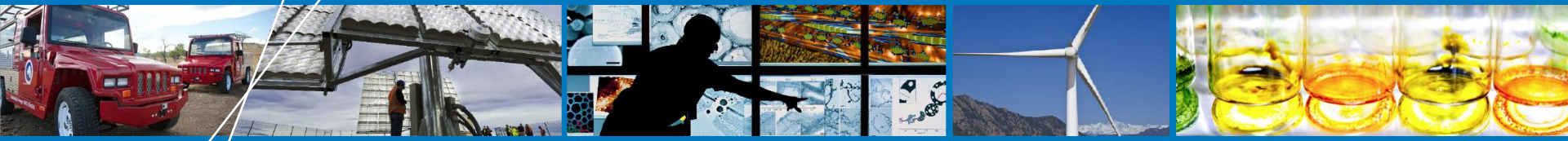
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

CSD Safety & Reliability Data



Forecourt CSD Workshop

Argonne National Laboratory

Kevin Harrison

20-Mar-2013

Approach – Composite Data Products

Bundled data (operation & maintenance/safety) delivered to NREL quarterly

Internal analysis completed quarterly

HSDC

NREL's Hydrogen Secure Data Center

DDPs

Confidential

Public

CDPs

Detailed Data Products (DDPs)
- Individual data analyses
- Identify individual contribution to CDPs
- Only shared with partner who supplied data every 6 months[1]

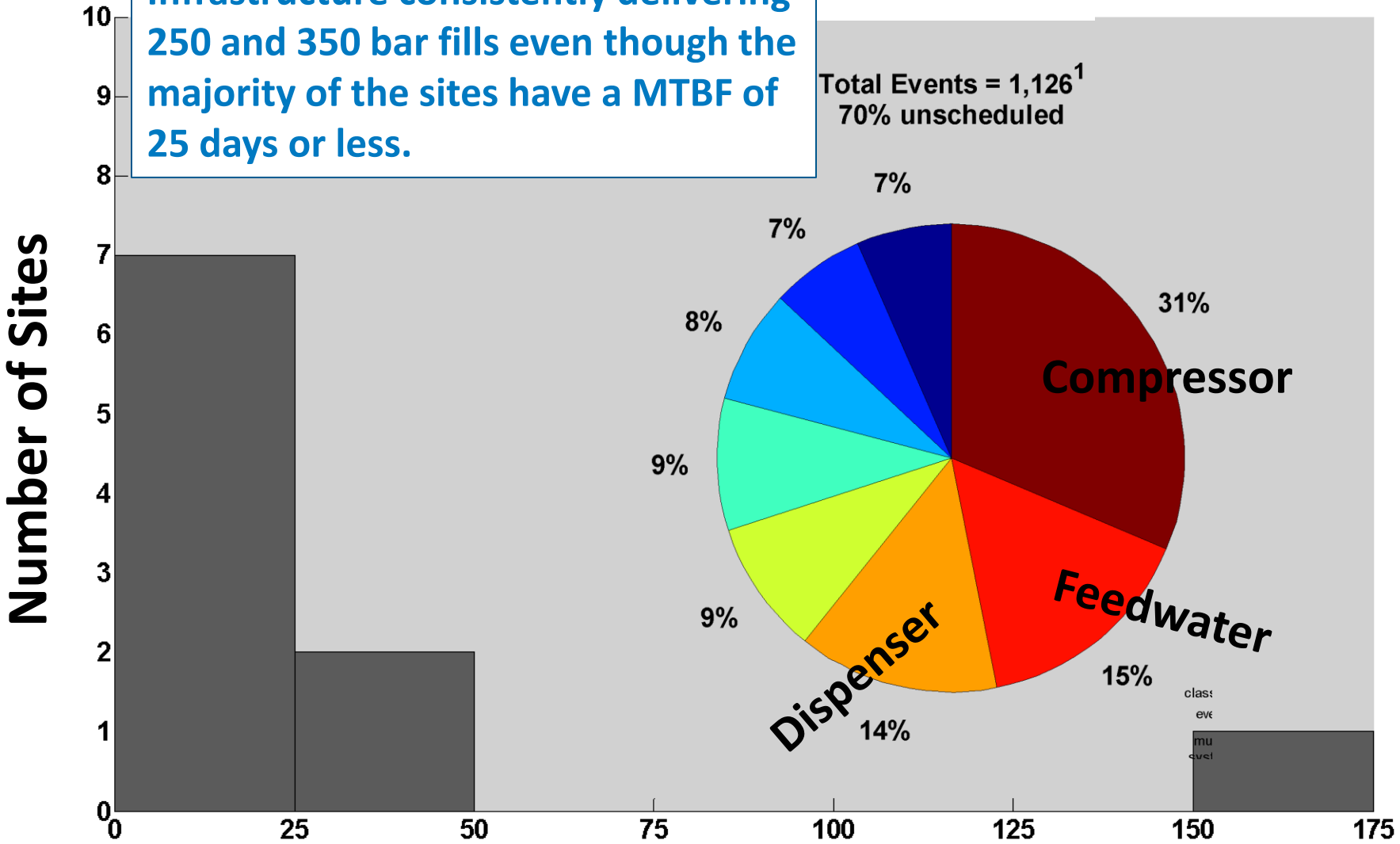
Composite Data Products (CDPs)
- Aggregated data across multiple systems, sites, and teams
- Publish analysis results without revealing proprietary data every 6 months[2]

