Alarms Analysis Report

Per ISA-18.2 and EEMUA 191 Standards

1. Executive Summary

Analysis Overview

Data File: synthetic_alarms.csv

Analysis Period: 2026-01-01 00:00:30 to 2026-01-07 23:57:30

Duration: 167.9 hours

Total Records: 20081

Alarm Activations: 10055

Alarm Recoveries: 10026

Alarm System Health Assessment (EEMUA 191)

Extremely Dangerous Overloaded - immediate action required

Average Alarms per 10 Minutes: 9.98

Peak Alarms per 10 Minutes: 29

Peak-to-Average Ratio: 2.91

Flood Analysis (ISA-18.2)

ISA-18.2 defines an alarm flood as more than 10 alarms within a 10-minute period. During this analysis period:

Flood Intervals Detected: 422

Percentage of Time in Flood: 41.9%

Total 10-Minute Intervals: 1008

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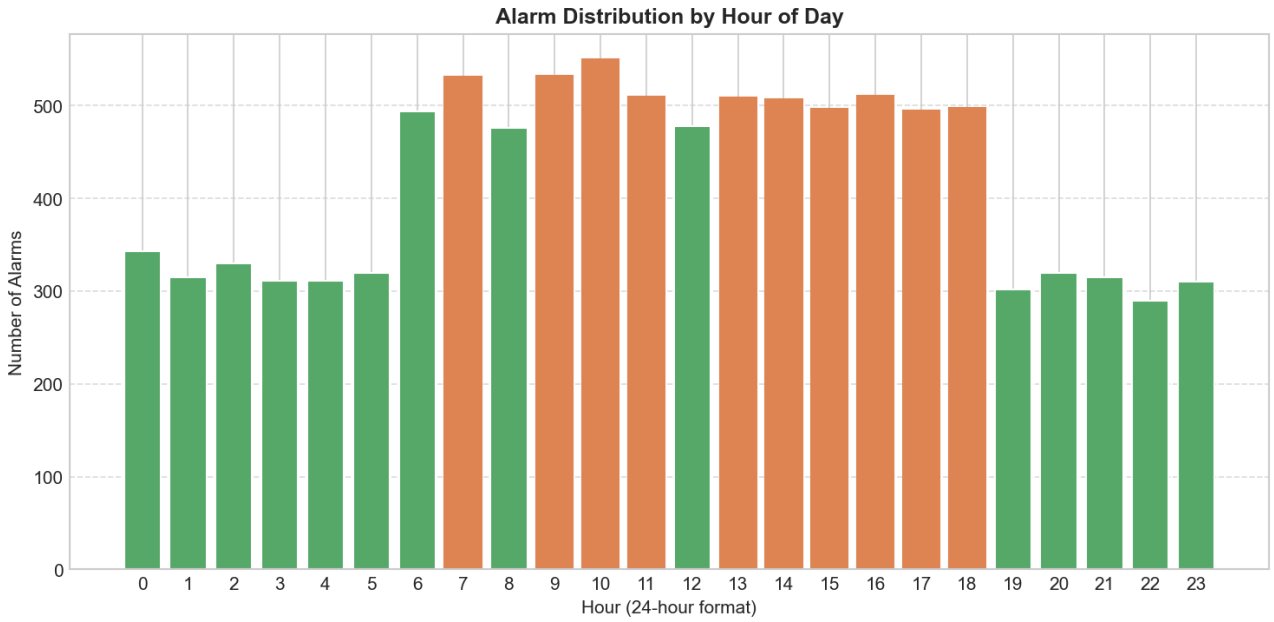
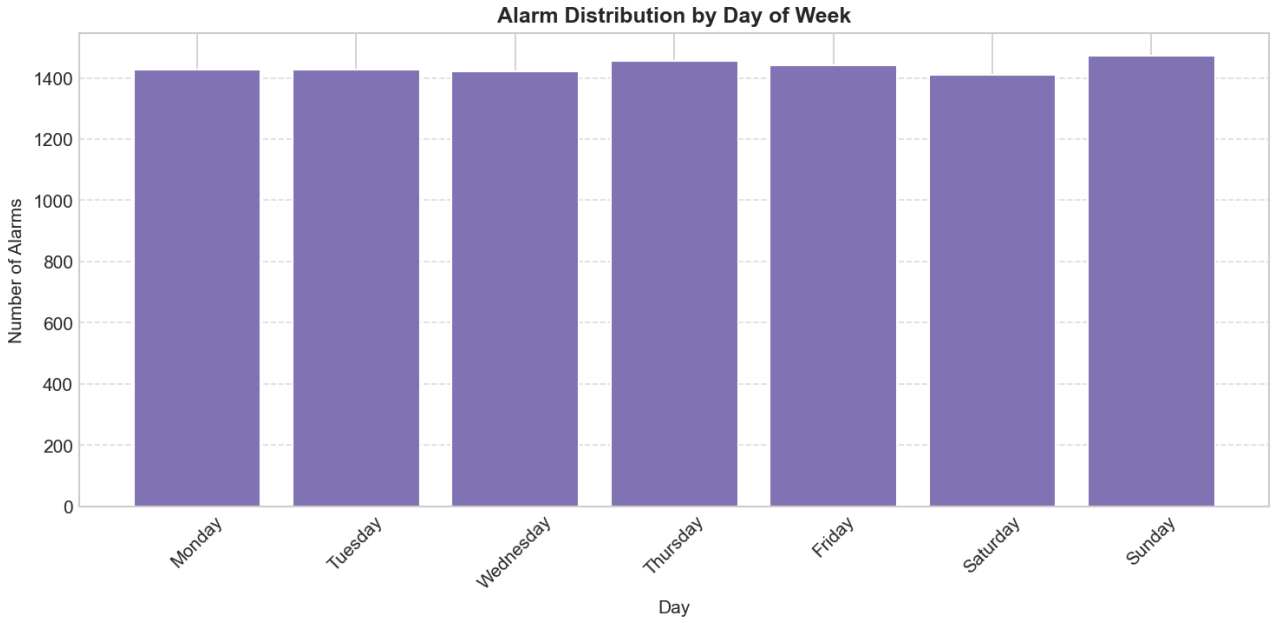
2. Temporal Analysis

