Understanding the Impact of Changing Safety Metrics
(Inside Electrical Construction)

May 25, 2023

This session is eligible for 1.25 Continuing Education Hours.

For these hours to appear on your certificate, you must:
- Have your badge scanned at the door
- Attend 90% of this presentation
- Fill out the online evaluation for this session

Online Evaluation

Use of Safety Metrics

- Used by OSHA
  - Collected by Burrough of Labor Statistics (BLS)
  - Used to establish industry benchmarks
  - Used to target enforcement initiatives

- Used by insurance companies
  - Determines rates and premiums

- Used by host employers to assess contractor safety
  - Collected by host employers or third-party administrators
  - Used to access and qualify (pre-qualify) contractors

What's Changing for Contractors

- Host Employers | Contractor Assessment Criteria

  - Focus on Serious Injuries and Fatalities (SIFs)

  - Increased Inclusion of Leading Indicators

Pre-Metrics 101

METRICS

Advantages
- Identify areas that need improvement
- Track progress and identify trends
- Can identify potential problems before they occur

Disadvantages
- Time-consuming
- Can be difficult to interpret
- Can be misused/misinterpreted
- **Can take focus away from the injured**

Metrics 101

METRICS

- **Metric |** A system or standard of measurement

- **Reliability and Validity |** Determines the quality of the metric

- **Reliability |** The consistency of a measure (reproduce same results under the same conditions)

- **Validity |** The accuracy of a measure (measures what it is intended to measure)

Lagging & Leading Indicators

Leading — Analyse past performance
Influence future performance — Lagging

- **Lagging Indicator |** An output measurement. Measures the occurrence and frequency of events that occurred in the past, such as the number or rate of injuries, illnesses, and fatalities.

- **Leading Indicator |** A predictive measurement. Proactive and preventative measures that can impact a future outcomes.
  - Number Safety Observations : Number of Accidents

Lagging | Traditional OSHA Metrics

- **TRIR |** Total Recordable Incident Rate
- **DART |** Days Away, Restricted, Transferred Rate
- **LWCR |** Lost Workday Case Rate

$$\frac{\text{Number of Reported Cases x 200,000}}{\text{Employee Total Hours Worked}}$$

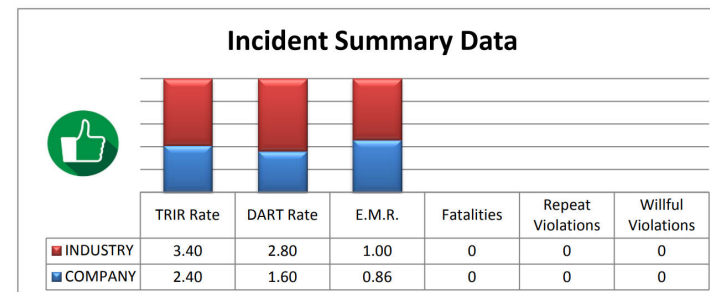* Normalization | Rescaling the data to arrive at values relative to some size variable.

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

BLS Data

TABLE 1. Incidence rates[1] of nonfatal occupational injuries and illnesses by industry and case types, -- Continued

Industry[2]	NAICS code[3]	Total recordable cases	Cases with days away from work, job transfer, or restriction			Other recordable cases
			Total	Cases with days away from work[4]	Cases with job transfer or restriction	
Framing contractors	23813	7.2	4.5	2.7	1.8	-
Masonry contractors..	23814	3.8	2.2	1.6	0.6	1.5
Roofing contractors	23816	6.0	3.3	2.0	-	-
Siding contractors	23817	4.8	2.5	2.0	0.5	2.3
Other foundation, structure, and building exterior contractors	23819	3.5	2.5	2.0	0.5	1.0
Building equipment contractors	2382	3.5	1.8	1.3	0.5	1.7
Electrical contractors and other wiring installation contractors	23821	2.8	1.4	1.0	0.4	1.4
Plumbing, heating, and air-conditioning contractors...............................	23822	4.2	2.3	1.6	0.6	1.9
Other building equipment contractors	23829	2.6	1.3	0.8	0.5	-

* OSHA Metrics: Most Valid and Reliable Metric | May not measure the quality or effectiveness of a safety program

---

Current Lagging Indicators

Incident Summary Data

	TRIR Rate	DART Rate	E.M.R.	Fatalities	Repeat Violations	Willful Violations
INDUSTRY	3.40	2.80	1.00	0	0	0
COMPANY	2.40	1.60	0.86	0	0	0

Current Lagging Indicators

2021 NAICS Code: 238210 Electrical Contractors and Other Wiring Installation Contractors				
TRIR	DART	EMR	Deaths	Willful
< 2.8	< 1.4	< 1	0	0

Serious Injuries & Fatalities

The Evolution of SIF Metrics and Prevention Strategies

SIF Presentation Outline

- BST/Mercer ORC Study
- Response to SIF
- Applied Solutions
- Actual SIF Event Criteria

Definition of SIF

- Life Threatening Injury
  - An injury that if not immediately addressed is likely to lead to death. Usually requires the intervention of emergency response personal providing life-sustaining support.

