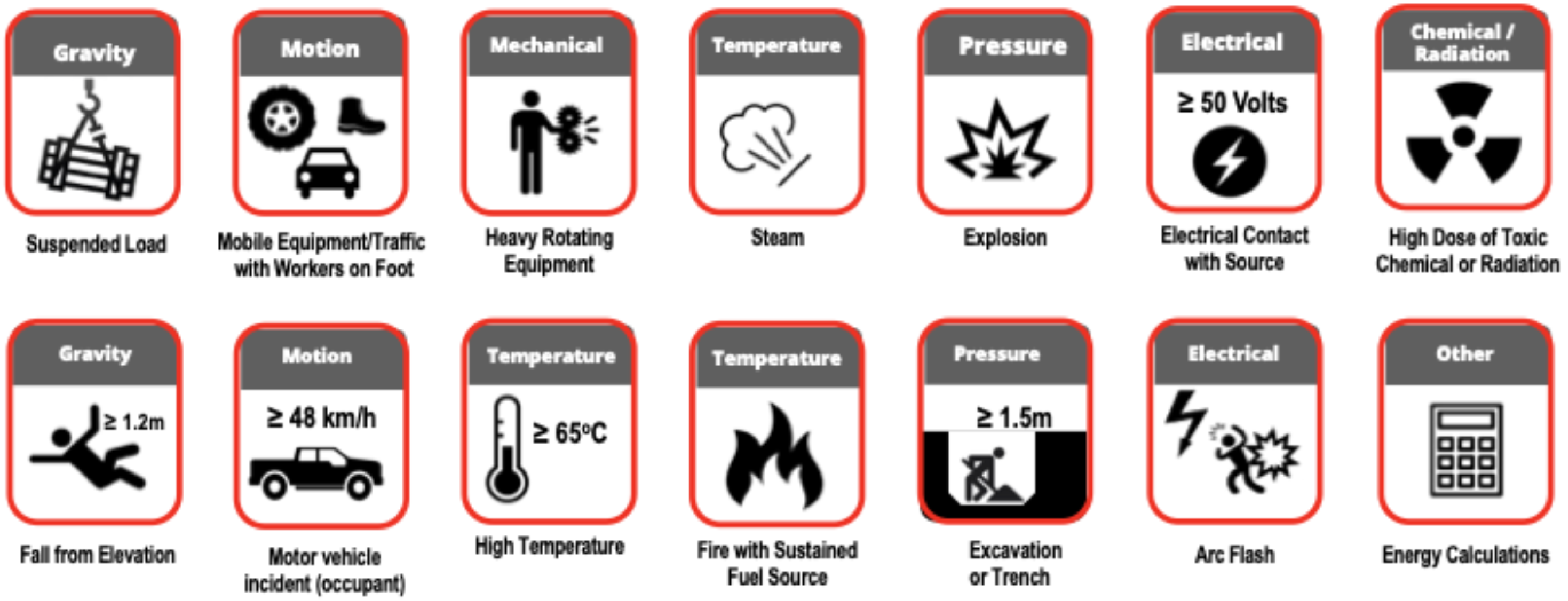
Differentiating Low vs High Energy Hazards



- High Energy Safety Hazards = >1,500 joules
- High Energy Health Hazards = >WES
- High-energy hazards cause serious injury and fatality
- Prioritise high energy in hazard ID and control
- Shift focus to where harm potential is greatest

Metrics and measures

Principles and Values of H&S measurement

- Safety is the presence of safeguards, not the absence of injuries
- SIF is a top priority
- Metrics must support deliberate, strategic, sustained, and regular learning
- Our metrics should help us to prevent future injuries

How do your metrics align with these values?

Attributes of a good safety metric

1. Valid: Data may be collected in sufficient volume to reveal statistically significant trends
2. Objective: Observations may be made with minimal potential for bias
3. Predictive: Trends from the past provide information about the future
4. Clear: Easy to explain to everyone on the project team
5. Functional: Enables strategic actions that improve future performance
6. Important: Reflects what matters most to the team

Input metrics

Lead indicators

Safety Leading Indicators

Measures of safety-related practices or systems that can be monitored during work to trigger positive responses.

Examples

- Frequency of safety observations
- Frequency of leadership engagements
- Proportion of corrective actions closed on time

Case Study: Standardising Safety Leading Indicators

Goal: Create one set of leading indicators that all participating utilities may use the same way.

- Job briefs
- JSAs
- Observations

Edison Electric INSTITUTE

Interstate Natural Gas Association of America

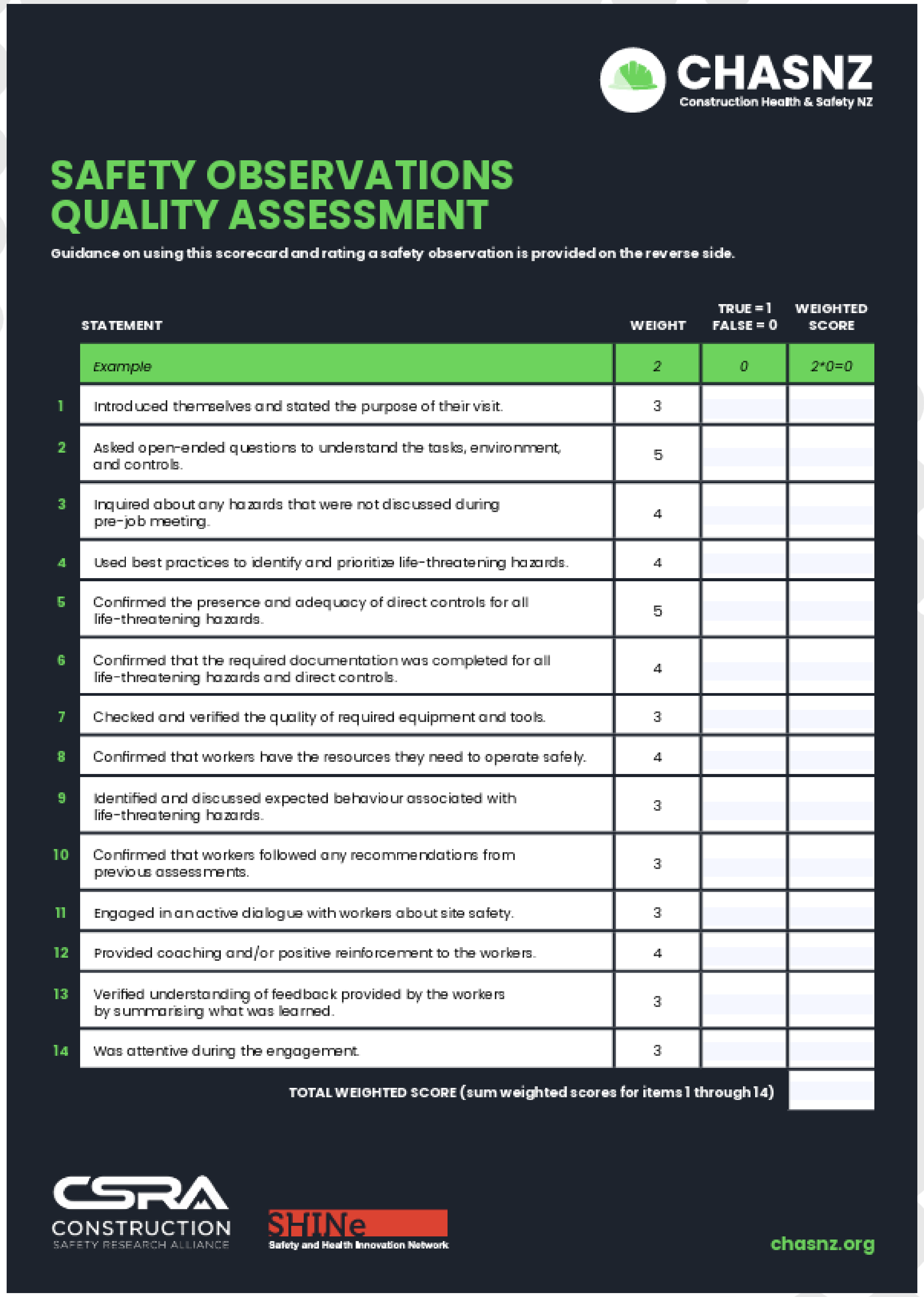
Quality of Safety Activities

Measure of how well key safety activities are performed

- Regular random sampling
- Leverages the calibrated CSRA scorecards
- Provides insights not just metrics
- Key measure of “safety”

Guidance and scorecards available for:

- Safety observations (Safety practitioners and reps)
- Crew briefings (Front-line leaders)
- Leadership observations (Senior management, Exec and Board)



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SAFETY OBSERVATIONS QUALITY ASSESSMENT

Guidance on using this scorecard and rating a safety observation is provided on the reverse side.

