

# Flight Simulator Telemetry and Pilot Gaze Tracking

Technology to support Competency based training and Assessment programs

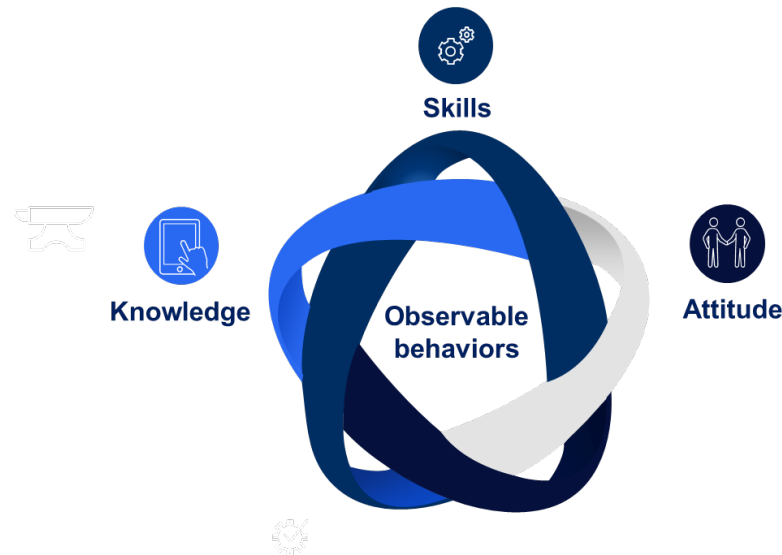
Chris Ranganathan



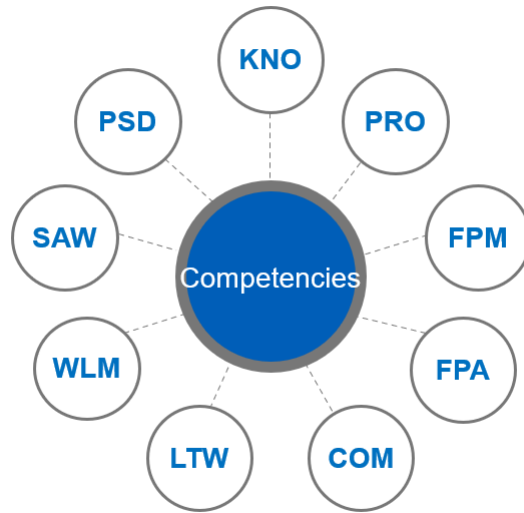
## ICAO Definitions > *Competencies and Observable Behaviours*

Competency refers to **a dimension of human performance** that is used to reliably predict successful performance on the job

- A competency is **manifested and observed through behaviors that mobilize the relevant knowledge, skills and attitudes** to carry out activities or tasks under specified conditions



# Assessment and Grading > *Observable Behaviors*



## Observable Behaviors

OB 8.1 Exercises self-control in all situations.

OB 8.2 Plans, prioritizes and schedules appropriate tasks effectively.

OB 8.3 Manages time efficiently when carrying out tasks.

OB 8.4 Offers and gives assistance.

OB 8.5 Delegates tasks.

OB 8.6 Seeks and accepts assistance, when appropriate.

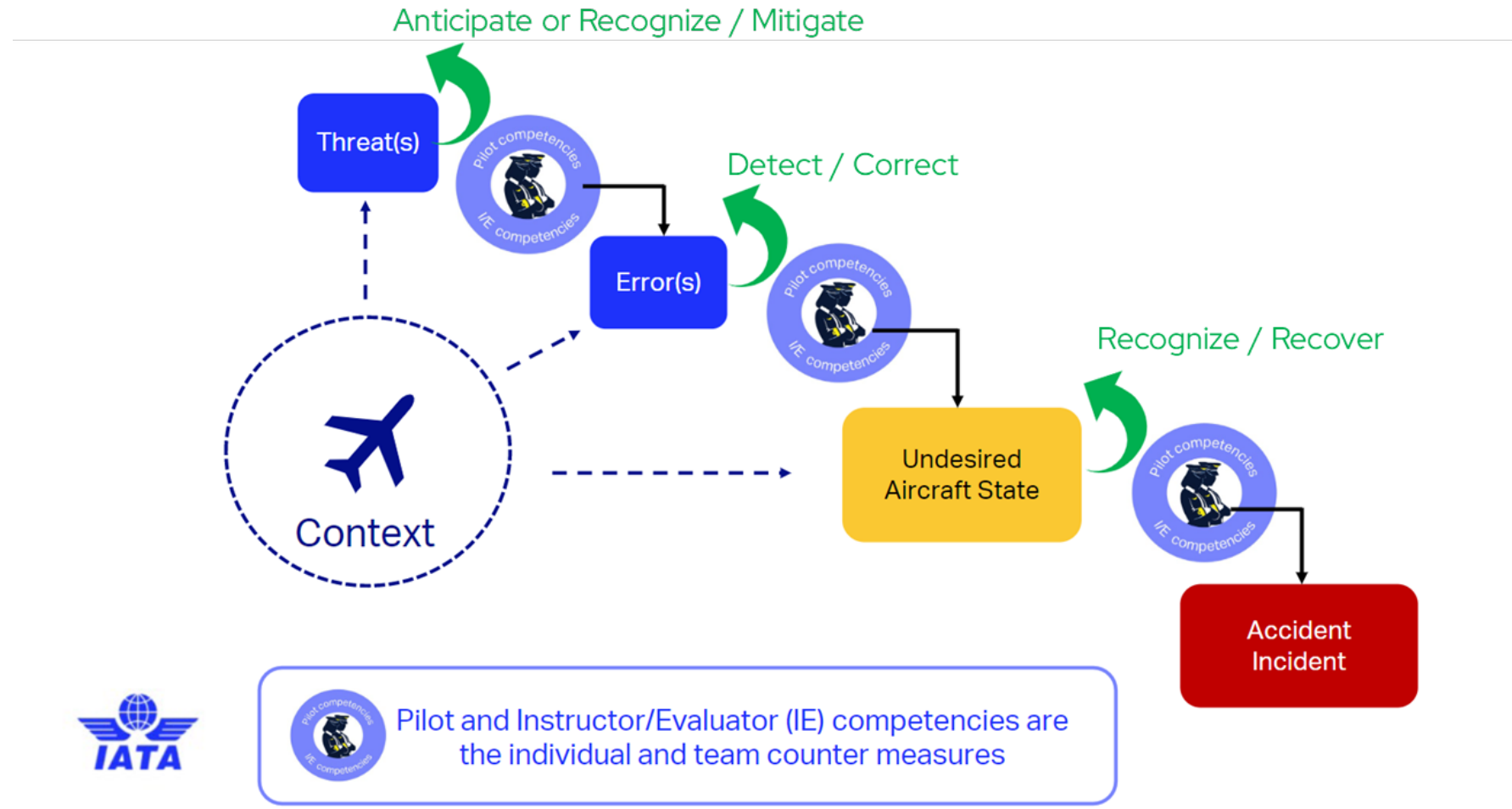
OB 8.7 Monitors, reviews and cross-checks actions conscientiously.