- Life Altering/Permanent Disability
  - An injury that results in permanent or long-term impairment.

- Work Related

Traditional Model (Paradigm)

Fatality	1
Lost Time	3
Recordable	10
First Aid	100
Near Miss	600

Heinrichs Triangle
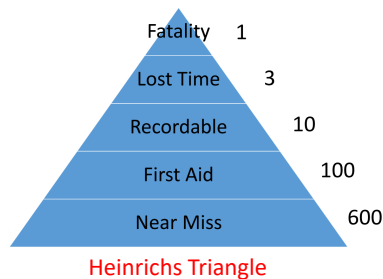
- Traditional prevention strategies based on Heinrichs Triangle.

- Reducing incidents at the bottom of the triangle corresponds with a proportional reduction at the top.

- Reducing recordable cases will reduce serious injuries.


SIF | Cause of Action

- Emerging Statistical Pattern
  - Recordable and Lost Time Accidents Are Going Down
  - SIF Accidents are Leveling or Increasing

- Prevention Strategies Inadequate
  - Not Addressing Their Worst Injuries
  - Not Addressing Fatalities

- BST/Mercer ORC Study
  - 7 Top Performing Organizations Participated
  - New Statistical Model, Metrics and Strategy Emerged

BST/Mercer ORC Study
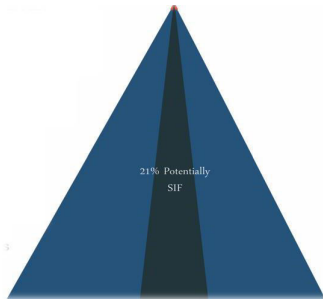
- Reducing less serious incidents MAY NOT reduce SIF events

- Traditional Safety Triangle is not predictive for SIFs

- Not all incidents have SIF potential

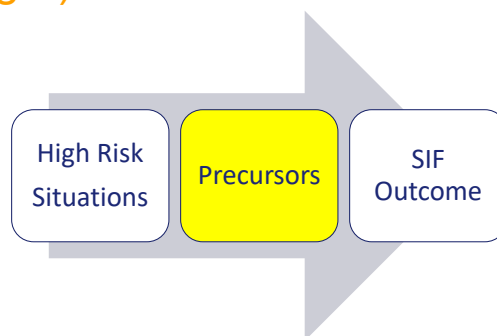- Focus on incidents with high SIF potential

21% Potentially SIF

BST/Mercer ORC Study

- SIF incidents have different causes and correlates than less serious incidents.

- Causes of SIFs are most often related to Cardinal and Life-Saving Rules. (e.g., minimum approach distance)

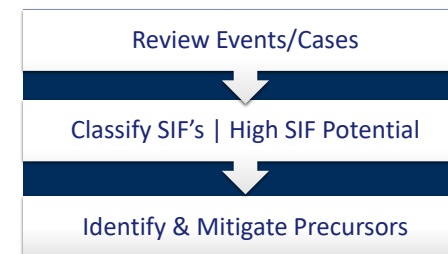- Less serious incidents are not related to Cardinal and Life-Saving Rules.

SIF Model (Paradigm)

High Risk Situations give rise to Precursors which are followed by Serious and Fatal Injuries.

High Risk Situations → Precursors → SIF Outcome

SIF Prevention Plan

Review Events/Cases

↓

Classify SIF's | High SIF Potential

↓

Identify & Mitigate Precursors

A Precursor is an unmitigated High-Risk condition that will eventually result in a SIF if allowed to continue.

SIF Classification/Determination

- Two classification or determination systems were identified from the study

  - Judgement Based Narrative Review

  - Event Based Decision Chart

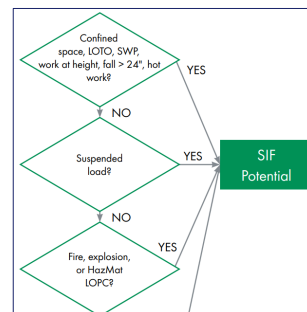- Procedure to identify incidents with SIF Potential. Actual and Potential SIFs were classified the same.

Judgement Bases Narrative Review

- Raters agreed upon definitions and participate in calibration exercises to achieve maximum reliability

- Raters read the complete accident narrative to understand context and circumstances in order to determine SIF Potential.