	STATEMENT	WEIGHT	TRUE = 1 FALSE = 0	WEIGHTED SCORE
	Example	*2*	*0*	*2*0=0*
1	Introduced themselves and stated the purpose of their visit.	3		
2	Asked open-ended questions to understand the tasks, environment, and controls.	5		
3	Inquired about any hazards that were not discussed during pre-job meeting.	4		
4	Used best practices to identify and prioritize life-threatening hazards.	4		
5	Confirmed the presence and adequacy of direct controls for all life-threatening hazards.	5		
6	Confirmed that the required documentation was completed for all life-threatening hazards and direct controls.	4		
7	Checked and verified the quality of required equipment and tools.	3		
8	Confirmed that workers have the resources they need to operate safely.	4		
9	Identified and discussed expected behaviour associated with life-threatening hazards.	3		
10	Confirmed that workers followed any recommendations from previous assessments.	3		
11	Engaged in an active dialogue with workers about site safety.	3		
12	Provided coaching and/or positive reinforcement to the workers.	4		
13	Verified understanding of feedback provided by the workers by summarising what was learned.	3		
14	Was attentive during the engagement.	3		
	TOTAL WEIGHTED SCORE (sum weighted scores for items 1 through 14)			

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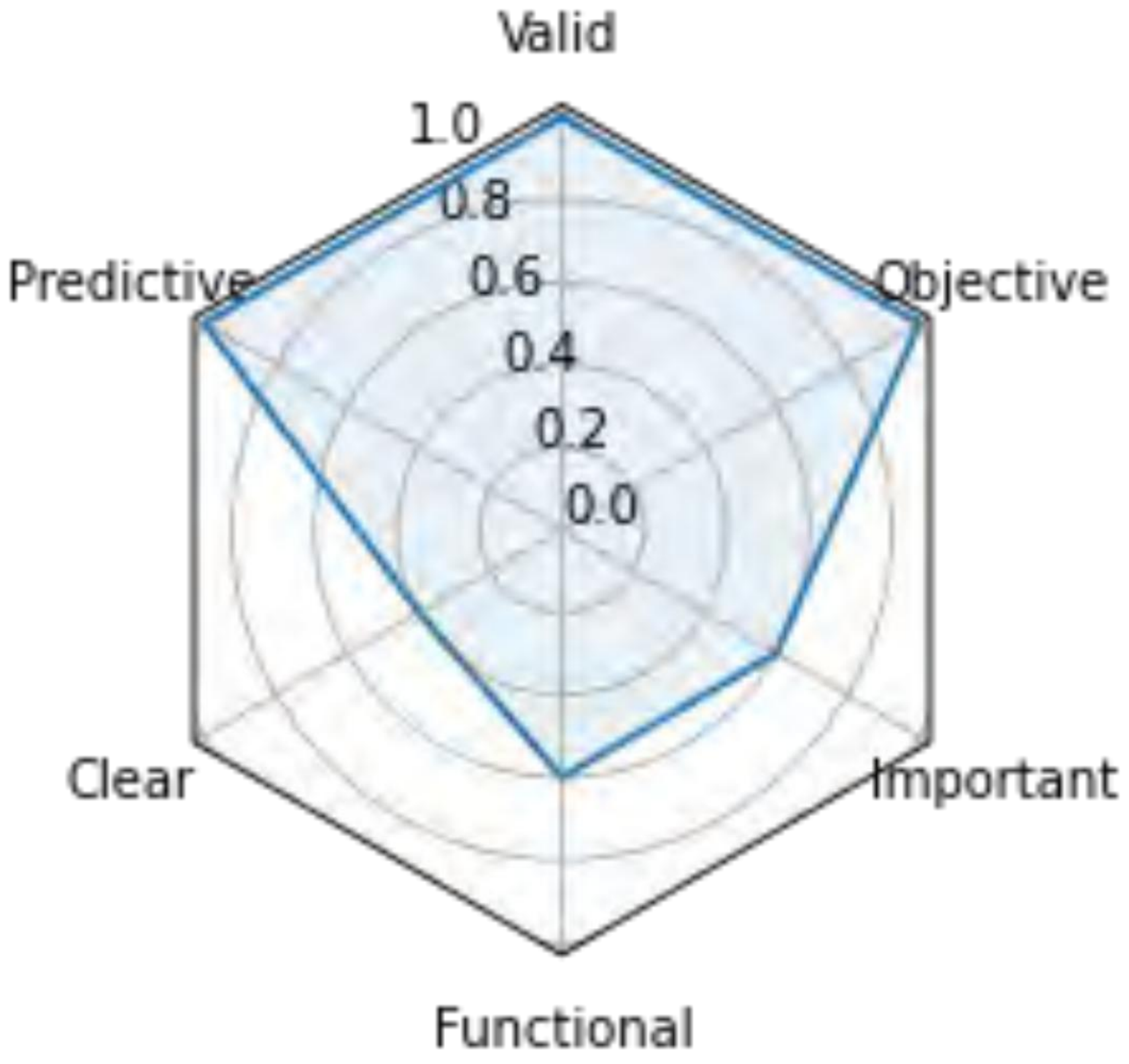
SAFETY RESEARCH ALLIANCE

SHINe
Safety and Health Innovation Network

chasnz.org

Safety Leading Indicators Evaluation

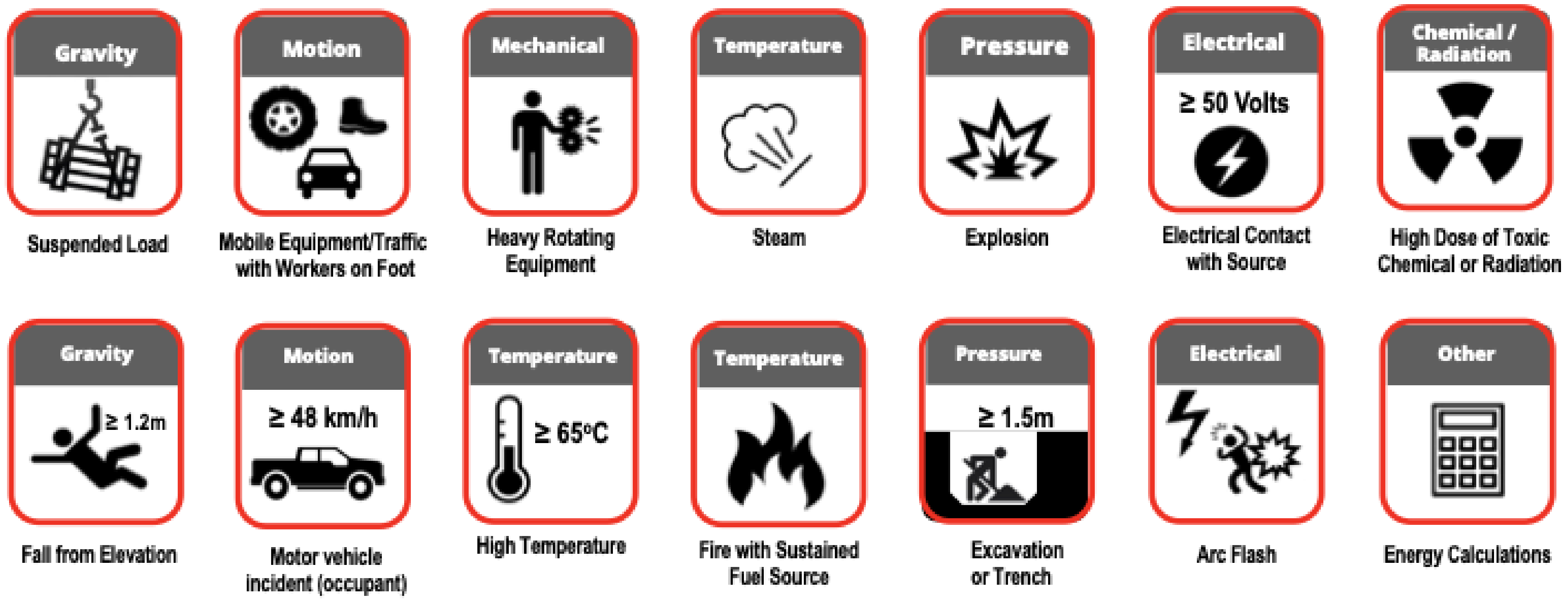


Monitoring metrics

Safety = Presence of effective controls

High-Energy Control Assessment (HECA) – Measuring Safety by Capacity, Not Luck

Proportion of life-threatening hazards that are observed to have an adequate control.




For each life-threatening hazard, we MUST have a control that is:

- Targeted at the high energy
- Installed, verified, and used properly
- Not vulnerable to human error

Direct Control

It will:

- Save your life
- All by itself
- Even if someone messes up

Targeted

- Specifically targeted to the source of the high energy

Strong

- Effectively mitigates the amount of energy present when it's installed properly

Forgiving

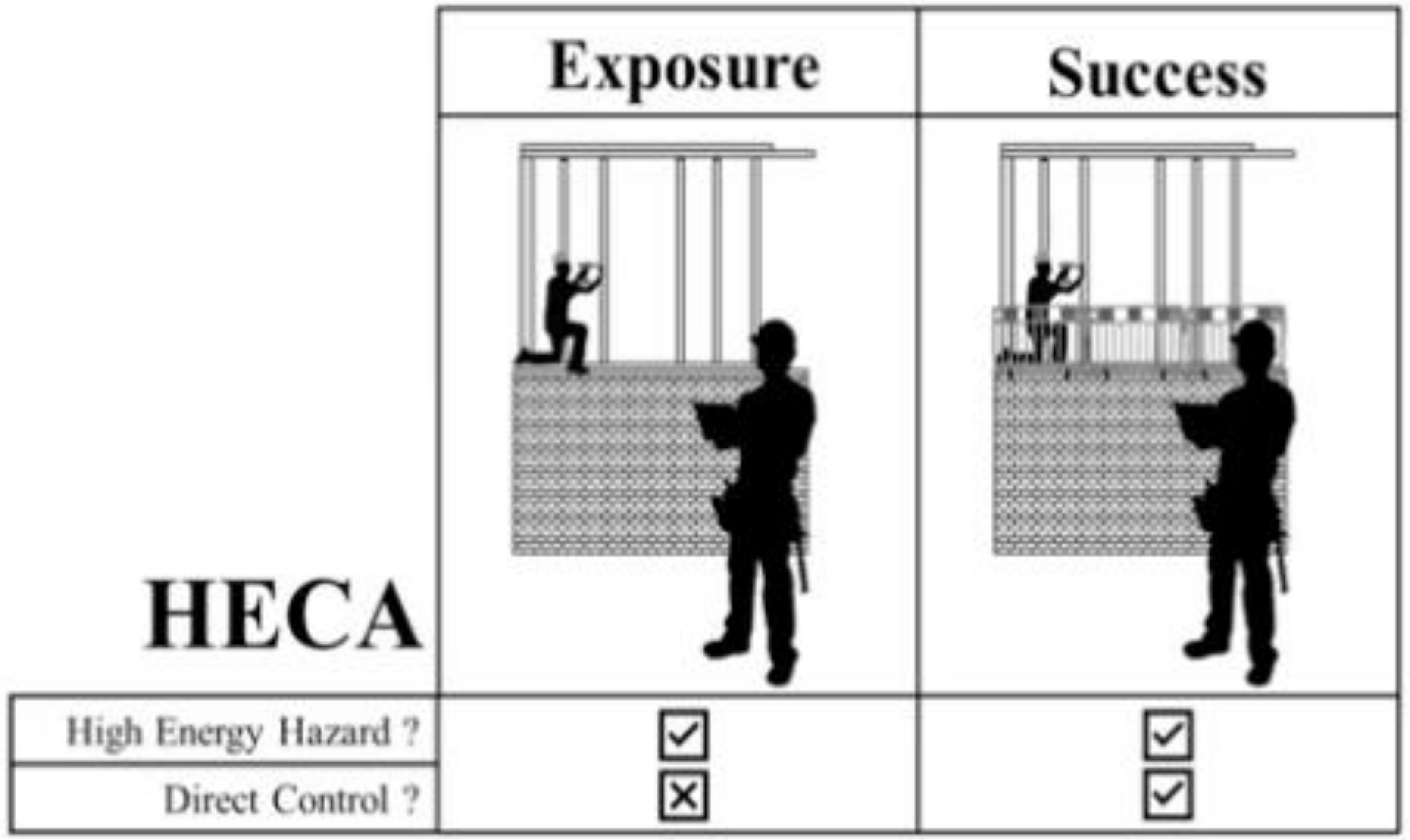
- Remains effective, even if unintentional human error occurs after installation