OB 8.8 Verifies that tasks are completed to the expected outcome.

OB 8.9 Manages and recovers from interruptions, distractions, variations and failures effectively while performing tasks.

	COMPETENCY
KNO	Application of Knowledge
PRO	Application of Procedures & compliance with Regulations
FPA	Aeroplane Flightpath Management- <b>automation</b>
FPM	Aeroplane Flightpath Management- <b>manual control</b>
COM	Communication
LTW	Leadership & Teamwork
PSD	Problem Solving & Decision Making
SAW	Situation awareness & management of information
WLM	Workload Management

# Effective threat and error management = competent pilots

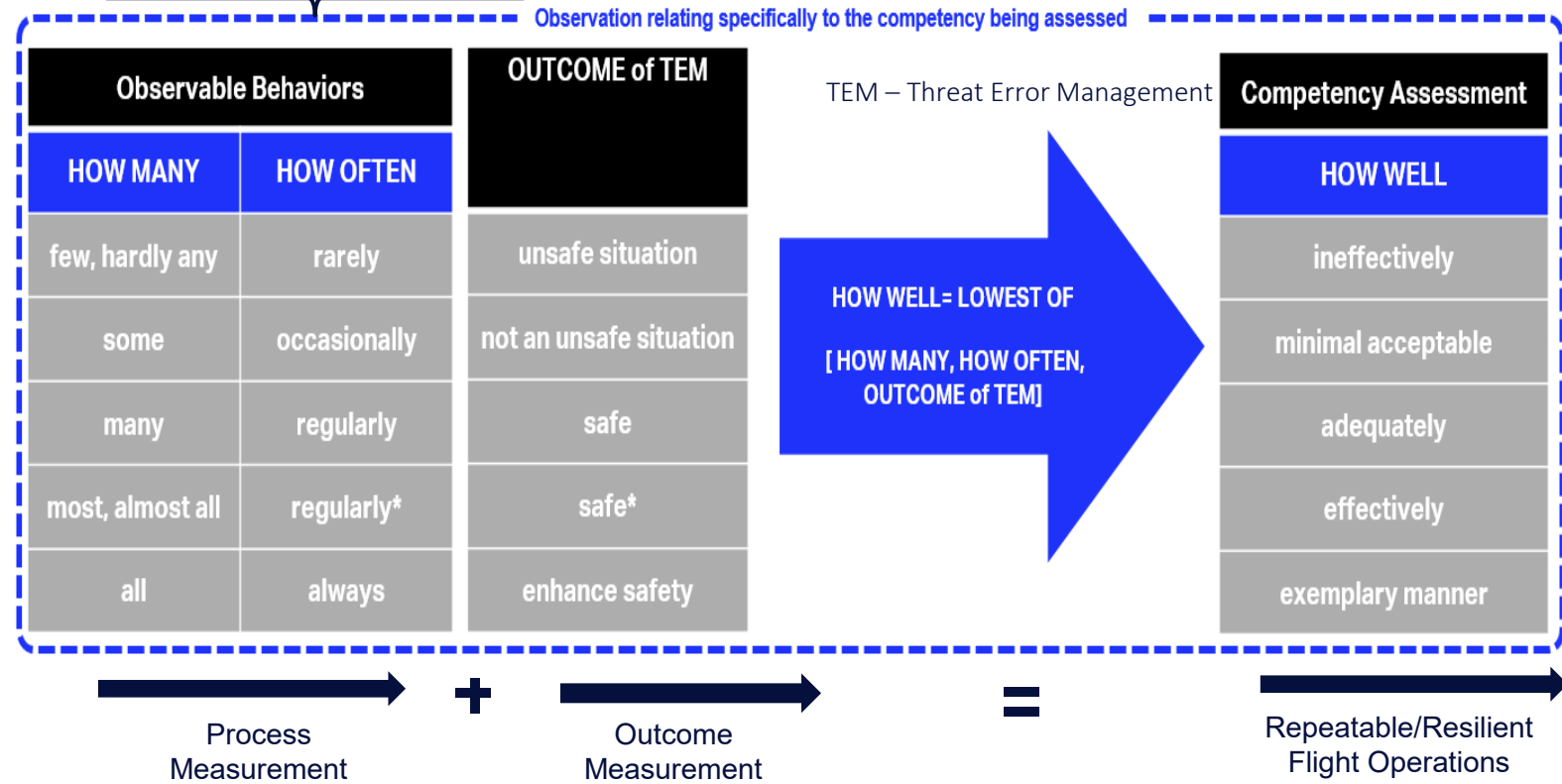


Competencies are TEM countermeasures.  
 Pilots demonstrate relevant observable behaviours to manage safety margins.

# Measuring Competence

Focus equally on process and outcomes, to ensure reliable/resilient flight operations.

What is relevant?