- Relies on professional judgment of the raters

- Suited for organizations with a small team of raters who review and classify all incident on a regular basis and engaged in frequent calibration exercises.

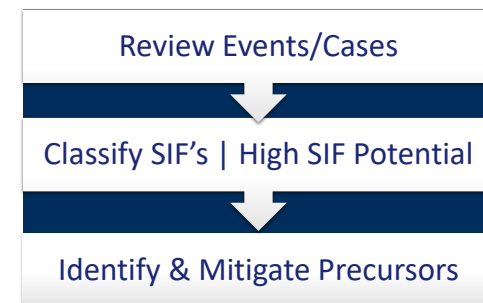## Event Based Decision Chart

- Activities w/SIF Potential
  - Confined Spaces
  - Suspended Loads
  - Elevations
- 90% Reliability

Confined space, LOTO, SWP, work at height, fall > 24", hot work? — YES

NO

Suspended load? — YES → SIF Potential

NO

Fire, explosion, or HazMat LOPC? — YES

Summary: SIF Prevention Plan

Review Events/Cases

↓

Classify SIF's | High SIF Potential

↓

Identify & Mitigate Precursors

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

Total Recordable Incident Rate

	Total Co	Fossil	Nuclear	Hydro	T & D	System
2007	2.66	2.49	0.58	3.31	3.53	0.82
2008	2.32	2.10	0.52	2.61	3.26	0.72
2009	2.02	1.91	0.44	2.04	2.59	0.54
2010	1.82	1.71	0.43	2.42	2.43	0.57
2011	1.63	1.53	0.27	1.84	1.89	0.60

DART Rate

	Total Co	Fossil	Nuclear	Hydro	T & D	System
2007	1.47	1.14	0.18	0.96	2.07	0.45
2008	1.30	0.92	0.15	0.70	1.88	0.39
2009	1.17	0.80	0.11	0.76	1.58	0.27
2010	1.04	0.75	0.11	0.97	1.48	0.28
2011	0.91	0.63	0.08	0.63	1.13	0.30

LWDC Rate

	Total Co	Fossil	Nuclear	Hydro	T & D	System
2007	0.73	0.47	0.12	0.62	1.01	0.28
2008	0.63	0.41	0.09	0.36	0.91	0.25
2009	0.55	0.37	0.08	0.35	0.78	0.17
2010	0.50	0.35	0.07	0.42	0.73	0.18
2011	0.45	0.35	0.05	0.39	0.60	0.20

Traditional Model | Heinrich's Triangle

Fatality
Serious injuries
Lost time injuries
Medical attention injuries
Incidents with no injury
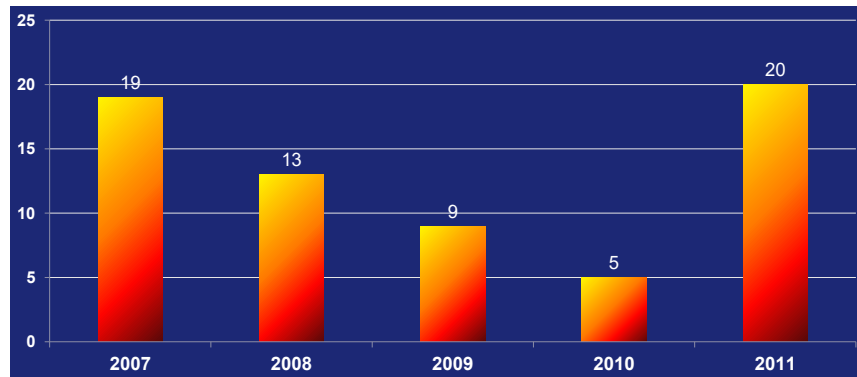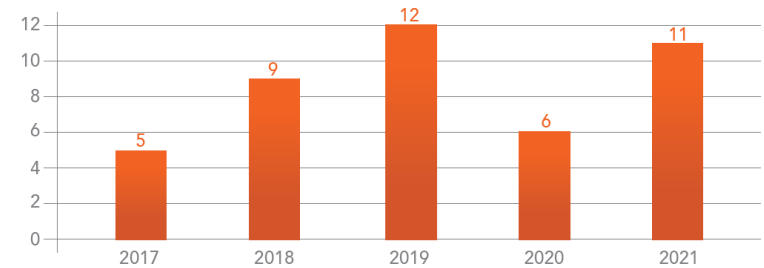Unsafe acts/conditions
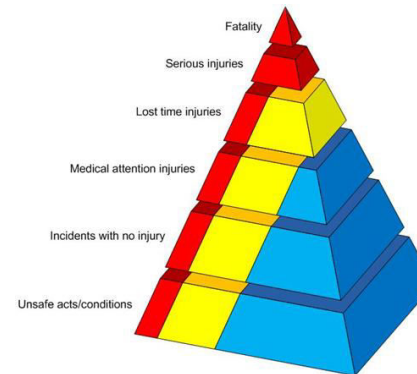
Reducing incidents at the bottom of the triangle corresponds with a proportionate reduction at the top of the triangle.