An energy-based observation

1. Identify high-energy hazards
2. Assess controls
3. Compute HECA Score

- HECA = % of high-energy hazards with direct controls
- Measures system resilience, not injury outcomes
- Simple: Success (Control) or Exposure (No Control)
- Focuses leaders on control presence, not luck

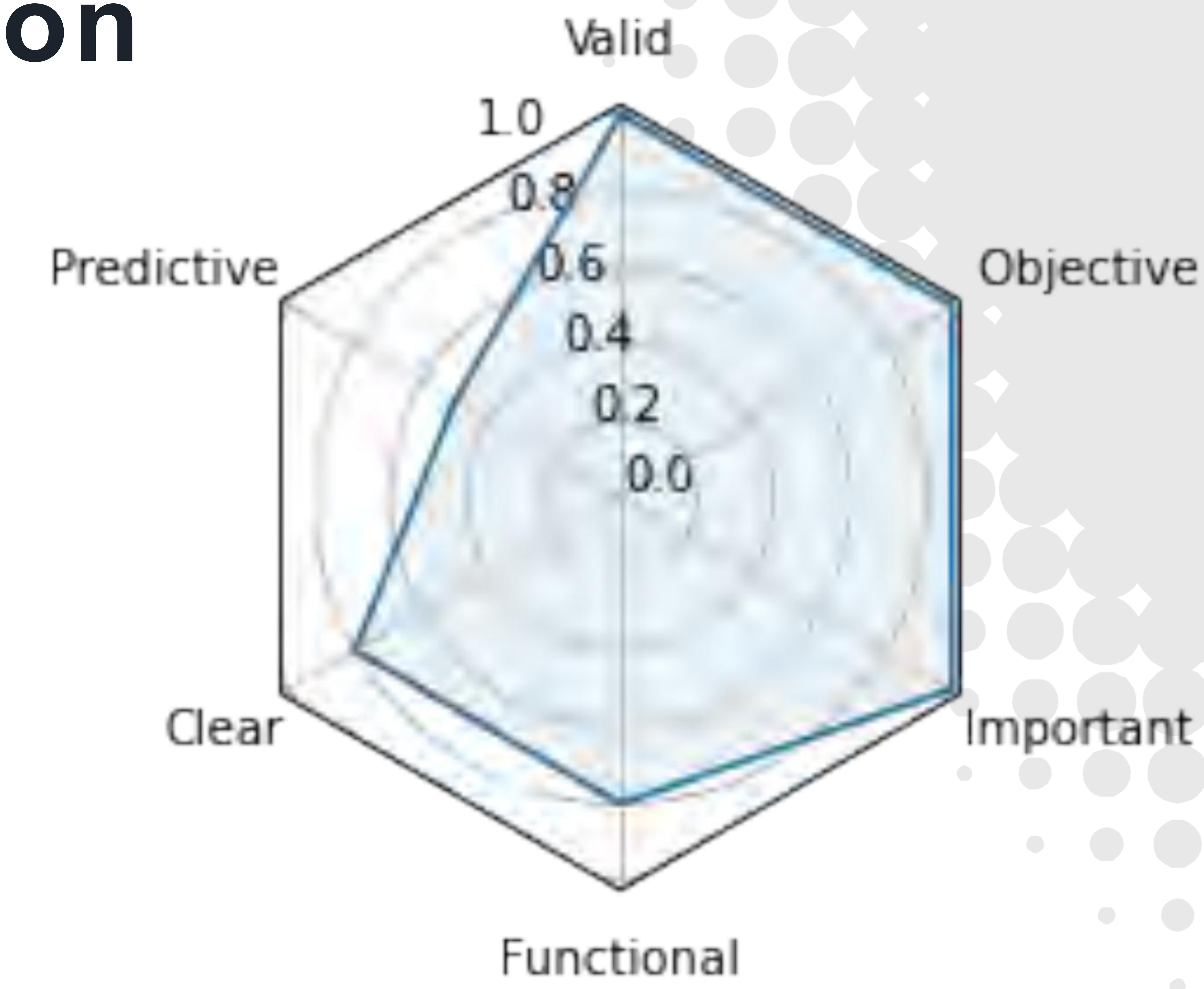
$$\mathit{HECA\ Score} = \frac{\mathit{Success}}{\mathit{Total}}$$



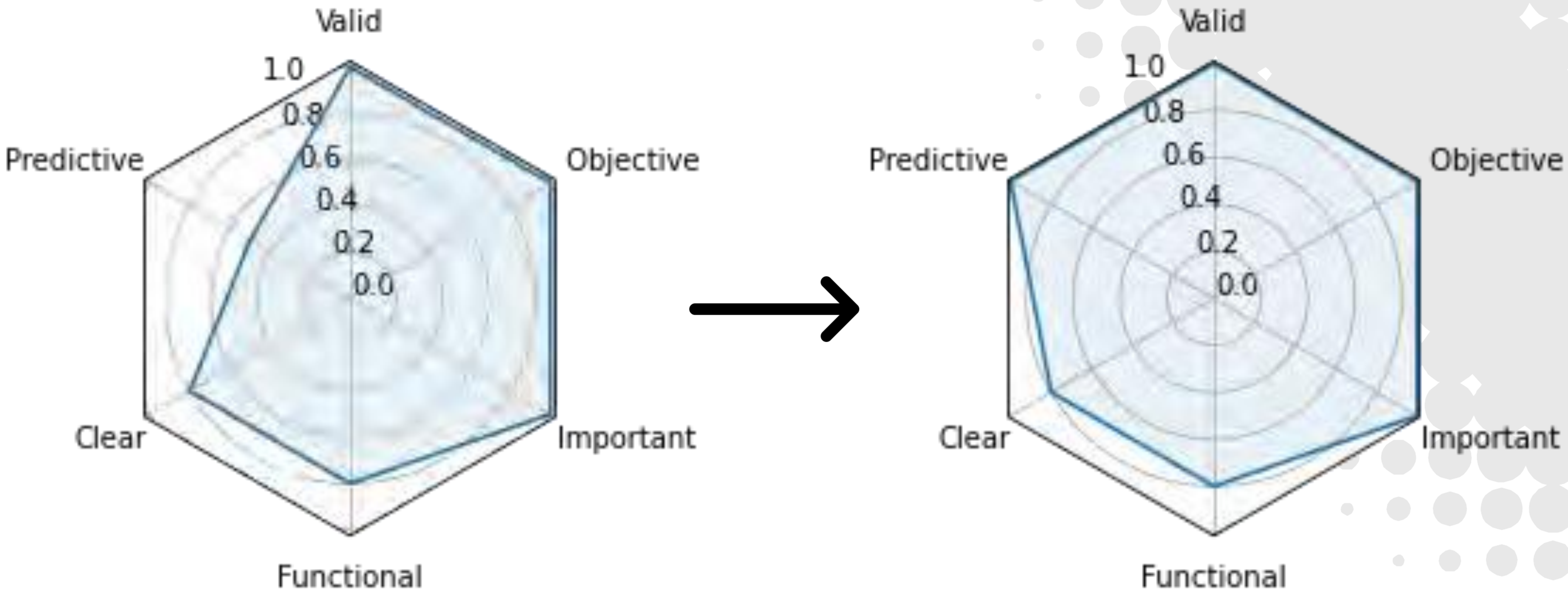
Why is HECA Special?

- Combines the science of energy-based safety with the principles of human and organisational performance
- Specifically focuses on SIF
- Can be regularly monitored and sampled
- Provides actionable insight
- Easy to communicate
- Aligns what we say, what we do, and what we measure

HECA Evaluation



Emerging evidence that HECA is predictive!