One Key for accurate application of this method of assessing process, is to define the Observable Behaviours **relevant** to the training event.

# CBTA Training Data and Metrics (adding context)

## Best practice of CBTA grading metrics

**Level 0** (competent metrics): The information whether the pilot(s) is (are) competent or not.

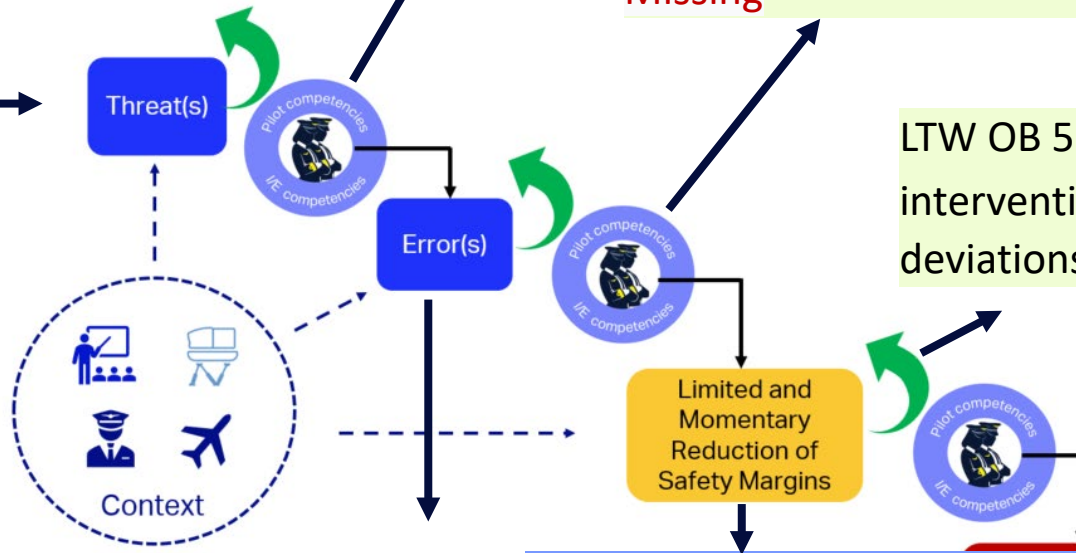
**Level 1** (competency metrics): Level of performance reflected by numeric grade of the competencies (e.g., 1 to 5).

**Level 2** (observable behavior metrics): The instructors record OBs predetermined or required by the organization (Regulatory or Policy requirements).

**Level 3** (TEM metrics): The instructor records Threats, Errors or Reduction of Safety Margin predetermined or required by the organization.

# CBTA data collection

- THREATS** (occurs outside the influence of the flight crew)
- E - Environmental Threats**
- E01 Meteorology (see breakdown)**
- E01.01 Thunderstorm
  - E01.02 Poor Visibility/IMC
  - E01.03 Gusty wind/ windshear
  - E01.04 Icing conditions
  - E01.05 Hail
- E02 Lack of Visual Reference
- E03 Air Traffic Services
- E04 Birds/foreign objects**
- E04.01 Birds
  - E04.02 Wildlife
  - E04.03 Foreign objects



SAW OB 7.3 Monitors and assesses the general environment as it may affect the operation. **Missing**

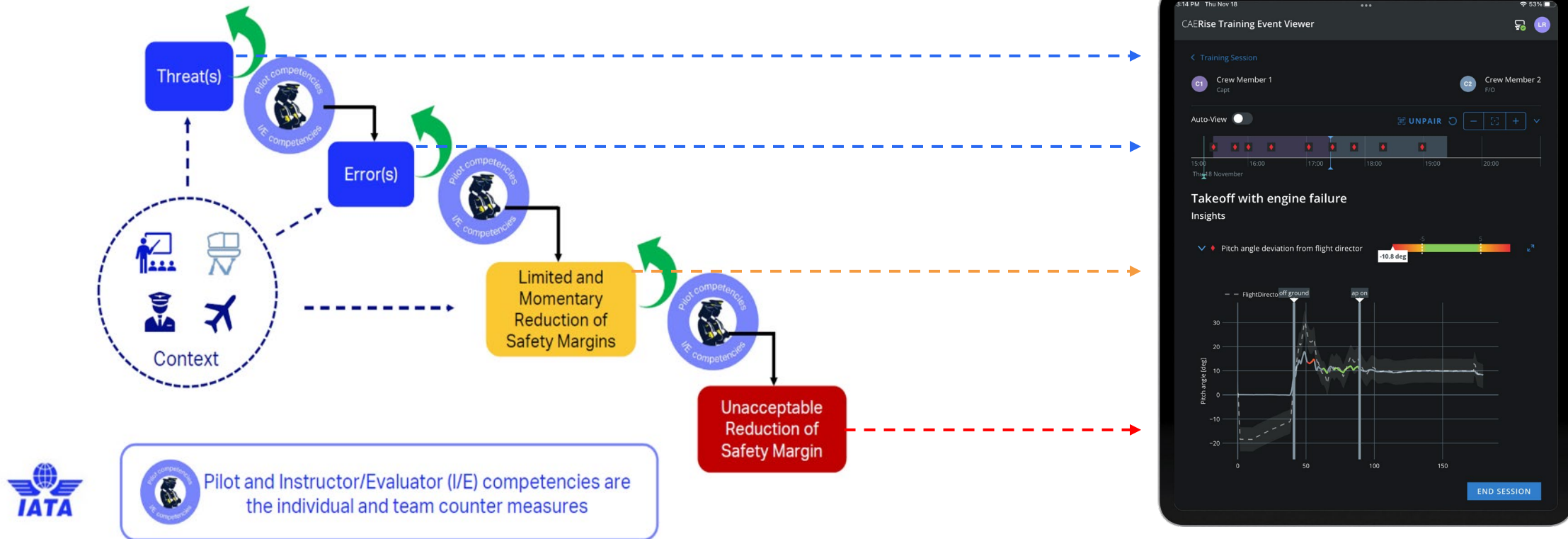
OB 3.4 Maintains the intended flight path during flight using automation while managing other tasks and distractions. **Missing**