Total Company Fatalities

TOTAL COMPANY FATALITIES

Call to Action

- Why was this occurring?
- What can be done?

- No actionable data
- No mechanism to collect actionable data

- No understanding of the SIF Paradigm

Industry Response - CSRA

- Unique Precursors of SIF
- The Tyranny of TRIR
- Quality of Safety Leading Indicator
- Predictive Analytics
- High Energy: Controlling the Uncontrollable

New Lagging Indicators

- SIF | Serious Injuries and Fatalities

- SCL Model | SIF Classification and Learning Model

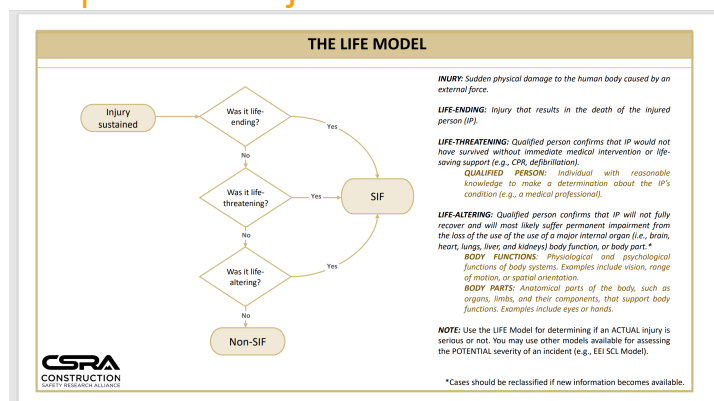- SBLI | Severity Based Lagging Indicator

---

SIF | Serious Injuries and Fatalities

- OSHA Severe Cases
  - Fatality, Amputation, Eye Loss, Hospitalization

- SIF Criteria
  - Occupational Fatality
  - Life Threatening or Life Changing Injury

SIF | Serious Injuries and Fatalities

THE LIFE MODEL

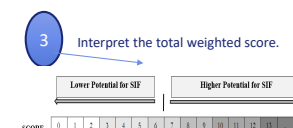INURY: Sudden physical damage to the human body caused by an external force.

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.

CRSA Precursor Analysis Study

CSRA CONSTRUCTION SAFETY RESEARCH ALLIANCE

SIF Precursor Scorecard

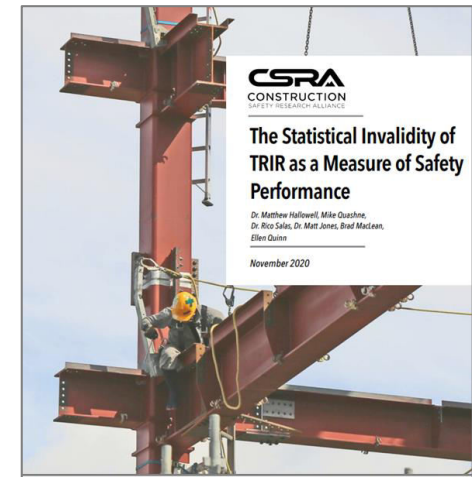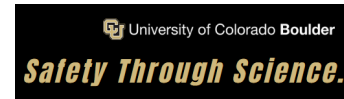| PRECURSORS	(check if present)	WEIGHT
Safe Work Procedure		3
Hazard Recognition		2
Departure from Routine		3
Plan to Address Change		1
Safety Attitudes		1
Rules and Procedures		3
Familiar with the Task		2
Risk Normalization		3
Productivity Pressure		3
Perceived Safety Culture		3
Stop Work Execution		2
Workers Inactive in Safety		2
Pre-Task Plan		3
TOTAL WEIGHTED SCORE:		SUM

1. Check the precursors that were present before any intervention was made.

2. Find the sum of all the weights for the selected precursors.

3. Interpret the total weighted score.

Lower Potential for SIF | Higher Potential for SIF

SCORE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 ... 30

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

SBLI | Severity Based Lagging Indicator

- Developed to be an improved lagging indicator.

- SBLI is an aggregated injury rate that weights injuries by their relative level of severity and aggregates them into one number.

- SBLI produces a more statistically stable and representative indication of safety performance.