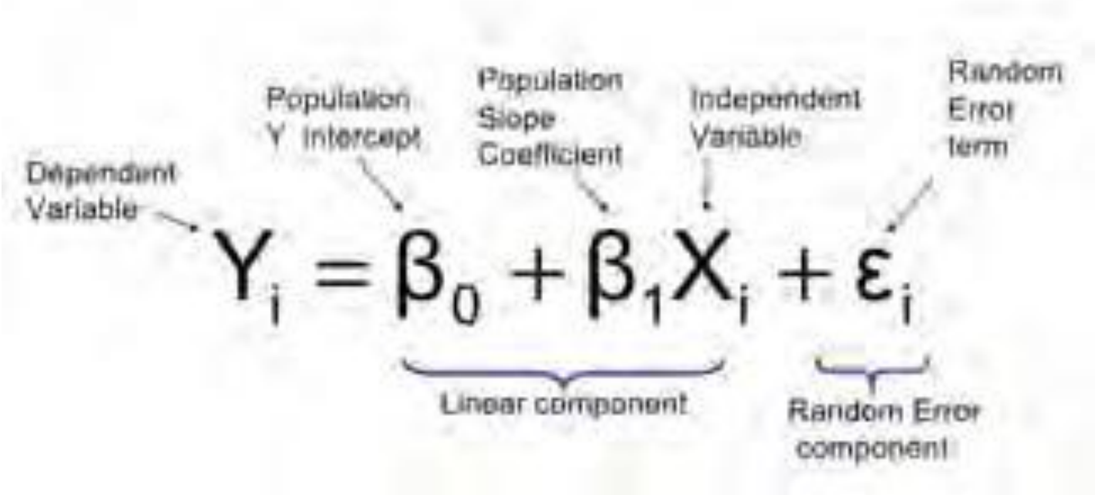


Output metrics

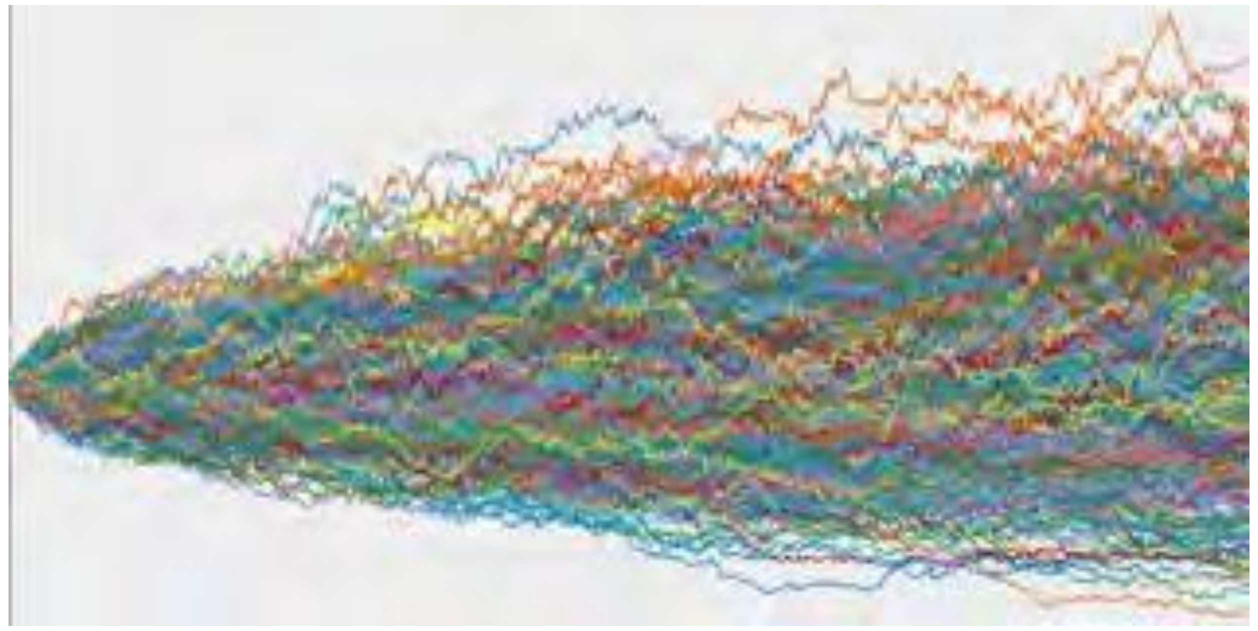
Lag indicators

TRIFR Analysis

Generalized Linear Modeling



Monte Carlo Simulations

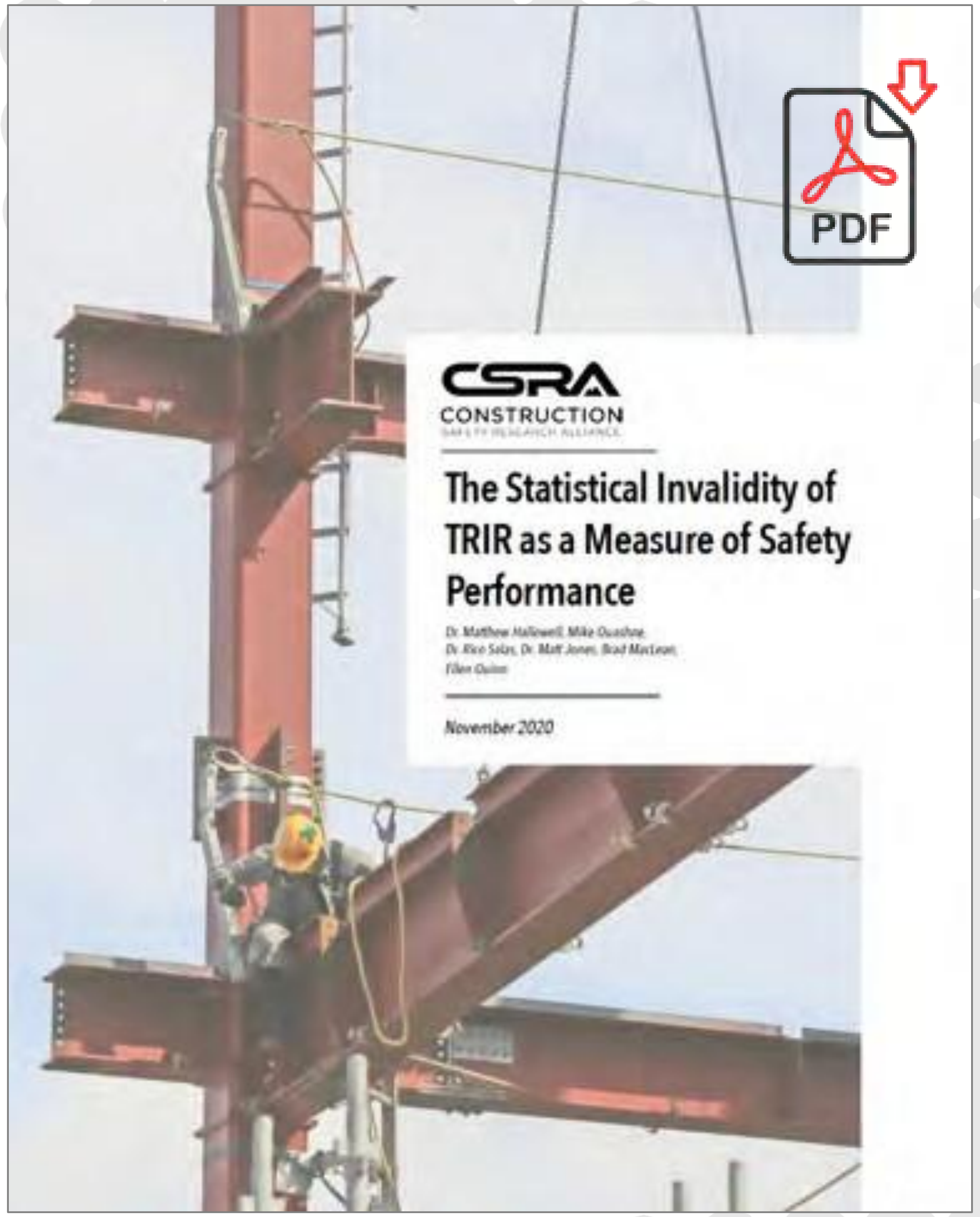


What did they find?

- TRIFR is not predictive of future TRIFR
- TRIFR is not predictive of fatalities
- TRIFR is approximately 98% random

What Does This Mean?

- IFR's should not be used to compare companies, business units, or projects
- IFR's should not be used for performance evaluations or incentives
- IFR's should be reported as a range, not a number
- IFR's are not a proxy for fatalities
- New approaches to safety measurement are needed!



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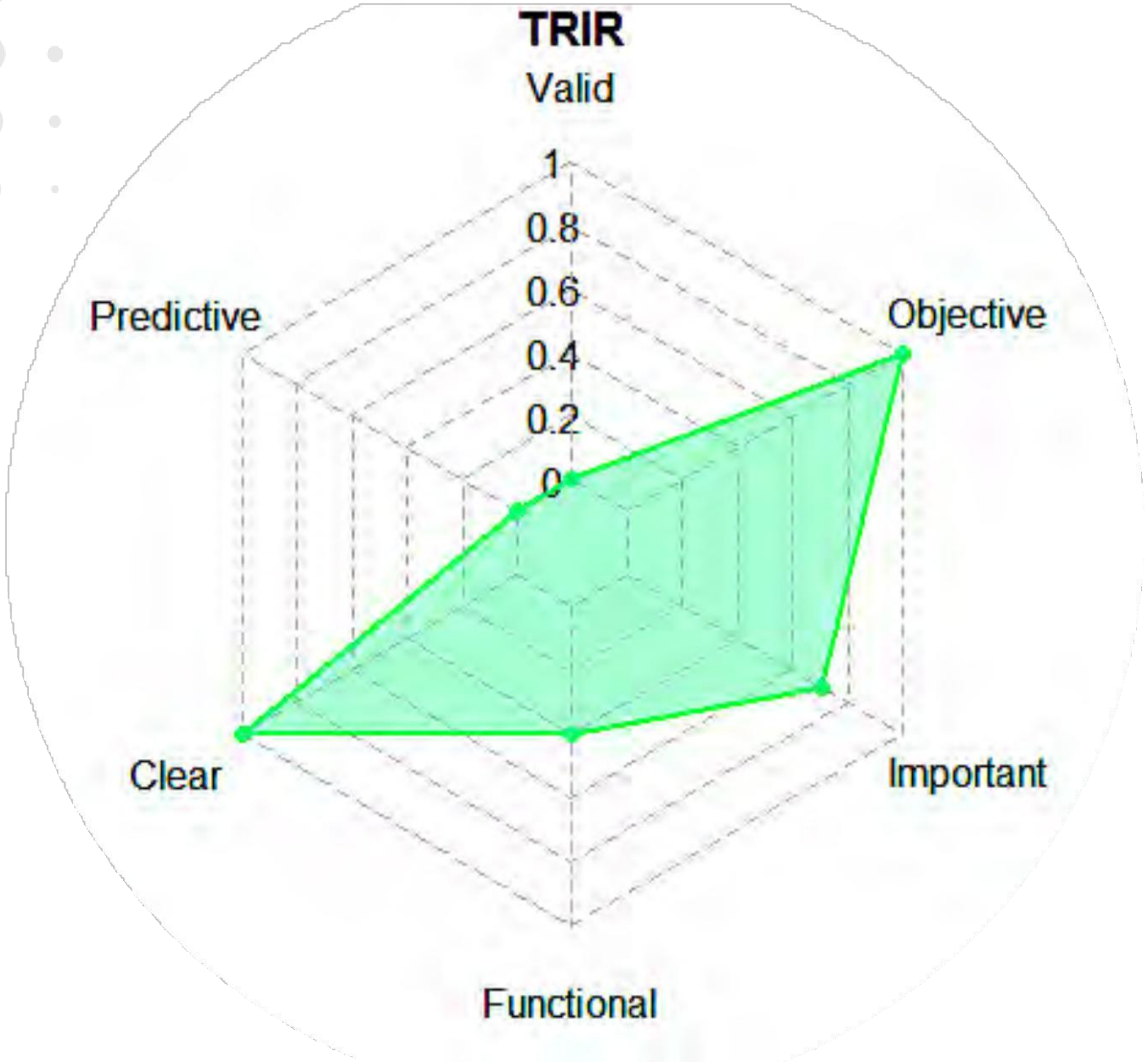
The Statistical Invalidity of TRIR as a Measure of Safety Performance