LTW OB 5.10 Applies effective intervention strategies to resolve identified deviations. **Observed**

- ERRORS** (flight crew deviation)
- H - Aircraft Handling Errors**
- H01 Manual handling/Flight Controls
  - H02 Ground Navigation (Surface nav)
  - H03 Automation (settings/selections)
  - H04 Systems/Radio/Instruments (settings/selections)
  - H99 Other
- P - Procedural Errors**
- P01 SOP adherence/ cross-verification (see breakdown)**
- P01.01 Intentional
  - P01.02 Unintentional
  - P01.03 Unknown
- P02 Checklist (see breakdown)**
- P02.01 Normal checklist (error)
  - P02.02 Abnormal checklist (error)

- UNDESIRABLE AIRCRAFT STATES** (flight crew induced, recoverable)
- U - Aircraft Handling**
- U01 Abrupt Aircraft Control
  - U02 Vertical, Lateral or Speed Deviations
  - U03 Unnecessary Weather Penetration
  - U04 Unauthorized Airspace Penetration
  - U05 Operation Outside Aircraft Limitations
  - U06 Unstable Approach
  - U07 Continued Landing after Unstable Approach
  - U08 Long, Floated, Bounced, Firm, Off centerline, Canted, Porpoised Landing
  - U09 Rejected Take-off after V1
  - U10 Controlled Flight Toward Terrain
  - U99 Other

# Use technology to reduce Instructor Workload



1. Use **Technology** to capture **Threats**, **Errors** and **Safety Margin** exceedances— allowing the **Instructor** to focus on the **Crew Behaviors** required to Evaluate Pilot Competence.
2. Use **Technology** to overcome **observation limitations** due to instructor seating position.

# Use modern technology to overcome limitations to instructor observation

The instructor's seating position in a simulator does not allow them to **effectively evaluate crew behaviours that address:**

- Active monitoring; e.g.
  - *"Observe that the autothrottles apply go-around thrust..."*
  - *"Verify positive rate of climb and call "Positive rate".*
- Effective scan patterns; e.g.
  - *"When the threshold passes under the airplane nose and out of sight, shift the visual sighting point to the far end of the runway."*
- Some OEM/Operator techniques; e.g.
  - *"Control column movement forward of neutral should not be required."*



We can use simulator telemetry and biometric data to mitigate these challenges.

# Use technology to support the Instructor

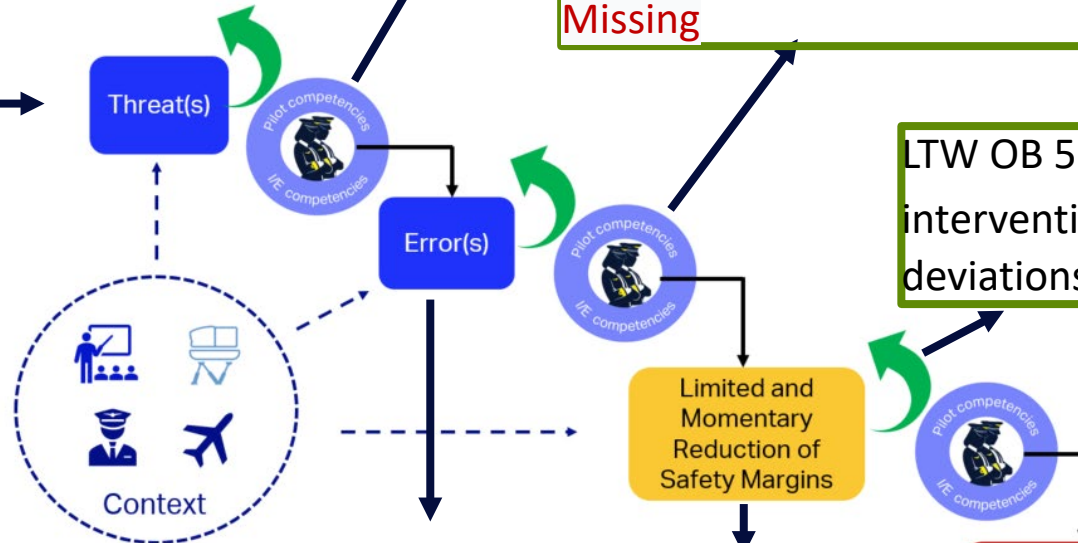
Instructor monitored

SAW OB 7.3 Monitors and assesses the general environment as it may affect the operation. **Missing**

OB 3.4 Maintains the intended flight path during flight using automation while managing other tasks and distractions. **Missing**

LTW OB 5.10 Applies effective intervention strategies to resolve identified deviations. **Observed**