Temporal analysis identifies patterns in alarm occurrence by time of day and day of week. This information supports staffing decisions and helps identify process conditions that generate excessive alarms.

Hourly Distribution



Day of Week Distribution



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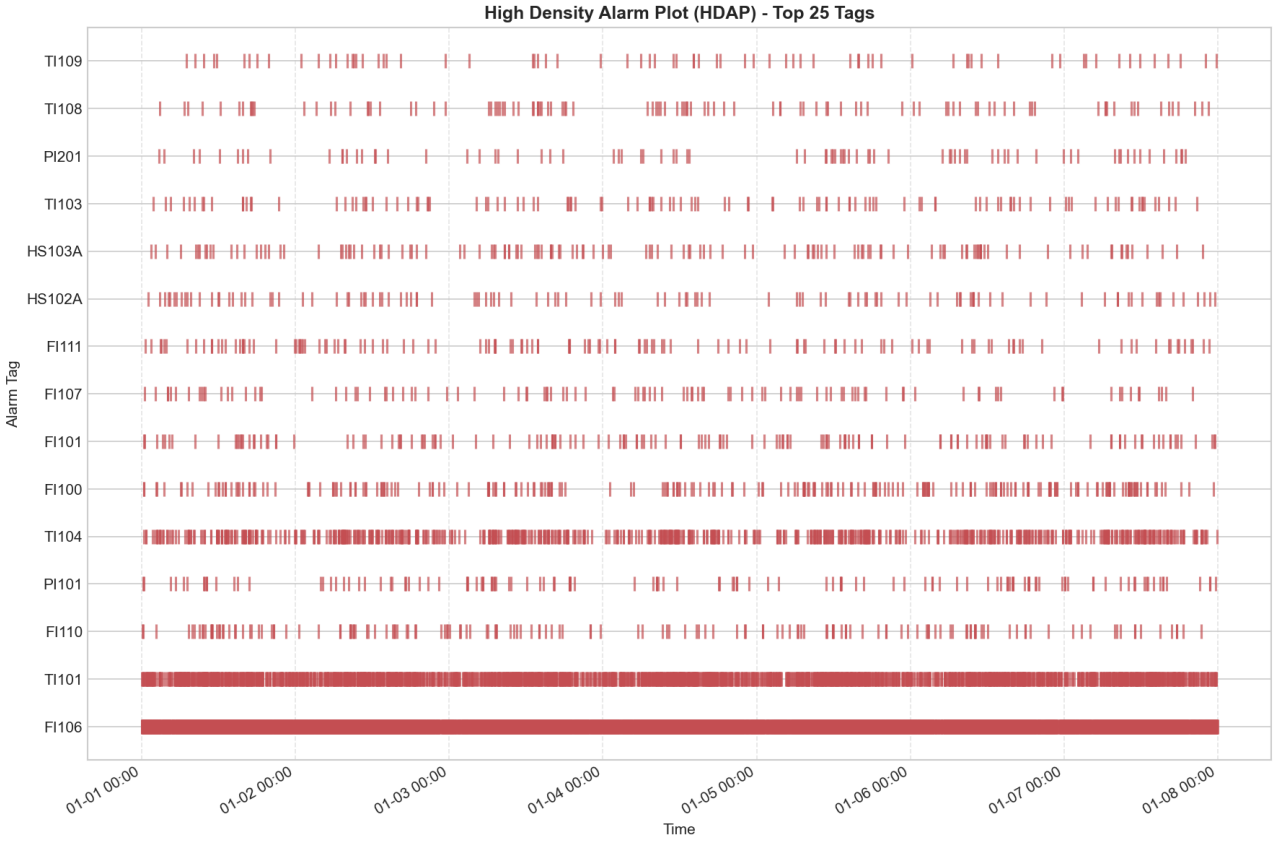
High Density Alarm Plot (HDAP)