Dr. Matthew Hallowell, Mike Quashne,
Dr. Rico Salas, Dr. Matt Jones, Brad MacLean,
Ellen Quinn

November 2020

TRIFR Evaluation



Severity Based Lagging Indicator (SBLI)

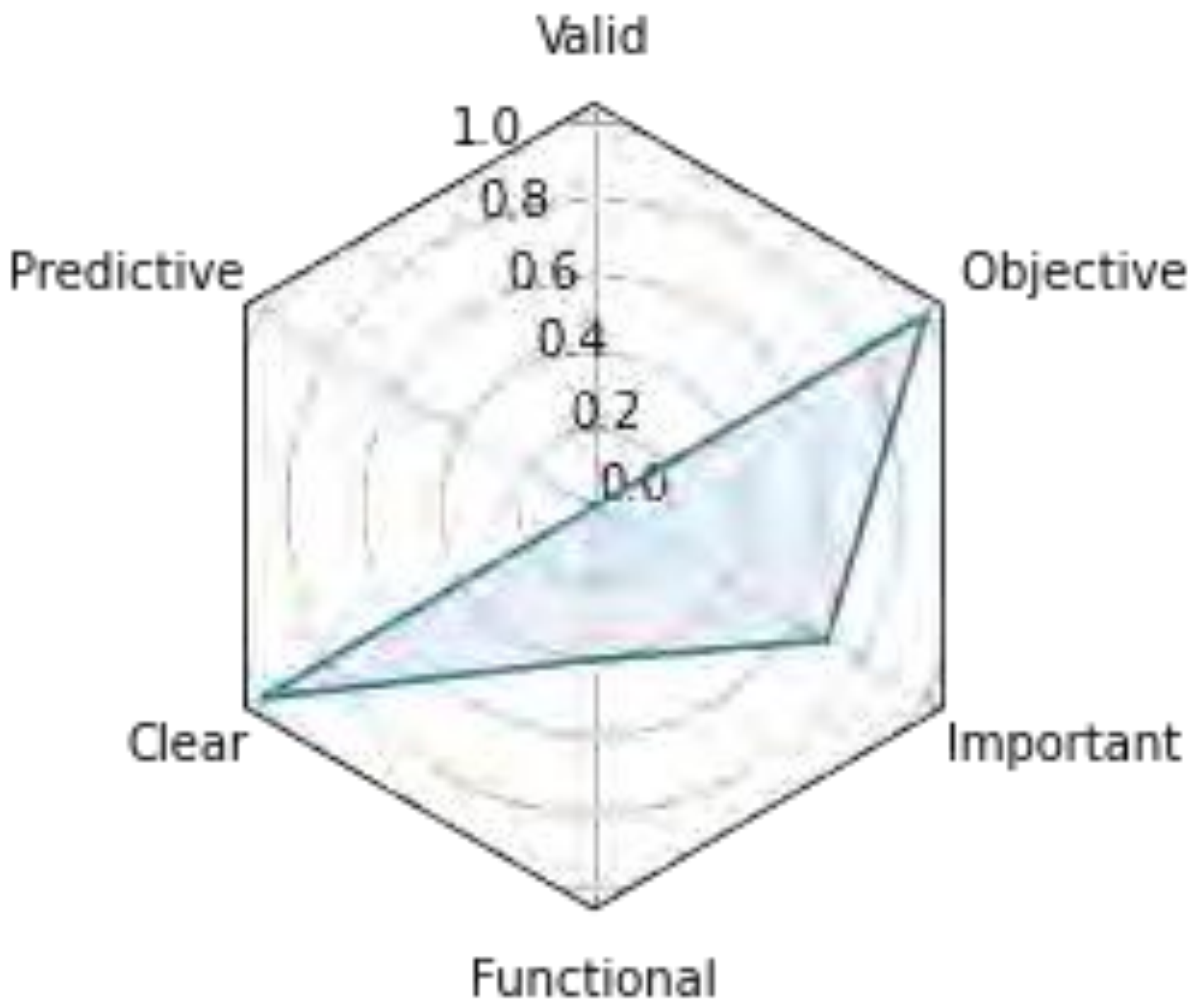
Aggregated injury rate that weights injuries by their relative level of severity.

$$SBLI = \frac{n_{fa}100 + n_{mt}500 + n_{jtr}750 + n_{daw}1500}{e} * 200$$

- Not all incidents have equal impact or importance
- Incidents are rare and random, and the data are too sparse to yield stable results

Tradeoffs

TRIR



Severity - based LI

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Alternate controls

What do we do when there is no direct control available?

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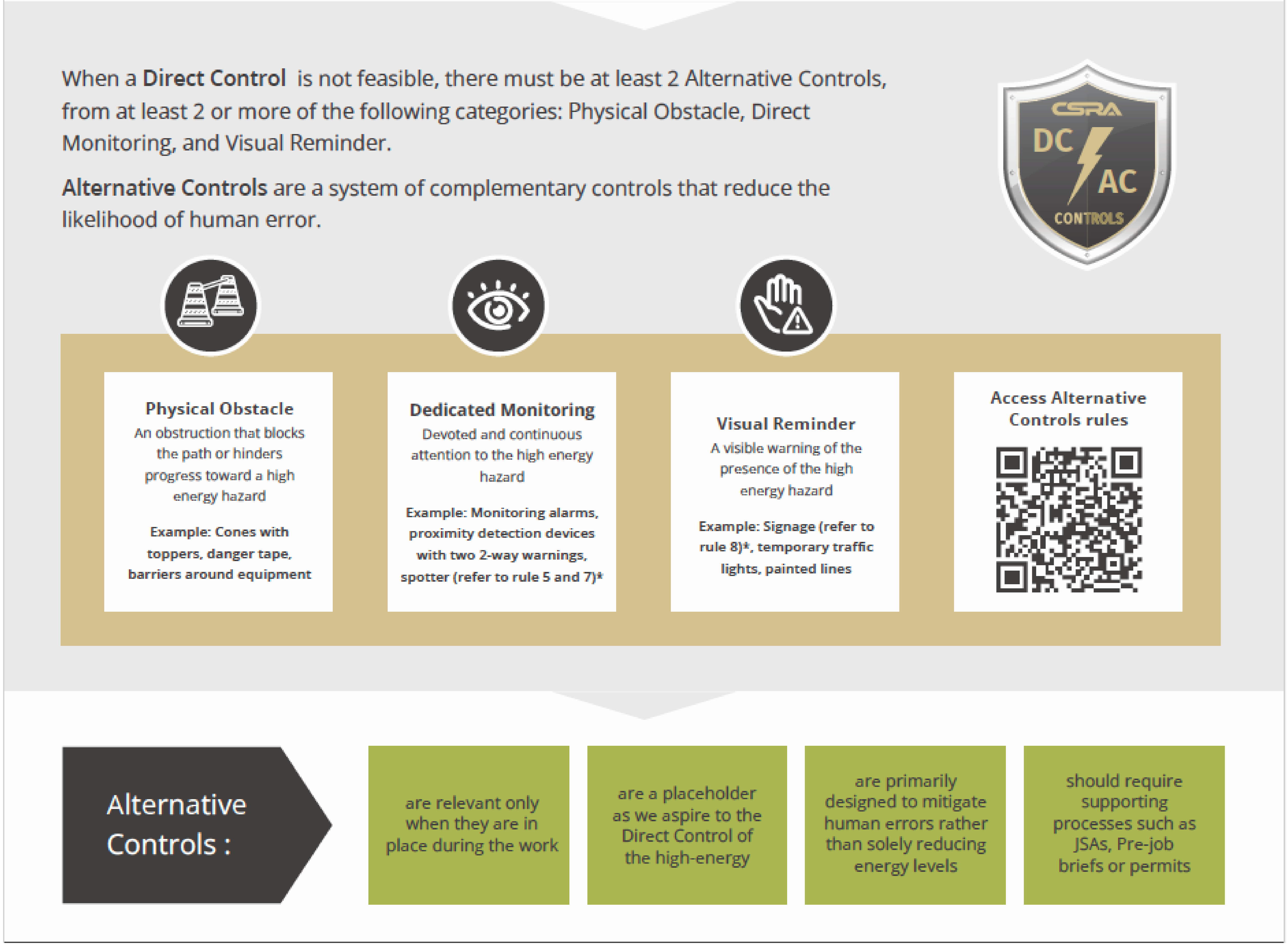
Alternative Controls – Operating Safely Under Exposure



When a **Direct Control** is not feasible, there must be at least 2 Alternative Controls, from at least 2 or more of the following categories: Physical Obstacle, Direct Monitoring, and Visual Reminder.

Alternative Controls are a system of complementary controls that reduce the likelihood of human error.