- What was the perceived need for this metric?

CSRA CONSTRUCTION SAFETY RESEARCH ALLIANCE

University of Colorado **Boulder**
Safety Through Science.

CSRA CONSTRUCTION SAFETY RESEARCH ALLIANCE
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

Invalidity of TRIR

- Not a valid measure of safety performance.

- The occurrence of recordable injuries is rare and random, making it statistically unstable even over long timeframes.

- It is not predictive of itself or of more severe injuries.

Severity-Based Lagging Indicator

Table 1 – Injury Severity Category Weightings

Injury Severity Level	Symbol	Assigned Weight
First Aid	FA	100
Medical Treatment	MT	500
Job Transfer or Restricted Duty	JTR	750
Days Away from Work	DAW	1500
Fatality	F	NOT WEIGHTED

Table 2 – SBLI Computation for Company X

Year	Month	Month (#)	Hours	FA	MT	JTR	DAW	SBLI
2018	Jan	1	1221702	5	5	3	4	1.84
2018	Feb	2	1069571	4	5	2	4	1.94
2018	Mar	3	1172202	10	7	5	5	2.69
2018	Apr	4	1294607	6	5	2	2	1.17
2018	May	5	1338205	7	4	2	6	1.97
2018	Jun	6	1180342	5	5	3	3	1.65
2018	Jul	7	1208402	12	8	3	5	2.47
2018	Aug	8	1209507	7	7	4	6	2.68
2018	Sep	9	1104894	6	5	2	6	2.46
2018	Oct	10	1428938	6	7	3	8	2.57
2018	Nov	11	1165845	7	5	4	3	1.84
2018	Dec	12	992878	5	4	1	4	1.86

$$SBLI = \frac{n_{fa} * w_{fa} + n_{mt} * w_{mt} + n_{jtr*}w_{jtr} + n_{daw} * w_{daw}}{e} * 200$$

Severity-Based Lagging Indicator

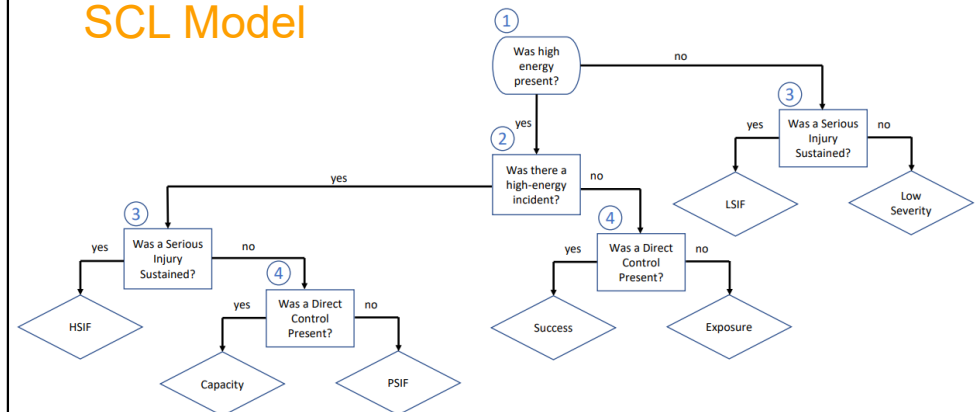Figure 2 – Rolling 12-month average SBLI for Company X

Company X - Rolling 12-Month SBLI
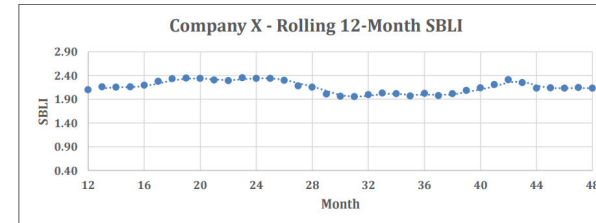
Table 3 – Company X Rolling SBLI Data

Month (#)	SBLI	12-month SBLI
1	1.84	-
2	1.94	-
3	2.69	-
4	1.17	-
5	1.97	-
6	1.65	-
7	2.47	-
8	2.68	-
9	2.46	-
10	2.57	-
11	1.84	-
12	1.86	2.10
13	2.61	2.16
14	1.84	2.15
15	2.79	2.16
16	1.55	2.19
17	2.94	2.27
18	2.33	2.33
19	2.64	2.34
20	2.59	2.34
21	2.08	2.30
22	2.39	2.29
23	2.53	2.35
24	1.74	2.34

Safety Classification and Learning (SCL) Model

- Uniform System for Classifying Incidents and Observations
- Underpinned by Participant Approved Definitions
- Supported by Flowchart, Icons, and Energy Wheels
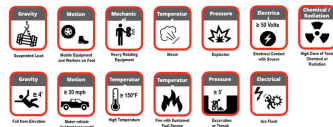- Tracked though an online database application

NSPC
NECA SAFETY PROFESSIONALS CONFERENCE

SCL Model

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

SCL Model Question #1

- **Was High-Energy Present?**

  - Refer to icons below or energy assessment charts

SCL Model Question #2

- **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.