The HDAP displays individual alarm activations over time for the most frequent alarm tags. Vertical clustering indicates periods of high activity.



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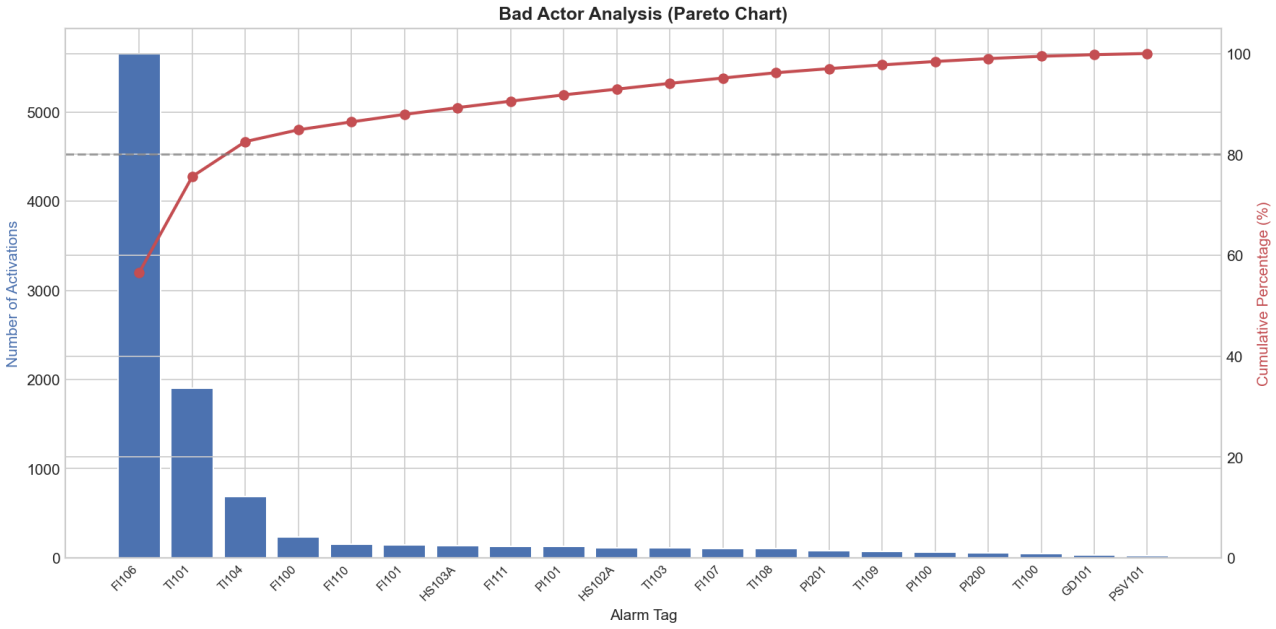
3. Bad Actor Analysis (ISA-18.2 Section 11)

Per ISA-18.2, 'bad actors' are alarms that contribute disproportionately to the total alarm load. Regular review of the most frequent alarms is essential for continuous improvement. The Pareto principle typically applies: a small percentage of alarms generate the majority of activations.