1) Data exchange may happen more frequently based on data, analysis, and collaboration
2) Results published via NREL Tech Val website, conferences, and reports

SITE MTBF (Calendars Days) - Infrastructure

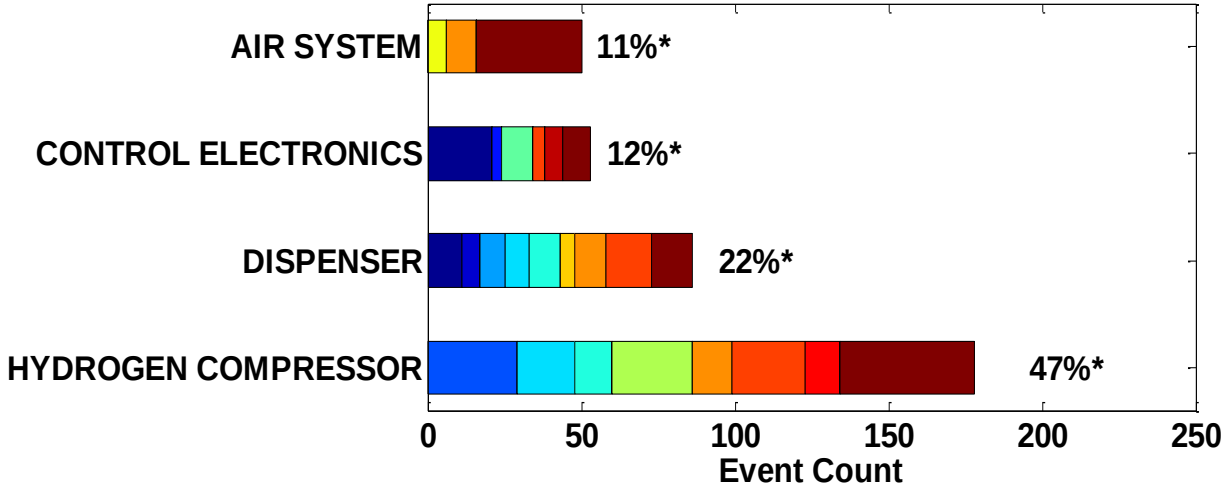
FORKLIFTS

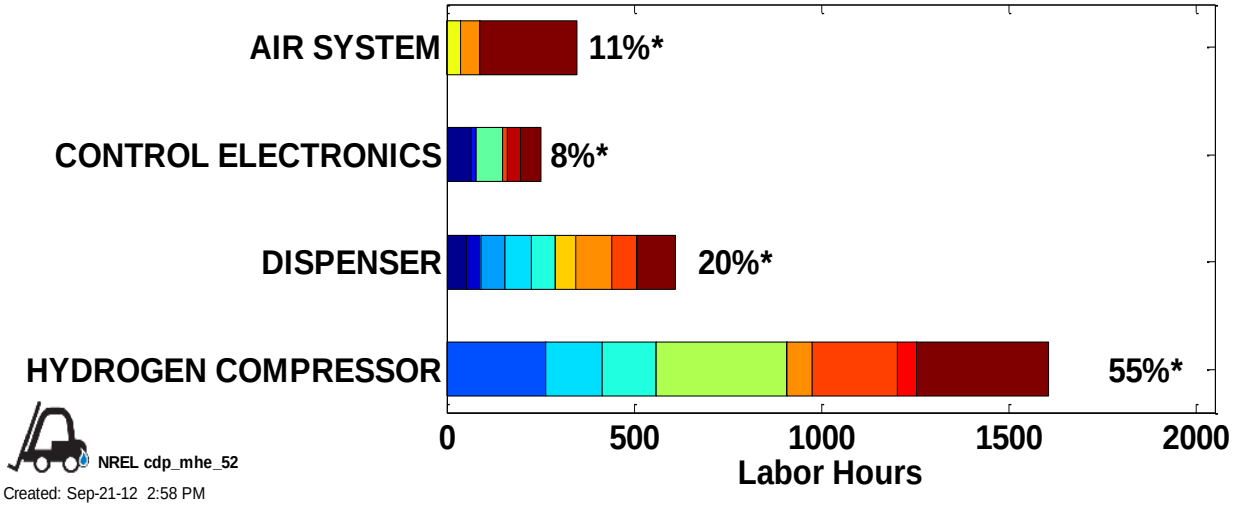
Infrastructure consistently delivering 250 and 350 bar fills even though the majority of the sites have a MTBF of 25 days or less.