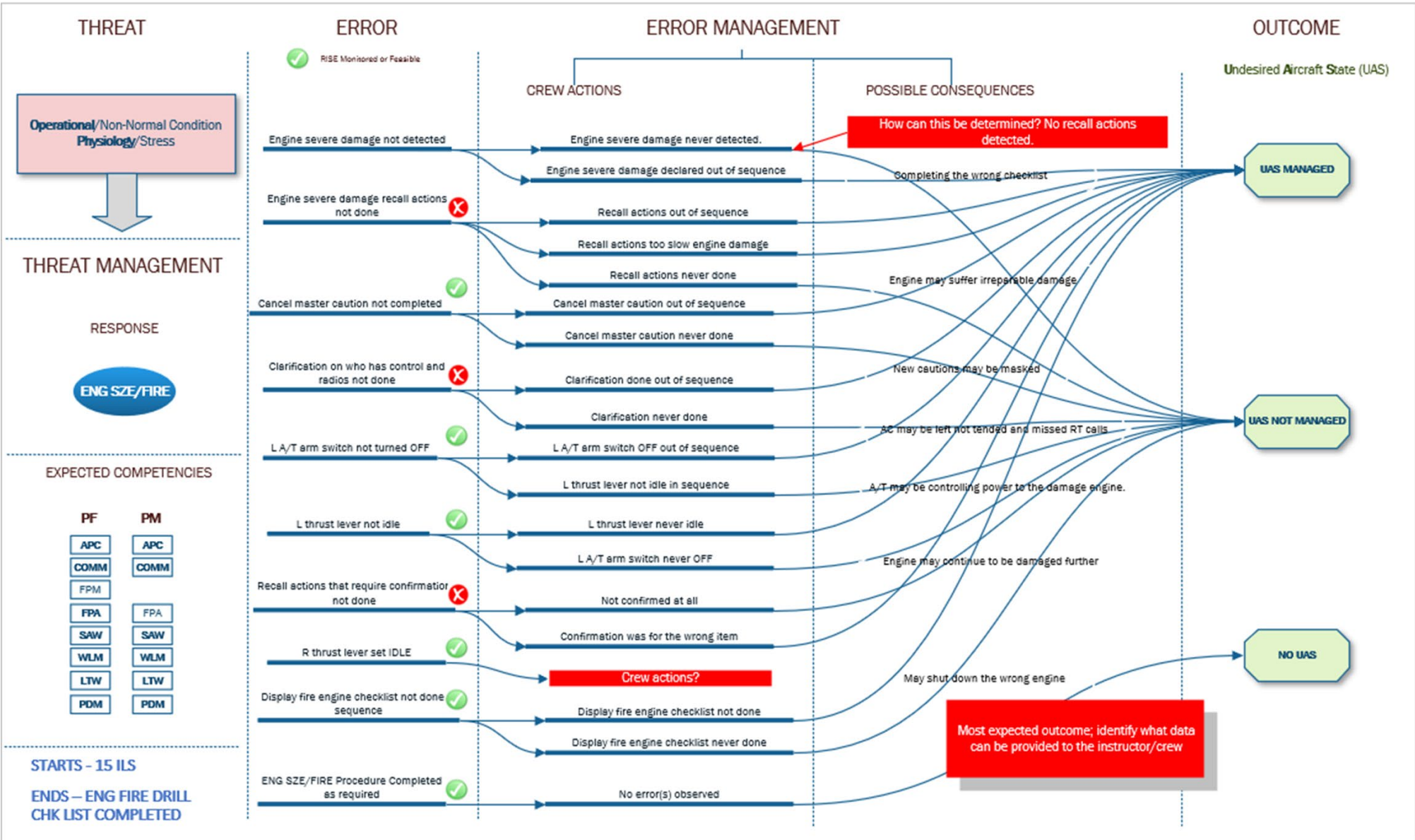
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- UNDESIRED AIRCRAFT STATES** (flight crew induced, recoverable)
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# TEM Analysis for Training Event



# Assisting the instructor with automated data collection

## Landing with engine failure

1
Situation
6
Watch Replay

Initial Weight: **195605 kg**    Initial Flap Lvr: **30**    Initial Gear Lvr: **DOWN**    Initial AP/FD/AT: **ON/ON/ON**    Surface Wind: **CALM**    Runway Crosswind: **0 kt**    Runway Headwind: **0 kt**    Windshear detected: **No**    Minimum RVR: **CAVOK**    OEI detected: **Yes**

Pilot Flying side: **Left**    (VREF/VAPP): **(145/150) kt**    Reference runway: **CYUL - RW24L**    Runway condition: **DRY**    Initial AutoBrake: **DISABLED**    Flare detected: **No**

2

### Monitoring Observable Behaviours relevant to the training

3

### Detecting Threats, Errors and Undesired Aircraft States related to the training event

4

### Maneuver Performance against tolerances

FAK: The data point of each parameter represent the highest measure for this maneuver

5

### Procedure Performance against SOP \_ Assessing Monitoring

# Monitoring Observable Behaviours relevant to the training

## Landing with engine failure

✕

> Situation Watch Replay

Competencies TEM Sim Data Eye tracking

**C1** Crew Member 1  
CAPT/PF

**PRO** • Observed - system  
OB 1.2 Applies relevant operating instructions, procedures and techniques in a timely manner

**PRO** • Observed - system  
OB 1.3 Follows SOPs unless a higher degree of safety dictates an appropriate deviation

**FPM** ♦ Not observed - system  
OB 4.5 Maintains the intended flight path during manual flight while managing other tasks and distractions

**FPM** • Observed - system  
OB 4.7 Effectively monitors flight guidance systems including engagement and automatic mode transitions

**PSD** ♦ Not observed - system  
OB 6.1 Identifies, assesses and manages threats and errors in a timely manner

**WLM** • Instructor  
OB 8.7 Monitors, reviews and cross-checks actions conscientiously

**C2** Crew Member 2  
FO/PM

**PRO** • Observed - system  
OB 1.2 Applies relevant operating instructions, procedures and techniques in a timely manner

**PRO** • Observed - system  
OB 1.3 Follows SOPs unless a higher degree of safety dictates an appropriate deviation

**FPM** • Observed - system  
OB 4.7 Effectively monitors flight guidance systems including engagement and automatic mode transitions

**WLM** • Instructor  
OB 8.7 Monitors, reviews and cross-checks actions conscientiously

Device: R00000342 Start: 1725645186

# Monitoring Observable Behaviours relevant to the training event

The screenshot displays a dark-themed interface with three rows of data. Each row contains a blue pill-shaped button with a white text label, a small colored icon, and a green text label. Below each row is a white text label describing the observable behaviour.