SCL Model Question #3

- **Was a Serious Injury Sustained?**

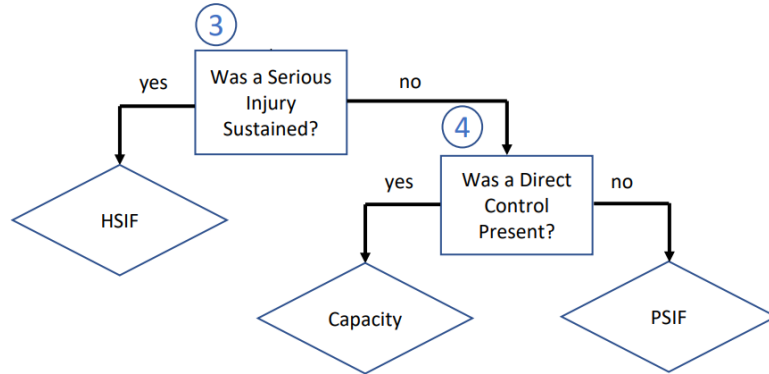 - Refer to EEI SIF criteria for a complete categorization and description of SIF events.

SCL Model Question #4

- **Was a Direct Control Present?**

  - The control is specifically targeted to the high-energy source

  - The control effectively mitigates exposure to the high energy source when installed, verified, and used properly

  - The control is effective even if there is unintentional human error during the work period (unrelated to the installation of the control)
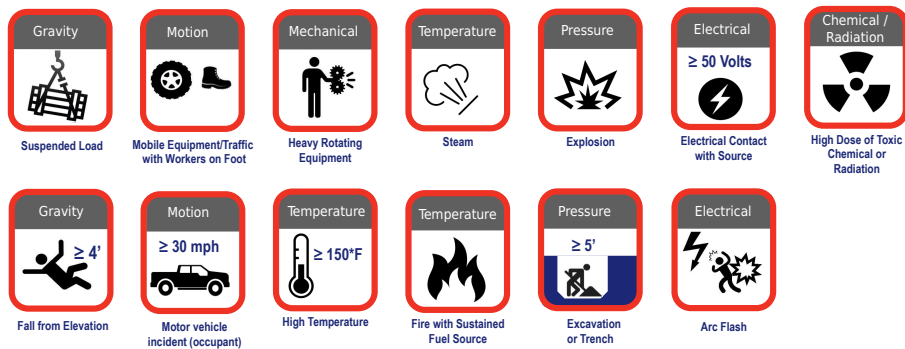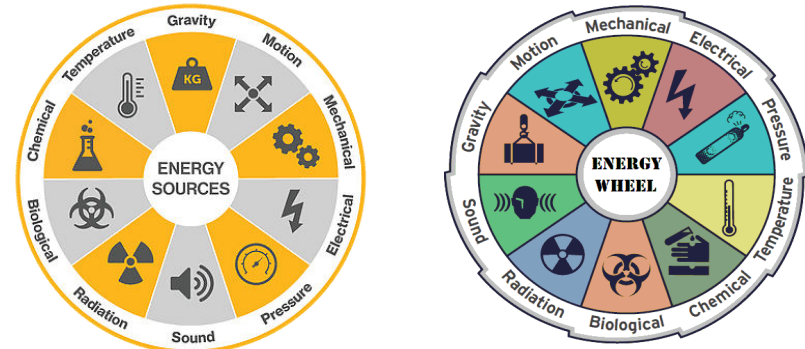
Yes | High Energy Incident (release)
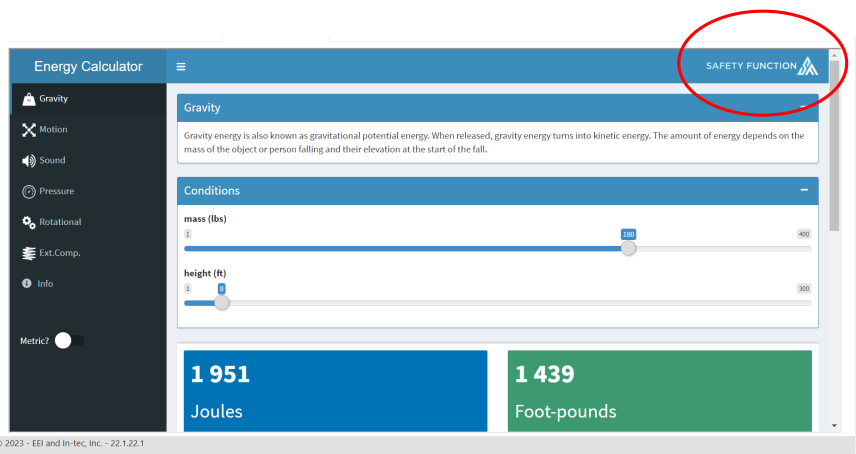