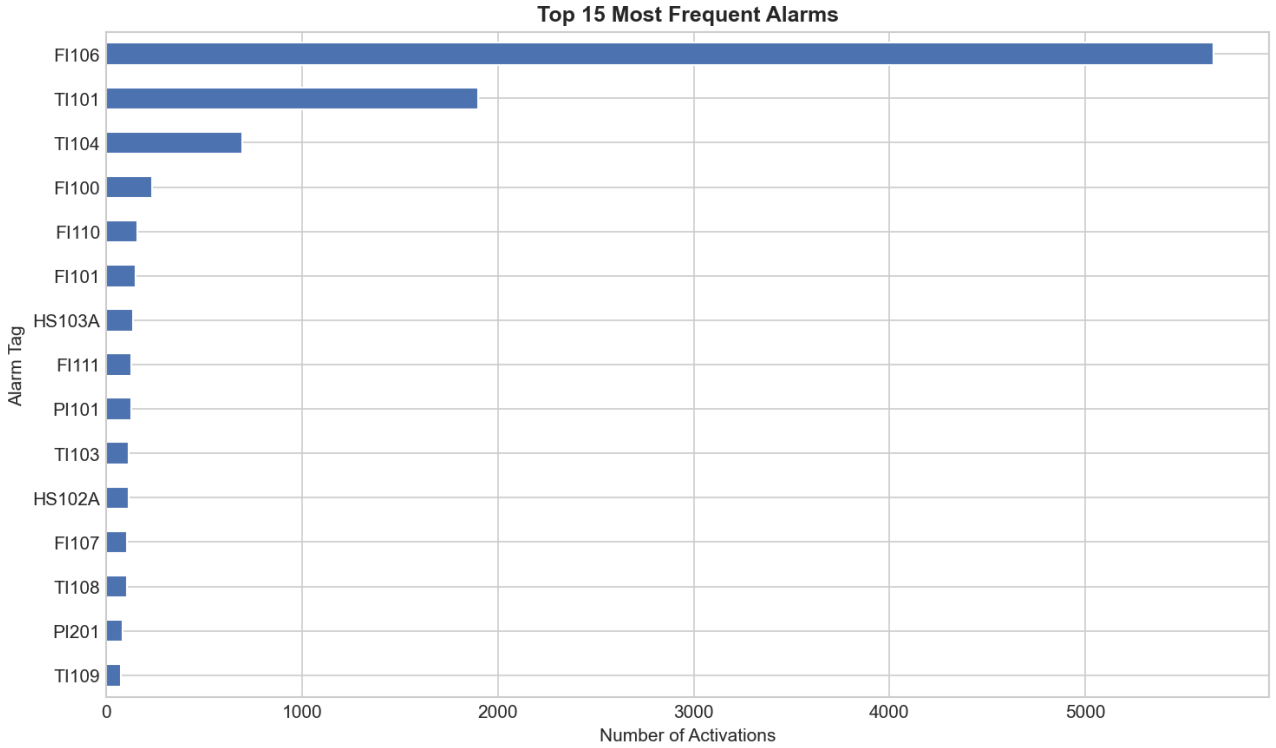
Alarms Contributing to 80% of Load: 2

Total Unique Alarms: 29

Bad Actor Percentage: 6.9%



Top 15 Most Frequent Alarms



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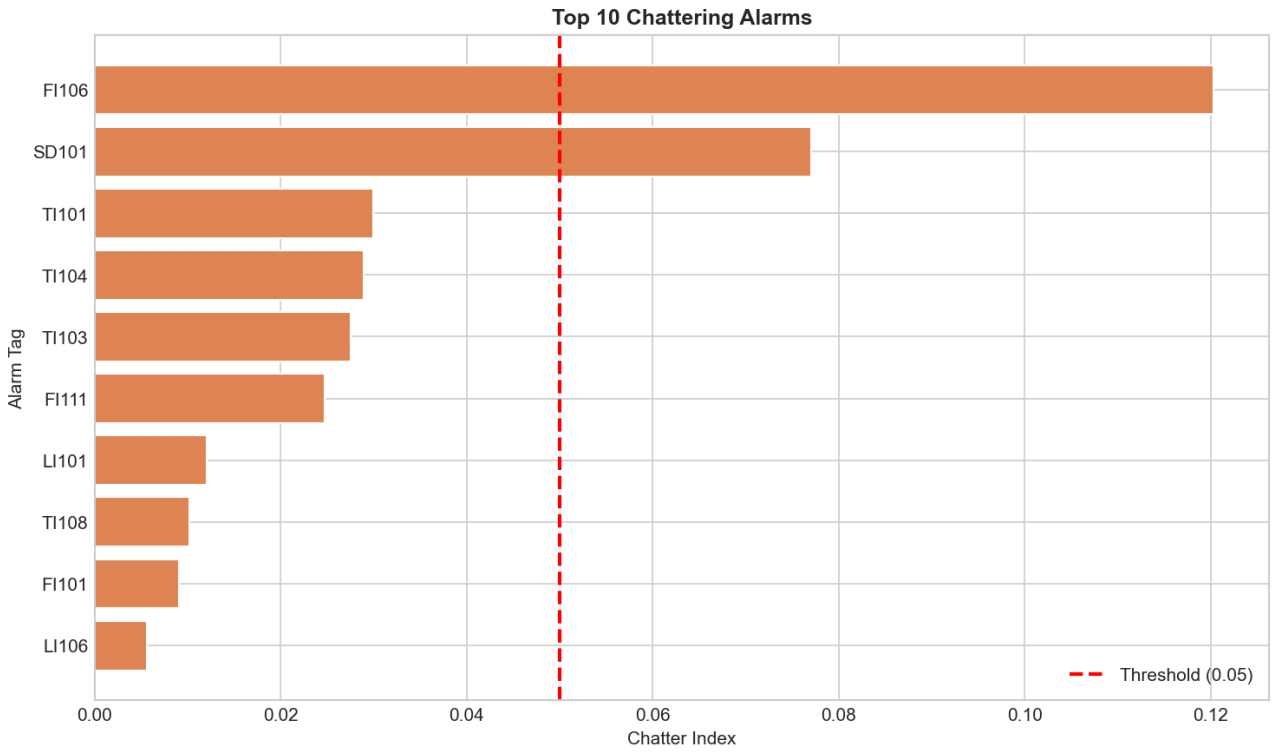
4. Alarm Chatter Analysis

Chattering alarms repeatedly activate and clear in rapid succession. Per ISA-18.2, chattering should be addressed through deadband adjustment, timer/delay implementation, or signal filtering. The chatter index quantifies the frequency of rapid cycling.

Chattering index is calculated based on "Quantification of Alarm Chatter Based on Run Length Distributions" (2010 Kondaveeti et al.)

Chatter Threshold: 0.05



Top Chattering Alarms

tag	chatter_index	total_activations	status
FI106	0.1202	5657	CRITICAL
SD101	0.077	14	CRITICAL
TI101	0.0299	1900	Normal
TI104	0.0289	692	Normal
TI103	0.0275	114	Normal
FI111	0.0247	127	Normal
LI101	0.012	3	Normal
TI108	0.0102	105	Normal
FI101	0.0091	149	Normal
LI106	0.0056	3	Normal

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5. Repeatability Analysis

Repeatability measures how often an alarm re-activates within a 10-minute window. High repeatability may indicate insufficient deadband, process instability, or need for alarm delay configuration.