Label	Status	System/Instructor	Description
FPM	Observed	system	OB 4.7 Effectively monitors flight guidance systems including engagement and automatic mode transitions
PSD	Not observed	system	OB 6.1 Identifies, assesses and manages threats and errors in a timely manner
WLM	Observed	Instructor	OB 8.7 Monitors, reviews and cross-checks actions conscientiously

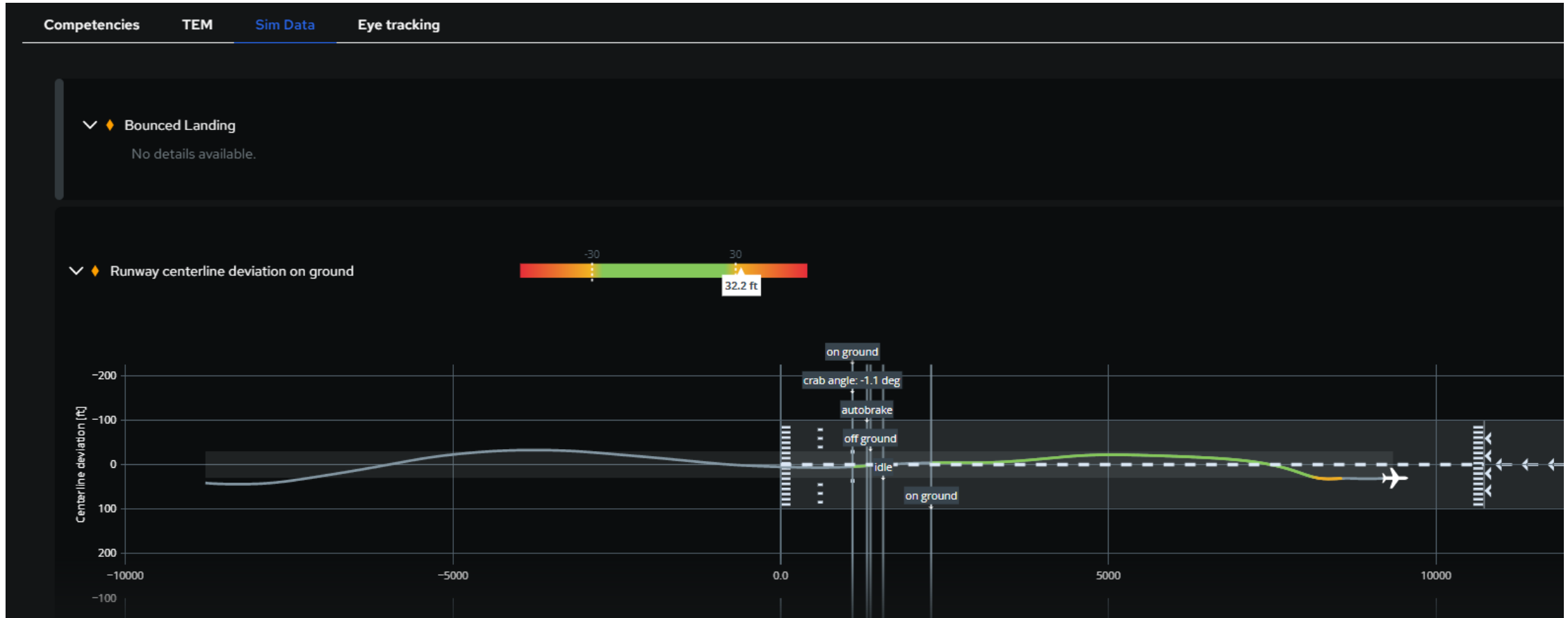
Device: R00000342 Start: 1725645186

# Detecting Threats, Errors and Undesired Aircraft States related to the training event

The screenshot shows a software interface for analyzing a training event titled "Landing with engine failure". At the top left, there is a breadcrumb navigation: "> Situation". Below this, there are three tabs: "Competencies", "TEM" (which is highlighted with a red border), and "Sim Data". To the right of these tabs is a button labeled "Watch Replay". The main content area is divided into three vertical columns by dashed lines, labeled "THREAT", "ERROR", and "OUTCOME".

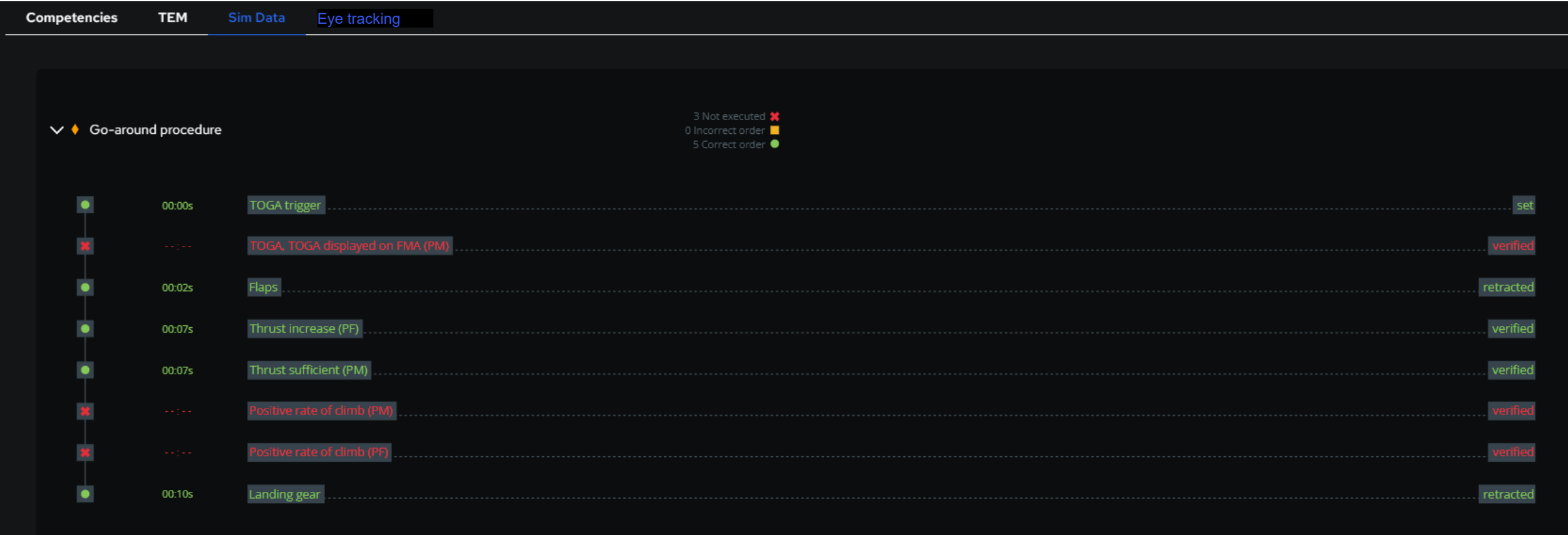
THREAT	ERROR	OUTCOME
A01.02 Contained engine failure	H01 Manual handling (Flight Controls) H02 Ground Navigation (Surface nav)	Vertical, Lateral or Speed Deviations