CSRA DC AC CONTROLS

Physical Obstacle
An obstruction that blocks the path or hinders progress toward a high energy hazard

Example: Cones with toppers, danger tape, barriers around equipment

Dedicated Monitoring
Devoted and continuous attention to the high energy hazard

Example: Monitoring alarms, proximity detection devices with two 2-way warnings, spotter (refer to rule 5 and 7)*

Visual Reminder
A visible warning of the presence of the high energy hazard

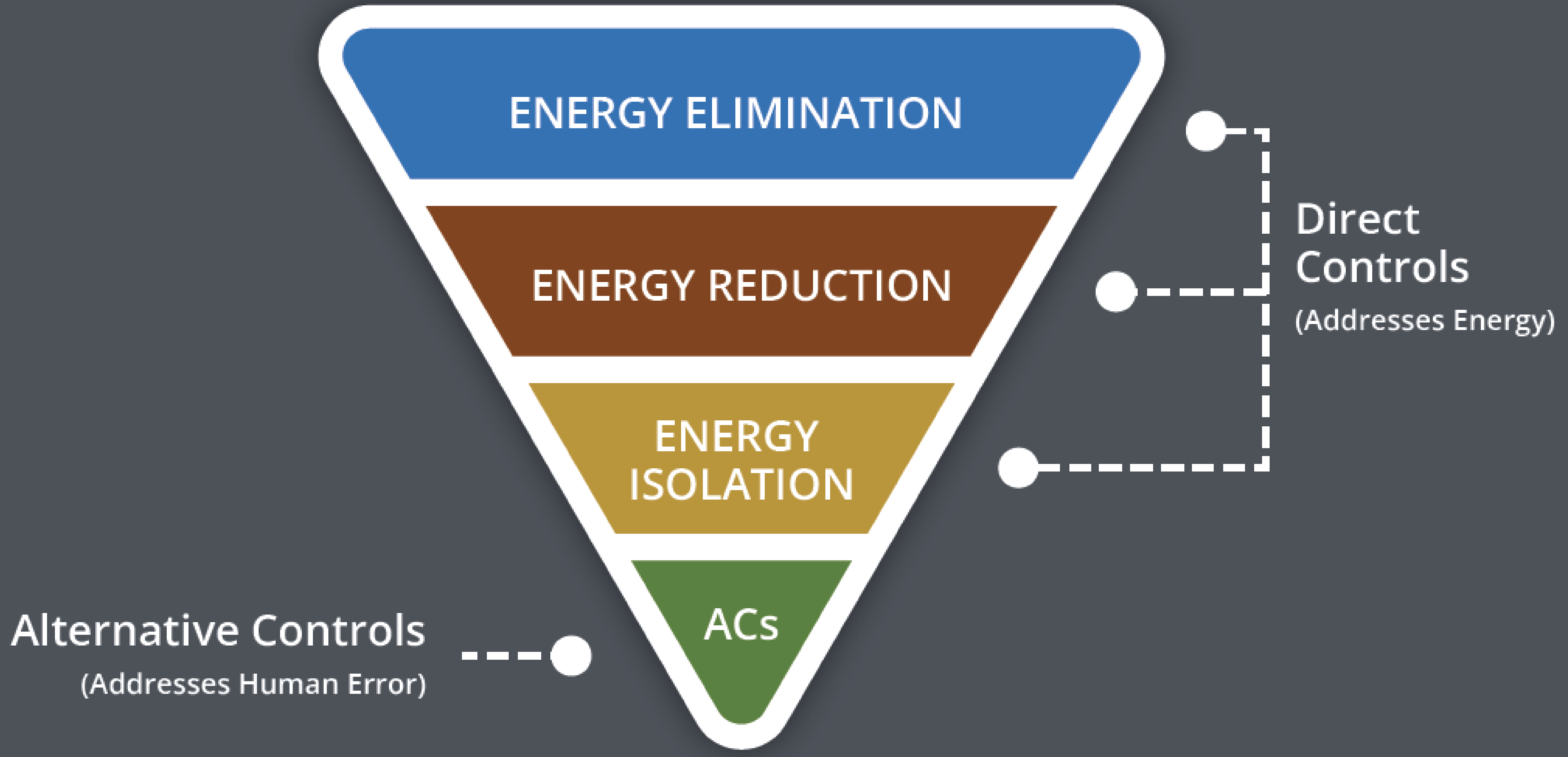
Example: Signage (refer to rule 8)*, temporary traffic lights, painted lines

Access Alternative Controls rules

Alternative Controls :

- are relevant only when they are in place during the work
- are a placeholder as we aspire to the Direct Control of the high-energy
- are primarily designed to mitigate human errors rather than solely reducing energy levels
- should require supporting processes such as JSAs, Pre-job briefs or permits

Hierarchy of Energy Controls



ENERGY ELIMINATION

ENERGY REDUCTION

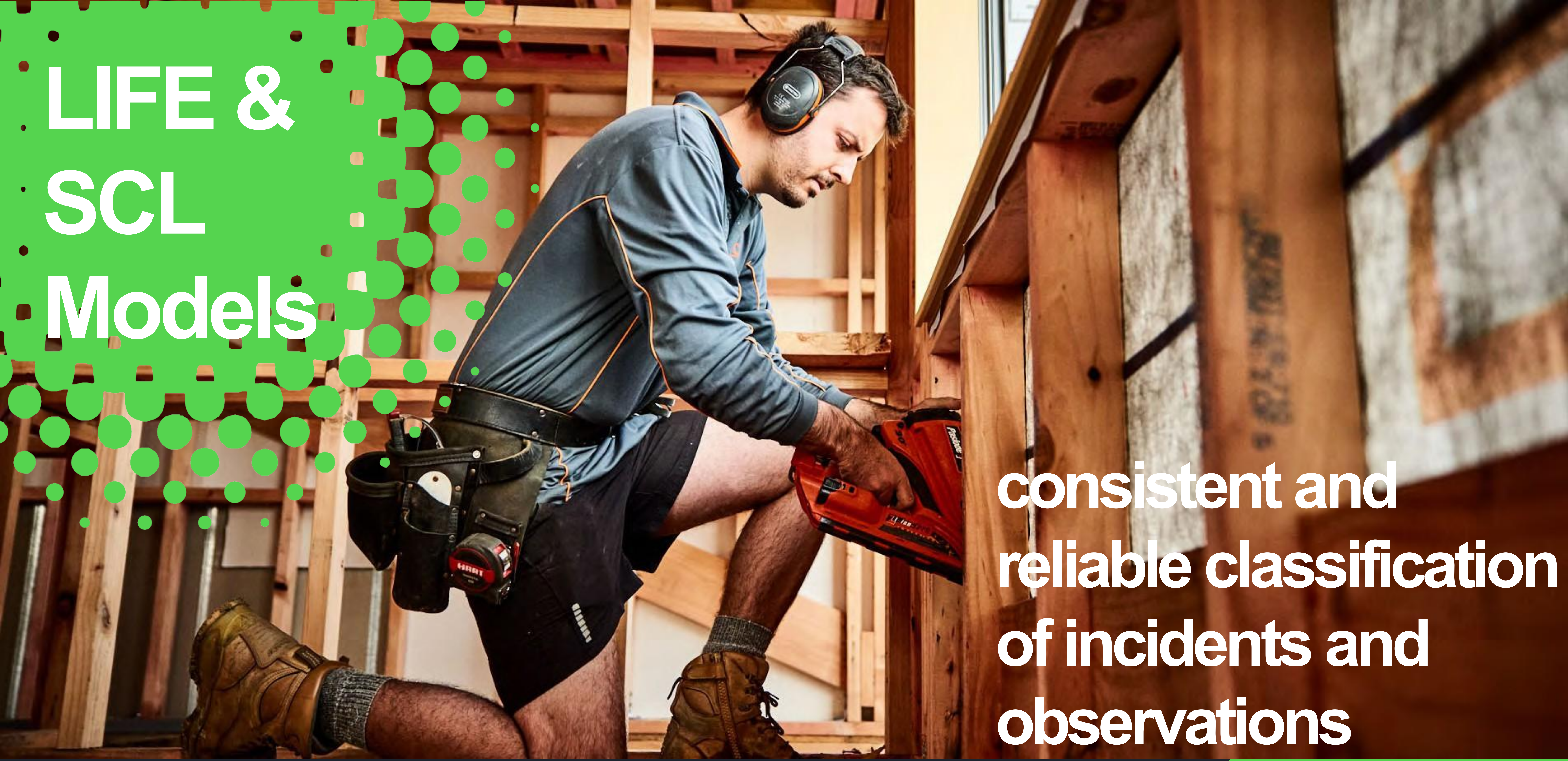
ENERGY ISOLATION

ACs

Direct Controls
(Addresses Energy)

Alternative Controls
(Addresses Human Error)

LIFE & SCL Models



consistent and reliable classification of incidents and observations

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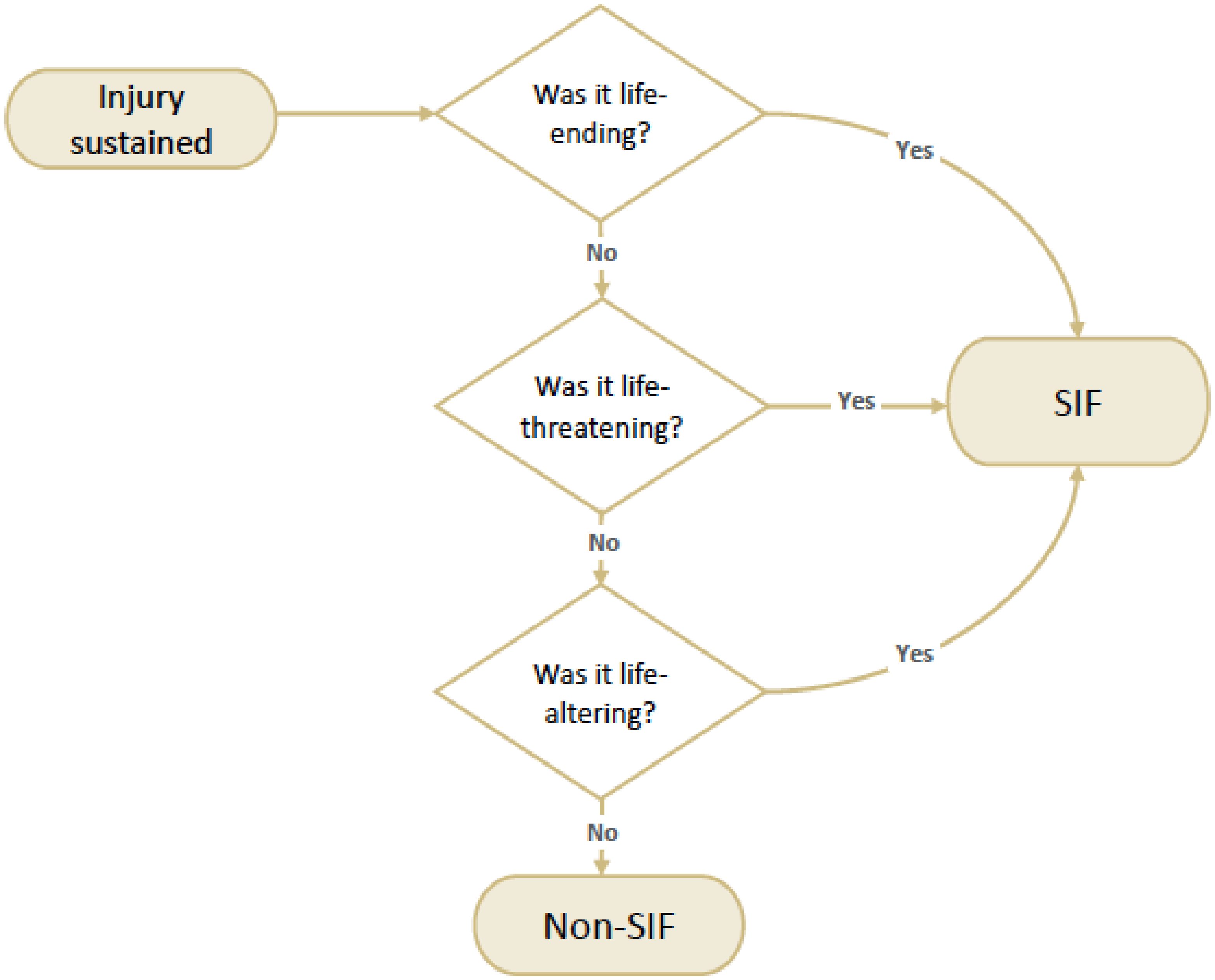
The LIFE and SCL Models – bringing #SIF & #pSIF to the table