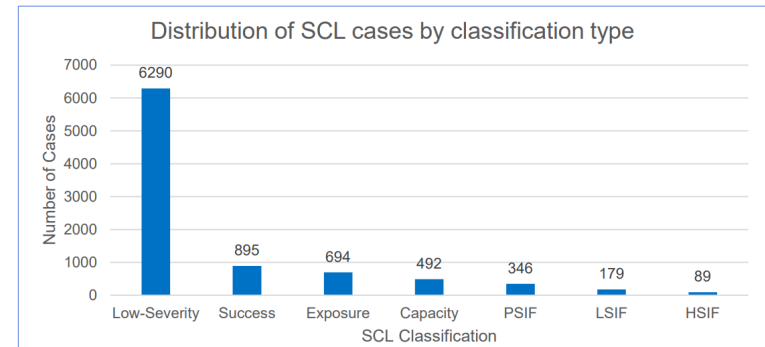# No | High Energy Incident (release)

High Energy Icons

Gravity	Motion	Mechanical	Temperature	Pressure	Electrical ≥ 50 Volts	Chemical / Radiation
Suspended Load	Mobile Equipment/Traffic with Workers on Foot	Heavy Rotating Equipment	Steam	Explosion	Electrical Contact with Source	High Dose of Toxic Chemical or Radiation

Gravity ≥ 4'	Motion ≥ 30 mph	Temperature ≥ 150°F	Temperature	Pressure ≥ 5'	Electrical
Fall from Elevation	Motor vehicle incident (occupant)	High Temperature	Fire with Sustained Fuel Source	Excavation or Trench	Arc Flash

SIF Energy Wheels

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

SCL Classifications

Distribution of SCL cases by classification type

SCL Classification	Number of Cases
Low-Severity	6290
Success	895
Exposure	694
Capacity	492
PSIF	346
LSIF	179
HSIF	89

Types of Leading Indicators

- Leading Indicator | A predictive measurement. Proactive and preventative measures that can impact a future outcomes.

- Active Leading Indicator
  - Can be readily changed during work
  - Increase number of observations to reduce number of accidents

- Passive Leading Indicator
  - Implemented before work begins and remains relatively static
  - Written Programs and Safety Management Program
  - Best Practices are a form of passive leading indicator

NSPC
NECA SAFETY PROFESSIONALS CONFERENCE

Common Leading Indicators

- Company Safety Committee

- Safety Professional Ratio

- Compliant Written Programs

- Safety and Health Management Program
  - Collection of Leading Indicators/Best Practices

NSPC
NECA SAFETY PROFESSIONALS CONFERENCE

Safety & Health Management Program

May 25, 2023

Safety Management Standards

A system that is designed to manage safety risk at the workplace. Program elements detect and correct workplace hazards.

- ANSI Z-10 | Occupational Health And Safety Management Systems
- ISO 45001 | Occupational Health and Safety Management Systems
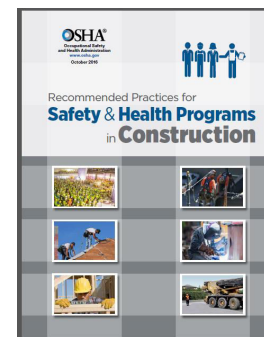- OSHA | OSHA Safety & Health Management Guidelines

---

Safety & Health Management Program

- System of passive leading indicators
- Collection of Best Practices (leading indicators)
- Historical Base: OSHA 4 Point Plan
  - Management Commitment & Employee Involvement
  - Workplace Analysis
  - Hazard Identification and Control
  - Training

Safety & Health Program Guidelines

- A program is required to detect and correct workplace hazards
- Provides recommended guidelines for an effective safety and health program.
- Contains best practices and leading indicators

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

OSHA Safety Management Guidelines

- Leadership & Participation
- Hazard Identification
- Hazard Control
- Information & Training
- Subcontractor Management
- Program Improvement
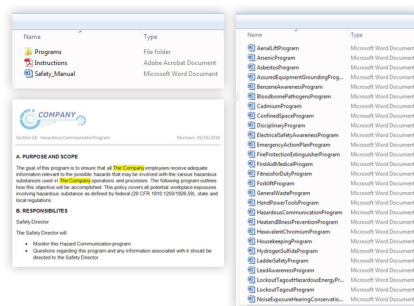

Safety Management Program Evaluation

- Review program elements address regulations, consensus standards and best practices
- Assessments typically performed by third-party
- Specific language required
- Third-parties assess programs using safety pro, admin, scoring rubric, computer app or combination of these

---

Safety Management Program Evaluation

Standards

- Required criteria
- Branding/Customization needed
- Unique organizational structure, procedures, & resources?