Top Repeating Alarms

tag	total_activations	repeat_count	repeatability_index
LI101	3	2	1.0
FI106	5657	5646	0.9982
TI101	1900	1667	0.8778
TI104	692	380	0.5499
LI106	3	1	0.5
GD101	32	10	0.3226
FI100	233	70	0.3017
PI101	125	30	0.2419
FI110	157	37	0.2372
FI101	149	31	0.2095

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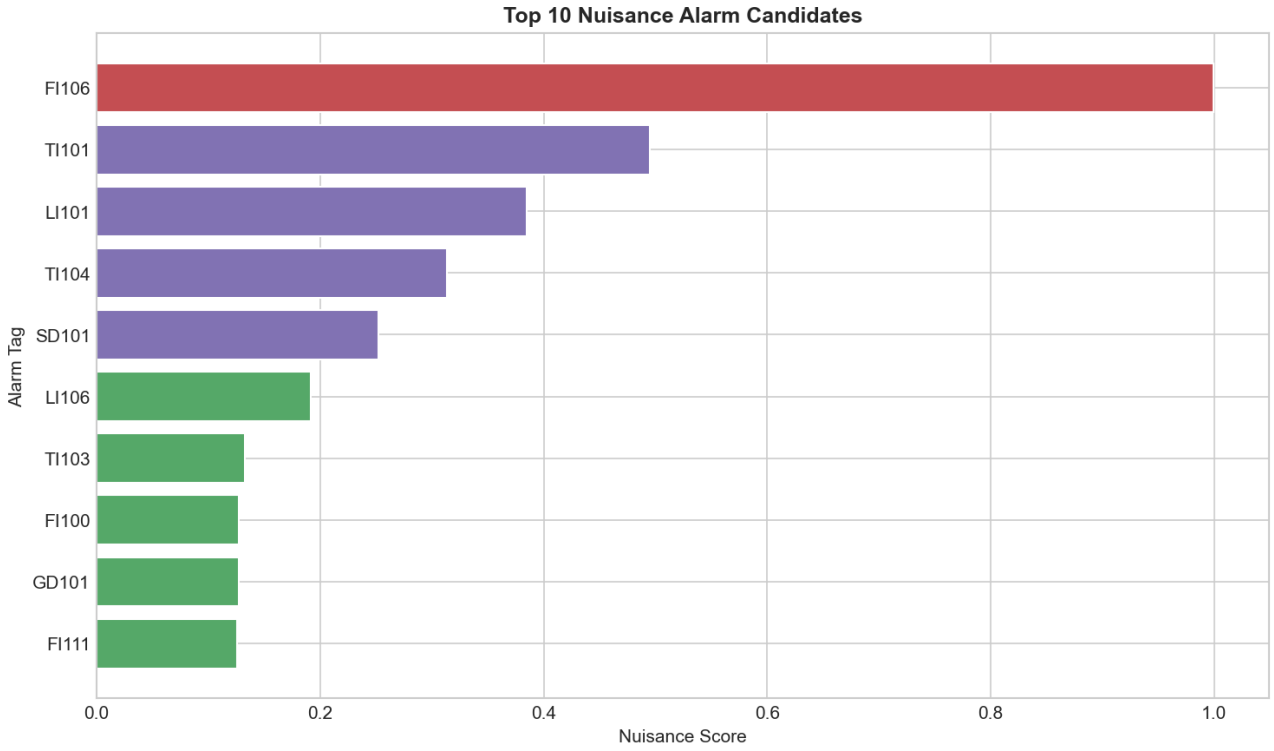
6. Nuisance Alarm Identification

Nuisance alarms are those that activate frequently, chatter, or have high repeatability. Per ISA-18.2, nuisance alarms should be rationalized for necessity and reconfigured or removed as appropriate. The nuisance score combines multiple factors: chatter index (35%), repeatability (35%), and occurrence frequency (30%).



Nuisance Alarm Ranking

tag	total_activations	nuisance_score	nuisance_level
FI106	5657	0.999	Critical
TI101	1900	0.495	Moderate
LI101	3	0.385	Moderate
TI104	692	0.313	Moderate
SD101	14	0.252	Moderate
LI106	3	0.192	Low
TI103	114	0.133	Low
FI100	233	0.127	Low
GD101	32	0.127	Low
FI111	127	0.126	Low

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7. Stale Alarm Analysis (ISA-18.2)

Stale alarms remain active for extended periods (>24.0 hours) without being addressed. Per ISA-18.2, stale alarms contribute to operator overload and may indicate process issues requiring attention.