- The term “serious injury and fatality” (SIF) has become increasingly popular.
- Companies have created SIF prevention programs, institutes have launched SIF prevention initiatives, and some countries have even established regulatory requirements for reporting potential SIFs.
- However, despite this momentum, there is no common definition for a serious injury that transcends organisational boundaries.
- As a result, it is unclear whether people mean the same thing when using the terms “SIF” or “potential SIF.”

The LIFE Model



Injury sustained

Was it life-ending?

Yes

No

Was it life-threatening?

Yes

SIF

No

Was it life-altering?

Yes

No

Non-SIF

INURY: *Sudden physical damage to the human body caused by an external force.*

LIFE-ENDING: *Injury that results in the death of the injured person (IP).*

LIFE-THREATENING: *Qualified person confirms that IP would not have survived without immediate medical intervention or life-saving support (e.g., CPR, defibrillation).*

> ***QUALIFIED PERSON:*** *Individual with reasonable knowledge to make a determination about the IP's condition (e.g., a medical professional).*

LIFE-ALTERING: *Qualified person confirms that IP will not fully recover and will most likely suffer permanent impairment from the loss of the use of the use of a major internal organ (i.e., brain, heart, lungs, liver, and kidneys) body function, or body part.**

> ***BODY FUNCTIONS:*** *Physiological and psychological functions of body systems. Examples include vision, range of motion, or spatial orientation.*
>
> ***BODY PARTS:*** *Anatomical parts of the body, such as organs, limbs, and their components, that support body functions. Examples include eyes or hands.*

NOTE: Use the LIFE Model for determining if an ACTUAL injury is serious or not. You may use other models available for assessing the POTENTIAL severity of an incident (e.g., EEI SCL Model).

*Cases should be reclassified if new information becomes available

The Safety Classification and Learning (SCL) Model

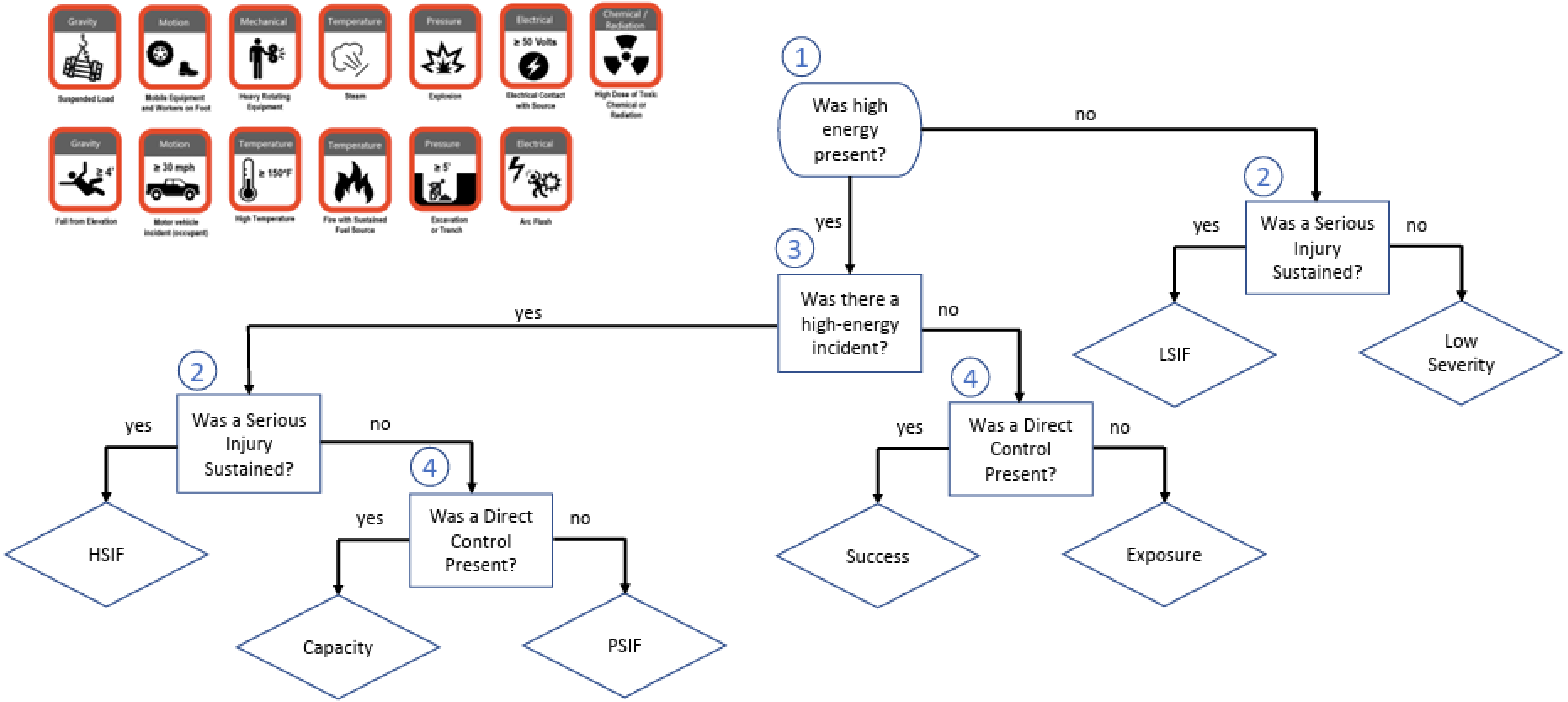
To enhance shared learning and create more meaningful safety metrics, SCL was created to help organisations ***consistently*** and ***reliably*** classify and define incidents and observations. The elegance of the SCL model is that any classification is based upon the answer to the following four yes/no questions:

1. Was there high energy?
2. Was there an incident?
3. Was there direct control?
4. Was a serious injury sustained?

Of course, the answers to these yes/no questions are not always easy—the SCL model and associated guidance help practitioners to answer these questions. By following consistent definitions of high energy, incident, direct controls, and serious injury, we can all classify incidents and observations similarly. This is exciting because a common understanding of commonly used terms like near-miss, PSIF, and success is the foundation for shared learning.

The SCL model was created by aggregating the best features of other classification models, inserting the scientific principles of energy, and testing and refining based on real cases. It avoids ambiguity, such as 'other' categories and incomplete lists of situations that have the potential to be serious.

① **Was High-Energy Present?** Refer to icons below or energy assessment charts if there is no applicable icon



② **Was a Serious Injury Sustained?** Refer to EEI SIF definitions for a complete categorization and description of SIF events.

① Was high energy present?

yes

③ Was there a high-energy incident?

yes

② Was a Serious Injury Sustained?

yes: HSIF

no: ④ Was a Direct Control Present?

yes: Capacity

no: PSIF

no

④ Was a Direct Control Present?

yes: Success

no: Exposure

no

② Was a Serious Injury Sustained?

yes: LSIF

no: Low Severity

③ **Was there a High-Energy Incident?** An instance where the high-energy source was released and where the worker came in contact with or proximity to the high-energy source.

- Released: An instance where energy source changes state while exposed to the environment
- Contact: An instance when high energy is transmitted to the human body
- Proximity: An instance with unrestricted egress where the boundary of the high energy exposure is within 6 feet of a worker or any distance to a high energy source when there is restricted egress from the energy source.