Safety Management Program Evaluations

- Score provided based on matching content with required language
- Most content generic based on common host employer needs regardless of contractor work
- Third party evaluators may have individual requirements based on a specific host employer

Leading Indicator Attributes

- Observable and Measurable
- Unidirectional
- Actionable
- Predictive
- Standardized (reliable)

Leading Indicator Attributes

- **Observable and Measurable**
  - The indicator must be readily observed and objectively measured.
  - Leading indicators can be measured frequently so they are not subject to the same statistical limitations as rarely occurring lagging indicators.

Leading Indicator Attributes

- **Unidirectional**
  - Indicators must have one direction (e.g., higher score is always better or lower score is always better).
  - This criterion renders some commonly used indicators like stop work authority and near miss reporting inviable.

Leading Indicator Attributes

- **Actionable**
  - It must be possible to take management action based on an observed measurement or trend.
  - If the frequency of safety observations were to drop, additional observations could be mandated before an injury occurs.

Leading Indicator Attributes

- **Predictive**
  - The best indicators have shown to predict future performance.

- **Standardized**
  - They must be measured and reported consistently by all stakeholders.

EEI
Edison Electric INSTITUTE

Leading Indicator List (examples)

- Frequency of pre-job safety meetings
- Frequency of safety observations
- Frequency of leadership engagements
- Frequency of safety training and refresher sessions
- Proportion of unresolved corrective action items
- Frequency of project risk assessments

Leading Indicator Study

CSRA CONSTRUCTION SAFETY RESEARCH ALLIANCE

Pre-job Briefing Document Review

- Job Briefing Documentation
  - Job Location
  - Job task
  - Hazard Identification
  - Mitigations/Controls:
  - Clearly identified person in charge
  - Emergency response plan
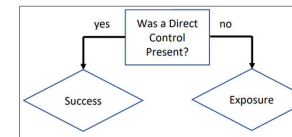- % of above completed

Leading Indicator Study

CSRA CONSTRUCTION SAFETY RESEARCH ALLIANCE

Pre-job discussion Review

- Quality of job briefing conversation
  - Score card
    Pre job Scorecard 8.28.21 (colorado.edu) (Inside)

HECA | High Energy Control Assessment

- Created from the SCL Model

- Target observations to access high energy hazards

- Determine if energy hazards have corresponding direct controls

- HECA **Monitoring** Metric
  - % of high energy hazards have a corresponding direct control

HECA Success Rate: 5/9 = 56%

How Are Contractors Being Assessed?

- Lagging Indicators
  - OSHA Rates, EMR, OSHA Violations
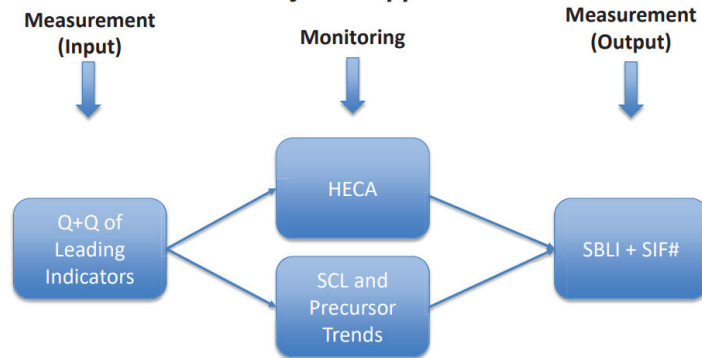
- Leading Indicators
  - Written Programs

How Will Contractors Be Assessed?

- Lagging Indicators
  - OSHA Rates, EMR, OSHA Violations
  - Serious Injury and Fatalities (SIF)
  - Severity Based Lagging Indicators (SBLI)

- Leading Indicators
  - Written Programs (Site Specific Plans)
  - Safety Management Systems
  - SIF Control Assessments

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

Questions?

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY

Please complete the Online Evaluation

FOR REFERENCE ONLY OF NECA SAFETY PROFESSIONALS CONFERENCE 2023 ATTENDEES ONLY