Stale Alarm Instances Found: 41

Stale Alarm Details

tag	condition	active_duration_hour	still_active
LI101	HIGH	167.93	True
LI101	LOW	167.91	True
TI107	LOW	167.88	True
LI101	LOW LOW	167.87	True
FI110	HIGH	167.71	True
PI101	LOW	167.68	True
TI102	LOW	167.27	True
LI106	LOW	167.24	True
PI100	LOW	166.93	True
TI100	HIGH	166.43	True

8. Standing Alarm Analysis

Standing alarms are those that activate but never return to normal. Per EEMUA 191, standing alarms reduce operator situational awareness and may indicate permanent process deviations or configuration issues.

Standing Alarms Found: 29

Standing Alarm Details

tag	condition	total_activations	total_recoveries	uncleared_count
TI101	LOW	645	644	1
LI106	LOW	1	0	1
TI109	LOW	1	0	1
HS102B	OVERLOAD	1	0	1
HS102B	FAULT	1	0	1
TI100	HIGH	1	0	1
PI100	LOW	1	0	1
HS102A	FAULT	1	0	1
PSV101	FAULT	1	0	1
AI110	HIGH	1	0	1

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9. Alarm Avalanche Detection (ISA-18.2)

An alarm avalanche occurs when many alarms activate in rapid succession, often due to a single root cause. ISA-18.2 recommends identifying root cause alarms and implementing state-based suppression strategies.

Avalanche Events Detected: 6

Average Alarms per Avalanche: 12.2

Maximum Alarms in Single Avalanche: 15

Avalanche Event Details

start_time	total_alarms	unique_tags	first_alarm_tag
2026-01-01 15:45	13	11	FI110
2026-01-03 07:07	11	9	FI106
2026-01-03 13:50	10	8	TI100
2026-01-04 07:18	11	10	TI101
2026-01-05 10:49	15	13	FI101
2026-01-06 08:48	13	12	FI106

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10. Alarm Pattern Analysis (Co-occurrence)

Pattern mining identifies alarms that frequently occur together within a 10min window. Co-occurring alarms may indicate redundancy or opportunities for alarm grouping and suppression.

Analysis Window: 10min

Minimum Support Threshold: 1.0%

Frequent Alarm Combinations

```
Support 88.6%: FI106, TI101
Support 46.0%: FI106, TI104
Support 42.3%: TI101, TI104
Support 42.2%: FI106, TI101, TI104
Support 18.8%: FI100, FI106
Support 16.9%: FI100, FI106, TI101
Support 16.9%: FI100, TI101
Support 13.4%: FI106, FI110
Support 12.8%: FI106, HS103A
Support 12.6%: FI101, FI106
```

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11. Suppression Recommendations

Based on association rule mining, the following alarms are candidates for state-based suppression per ISA-18.2. When the trigger alarm is active, the consequent alarm may be suppressed to reduce operator load.

Recommended Suppressions

```
Confidence: 100%, Lift: 2.2
  Trigger: PI201, TI103
  Suppress: FI106, TI104

Confidence: 100%, Lift: 2.2
  Trigger: FI106, PI201, TI103
  Suppress: TI104

Confidence: 100%, Lift: 2.2
  Trigger: PI201, TI103
  Suppress: TI104

Confidence: 92%, Lift: 2.0
  Trigger: FI101, PI201
  Suppress: FI106, TI104

Confidence: 85%, Lift: 2.0
  Trigger: FI110, PI100
  Suppress: FI106, TI101, TI104

Confidence: 85%, Lift: 2.0
  Trigger: FI101, PI201
  Suppress: FI106, TI101, TI104

Confidence: 92%, Lift: 2.0
  Trigger: FI101, FI106, PI201
  Suppress: TI104

Confidence: 92%, Lift: 2.0
  Trigger: FI101, PI201
  Suppress: TI104
```