# Maneuver Performance against tolerances



*Note: The data point of each parameter represent the highest measure for this maneuver*

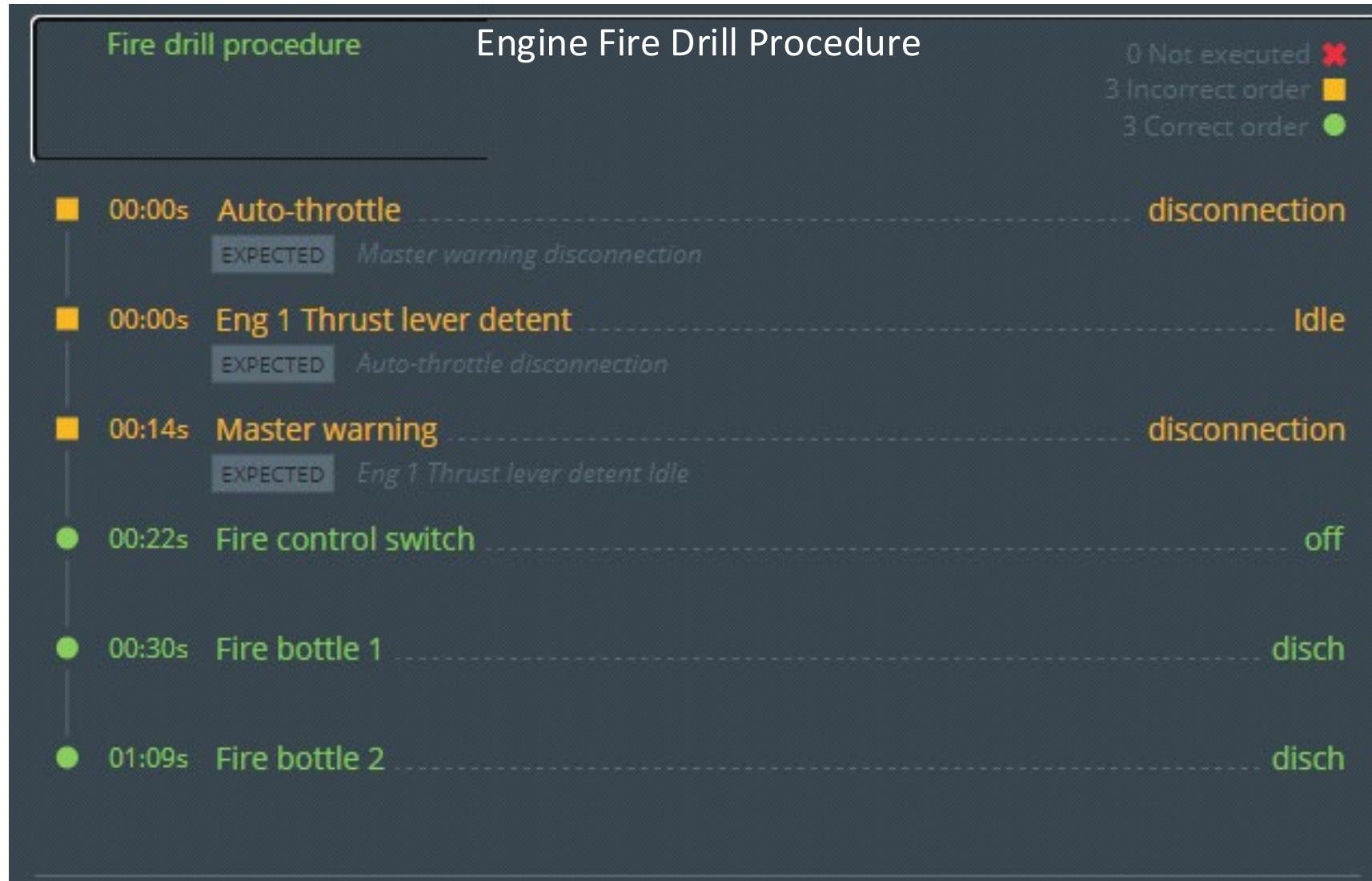
# Procedure/Maneuver Performance against SOP