④ **Was a Direct Control Present?** For each high energy source, a direct control is present if:

1. The control is specifically targeted to the high-energy source
2. The control effectively mitigates exposure to the high energy source when installed, verified, and used properly (i.e., a SIF incident cannot reasonably occur)*
3. The control is effective even if there is unintentional human error during the work period (unrelated to the installation of the control)

The vision for metrics

A balanced approach

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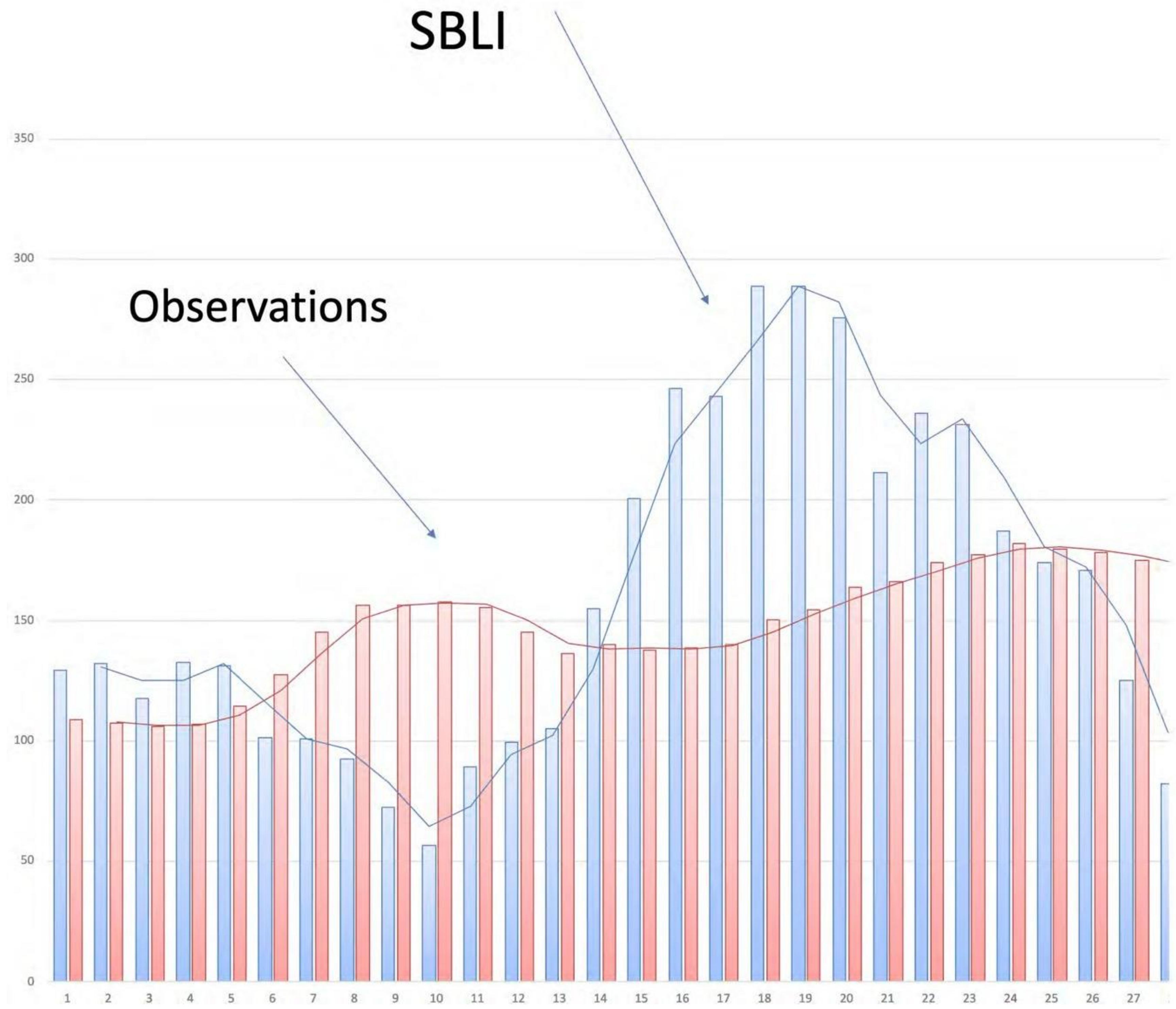
SBLI
Observations
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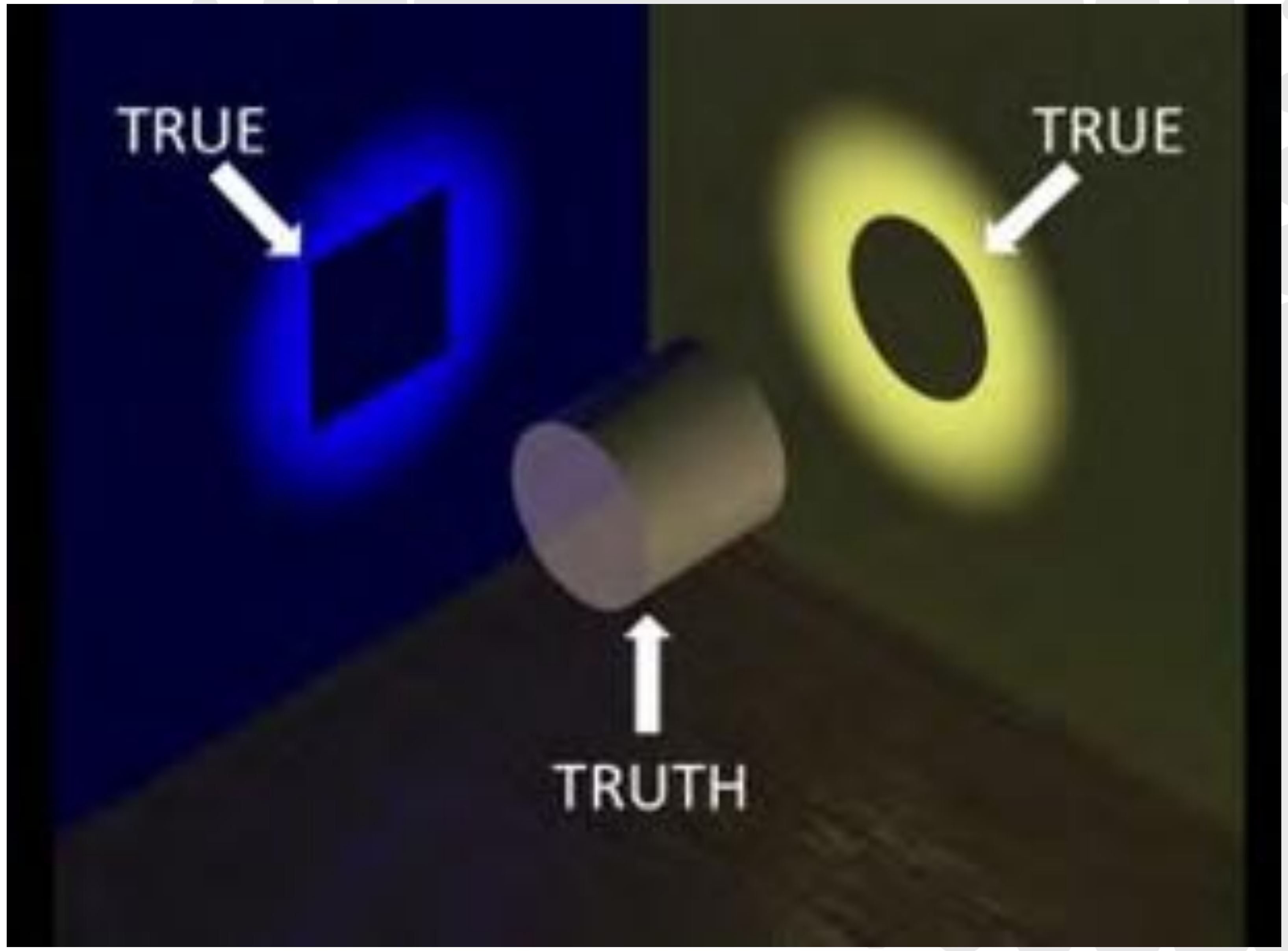
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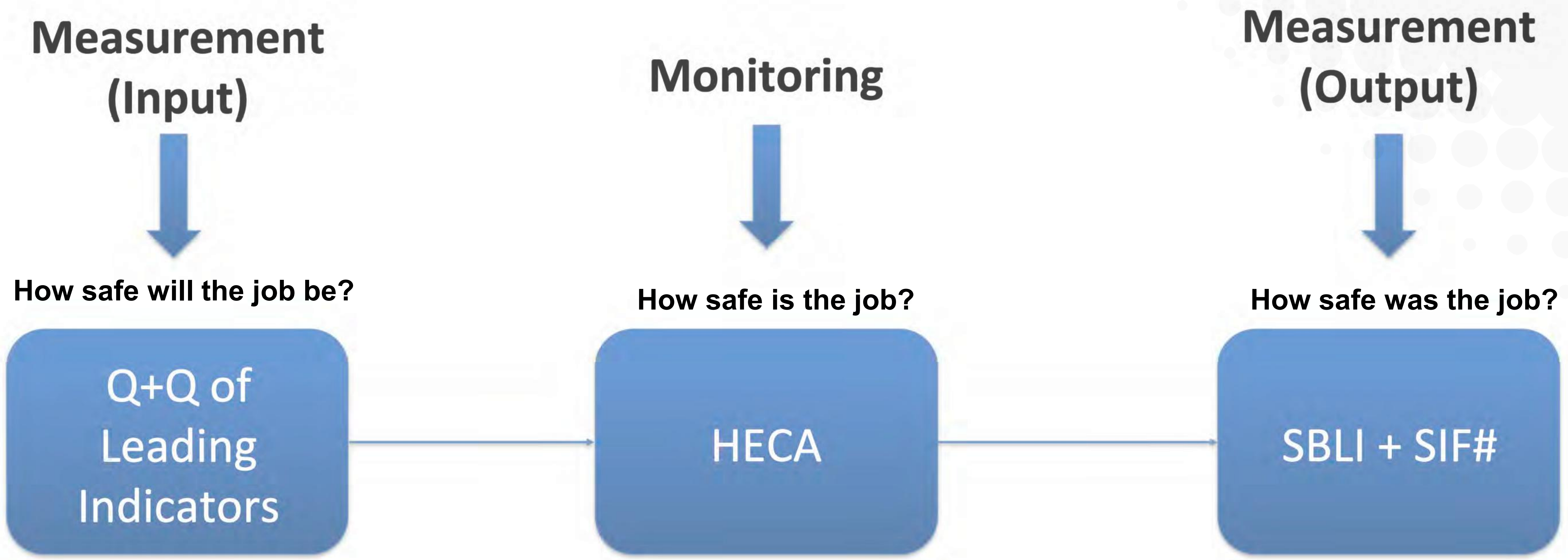
Measurement and Monitoring



Measurement (Input)

How safe will the job be?

Q+Q of Leading Indicators

Monitoring

How safe is the job?

HECA

Measurement (Output)

How safe was the job?

SBLI + SIF#

Final Thought - Energy-Based Safety

- See the energy, not just the hazard.
- Prioritise controlling high-energy hazards.
- Measure resilience.
- Monitor what matters.

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A big thank you and credit goes to our good friend **Dr Matt Hallowell**, who led the research and wrote the papers on which this presentation is based.

Dr Hallowell heads up the Construction Safety Research Association based out of the University of Colorado at Boulder in the USA and continues to ensure good, practical research is done to improve the safety of the work we do:

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