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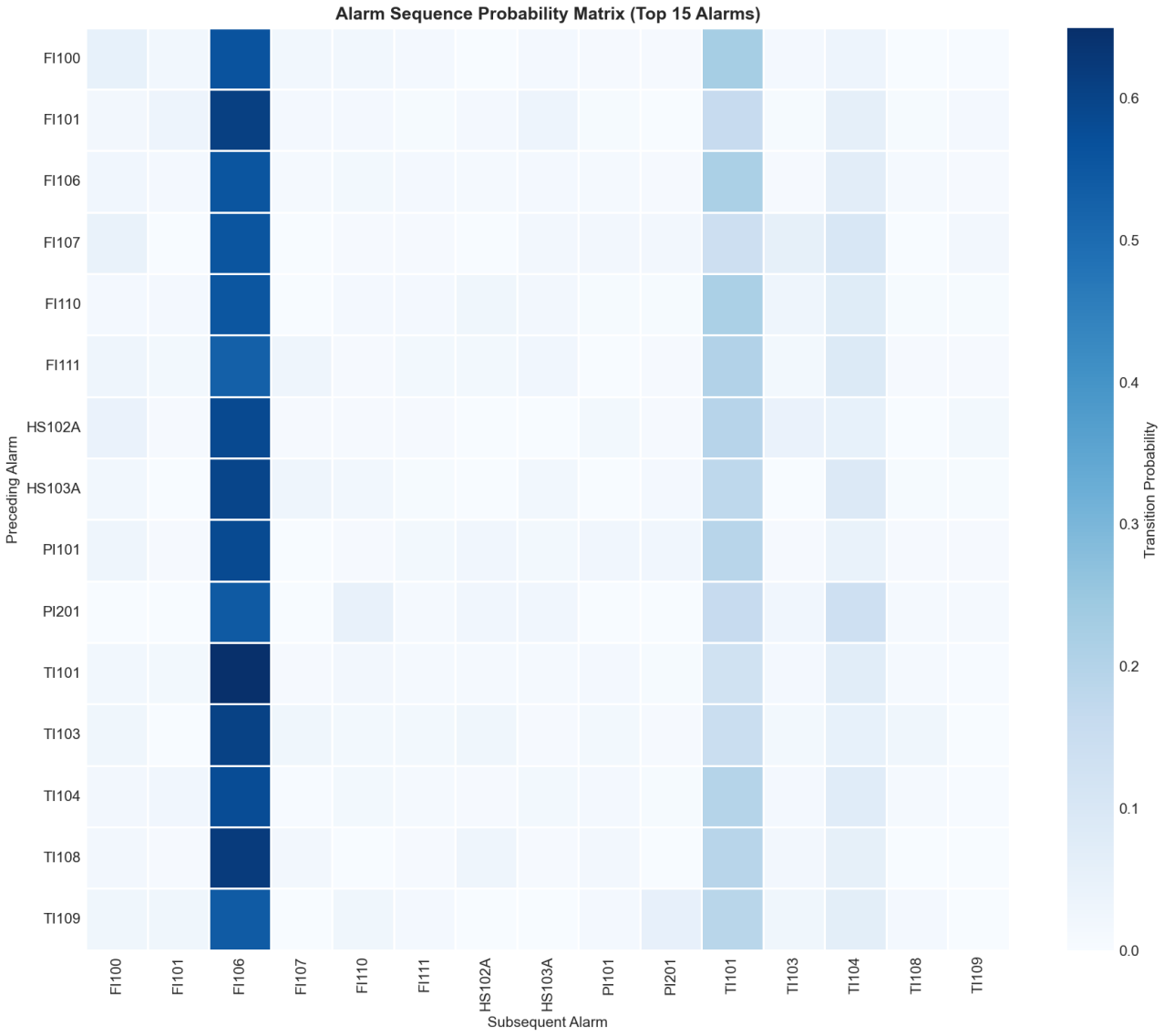
12. Alarm Sequence Analysis

Sequence analysis identifies which alarms tend to follow other alarms. The transition probability matrix shows the likelihood of each subsequent alarm given the preceding alarm. This supports root cause analysis and operator training.



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13. Summary of Recommendations

Based on the analysis results, the following actions are recommended for alarm system improvement per ISA-18.2 and EEMUA 191 guidelines:

1. Address alarm flood conditions (41.9% of time). Review root causes and implement state-based suppression.
2. Review 2 chattering alarms. Consider deadband adjustment, timer implementation, or signal filtering.
3. Investigate 41 stale alarm instances. Review process conditions and alarm configuration.
4. Address 29 standing alarms. Verify process conditions and implement corrective actions.
5. Focus improvement efforts on the top 2 alarms (6.9% of tags) that generate 80% of activations.
6. Evaluate 42 suppression opportunities identified through pattern analysis.