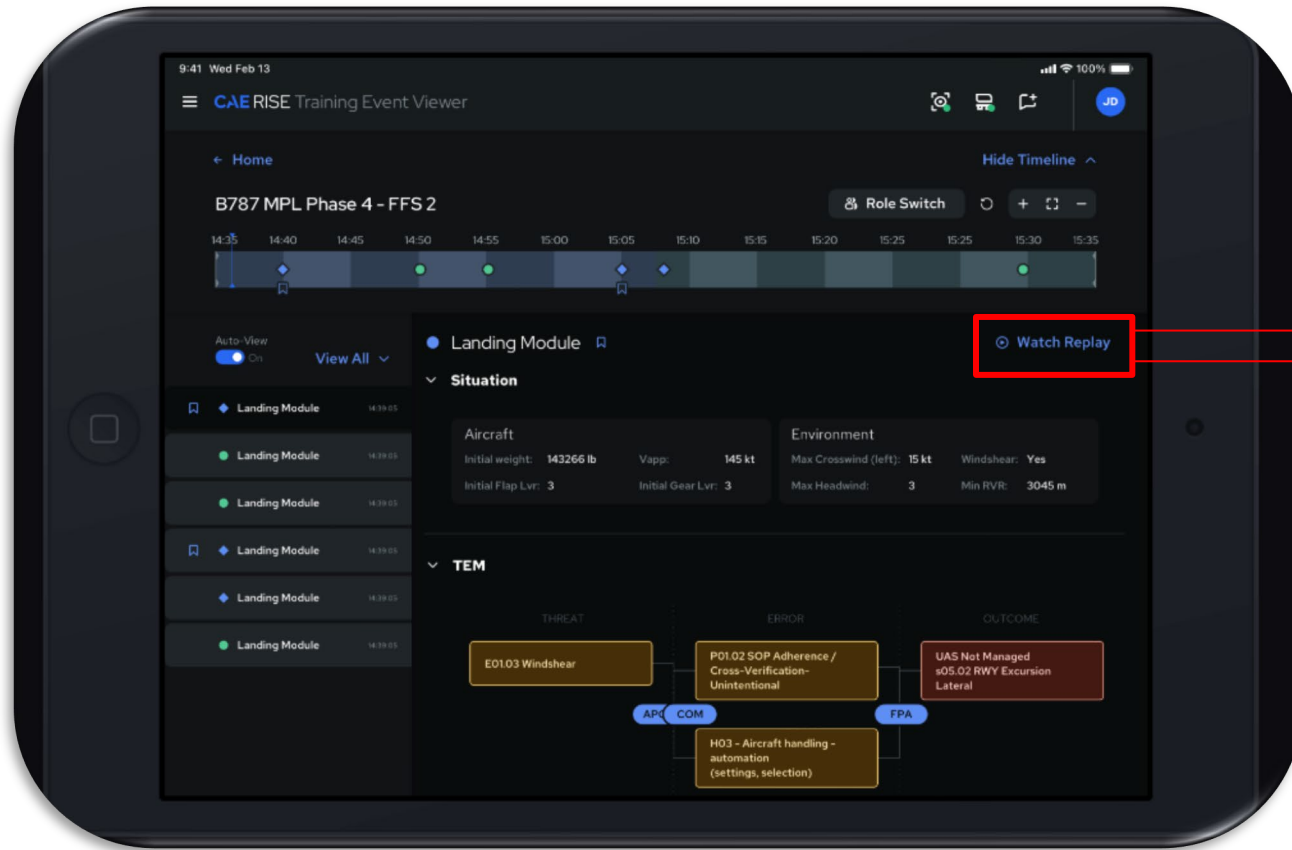
# Procedure Performance against SOP \_ Assessing Monitoring

●	00:07s	Thrust increase (PF)	verified
●	00:07s	Thrust sufficient (PM)	verified
✘	---	Positive rate of climb (PM)	verified
✘	---	Positive rate of climb (PF)	verified

# Procedure/Maneuver Performance against SOP



# Use in a “hot” or facilitative debriefing



Scan behaviors, correlated with competencies/observable behaviors.

PF



PM



Overhead

EFB

Window

Central Pedestal

EFB

Overhead

Central Pedestal

Window






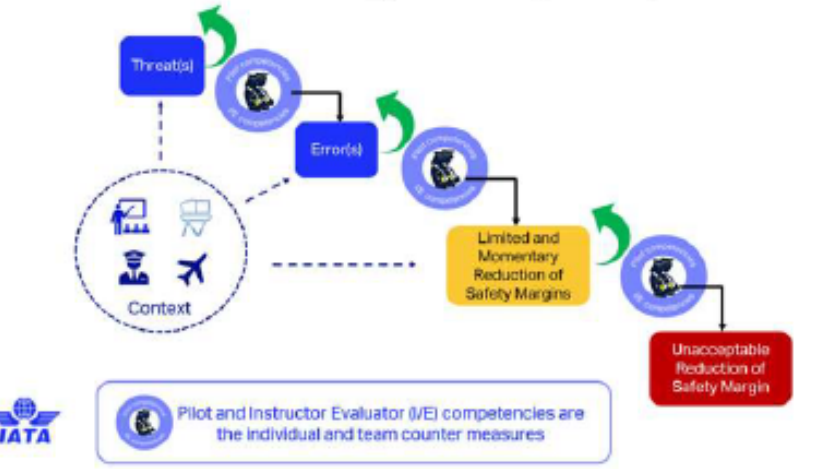


# Potential use cases of resulting training data in a CBTA context

1. To augment/ reduce “on aircraft” landing training for inexperienced pilots.
2. Analysis of required Training of “monitoring”.
3. Analysis of required Training of “SOP” compliance.
4. Comparison against TEM data from LOSA etc.
5. Benchmarking – internal and external.
6. Comparison of aggregate actual crew performance versus OEM and Operator system safety design assumptions.
7. Verification of the accuracy of the grading system.
8. Comparison of planned versus actual delivery of training tasks and the conditions under which they are administered.

**The underlying assumption is that sufficiently mature data analysis capability exists.**

# Proactive/Predictive Safety Management Partnership

Reactive	Reactive/Proactive	Proactive	Proactive/Predictive
<p>E.g. Analysis Accident-Incidents</p>	<p>E.g. Analysis of event including Undesired Aircraft States</p>	<p>E.g. Analysis of Threat and Error Management</p>	<p>E.g. Analysis of CBTA -EBT Training metrics (Grading/Telemetry/Biometric data)</p>
	<div data-bbox="639 625 924 1125"> <p>Flight Data Analysis (FDA)</p>  <p>Mandatory Occurrence reporting</p>  </div>	<div data-bbox="1166 625 1439 1125"> <p>Line Oriented Safety Audits (LOSA)</p>  <p>Voluntary Safety reporting</p>  </div>	<div data-bbox="1600 625 2458 1132"> <p>TEM Model for Training, Licensing and Operations</p>  <p>Pilot and Instructor Evaluator (I/E) competencies are the individual and team counter measures</p> </div>

Valid training data enables Proactive/Predictive Safety Management

Source: IATA whitepaper