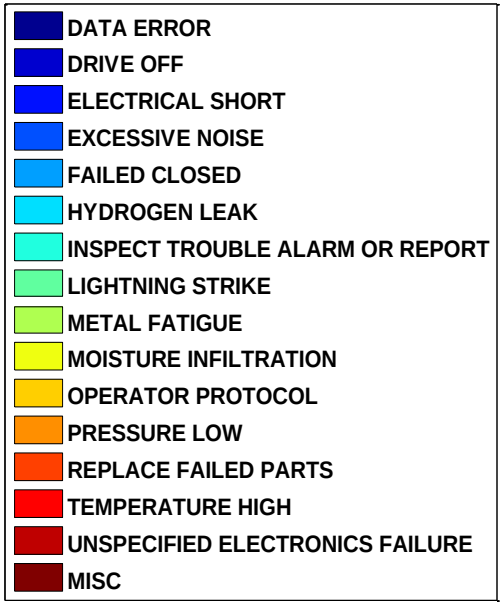


Infrastructure - Failures for Top 4

Failure Modes for Top Four Infrastructure Equipment Categories



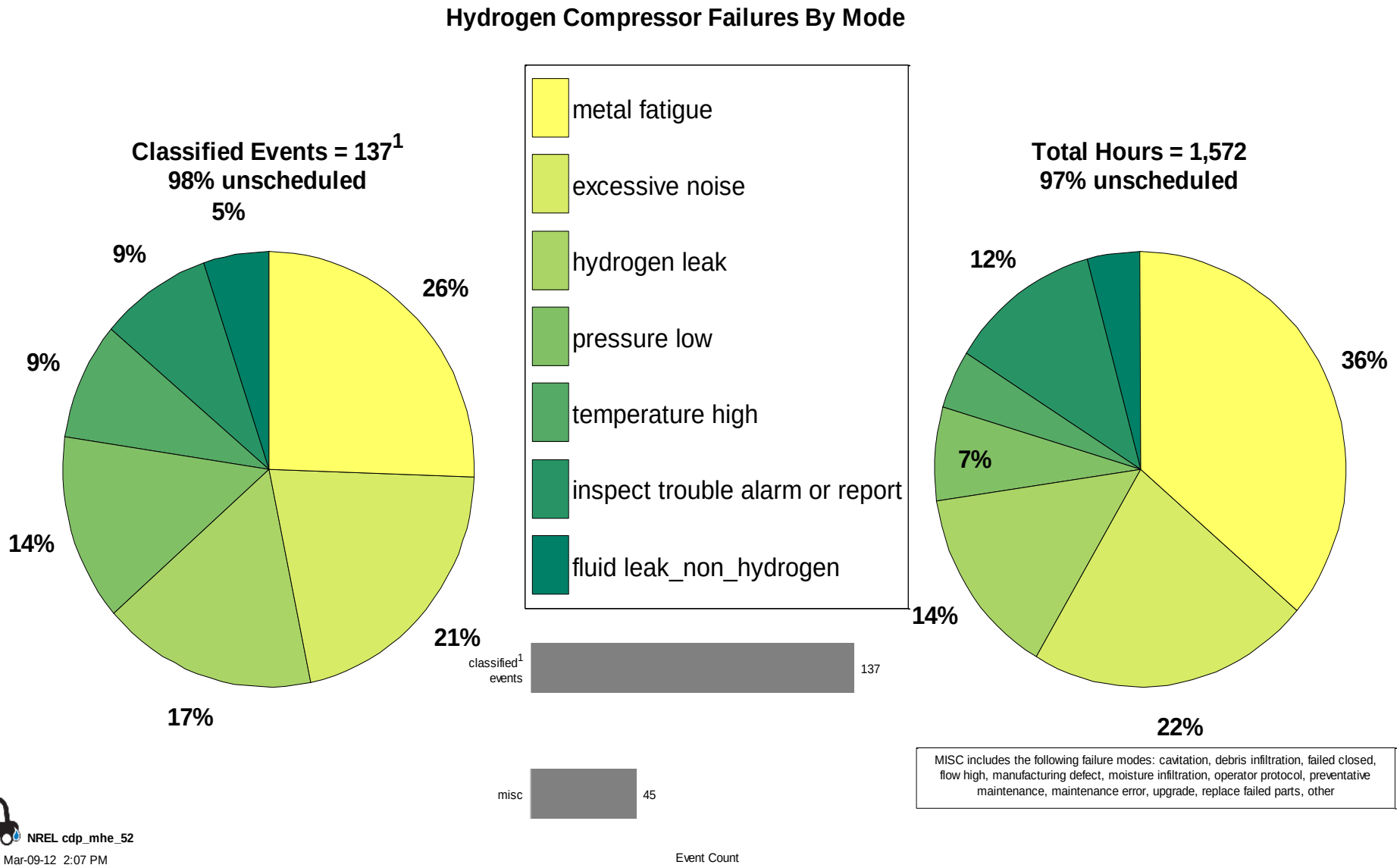




MISC includes the following failure modes: ambient temperature too low, broken wire, cavitation, debris infiltration, failed closed, flow high, flow low, fluid leak_non_hydrogen, inspect trouble alarm or report, maintenance error, manufacturing defect, metal fatigue, moisture infiltration, network malfunction, operator protocol, other, pressure high, software bug, vandalism, voltage low, other

*** Percentage of total events or hours, reference CDP 66.**

Hydrogen Compressors - Detailed



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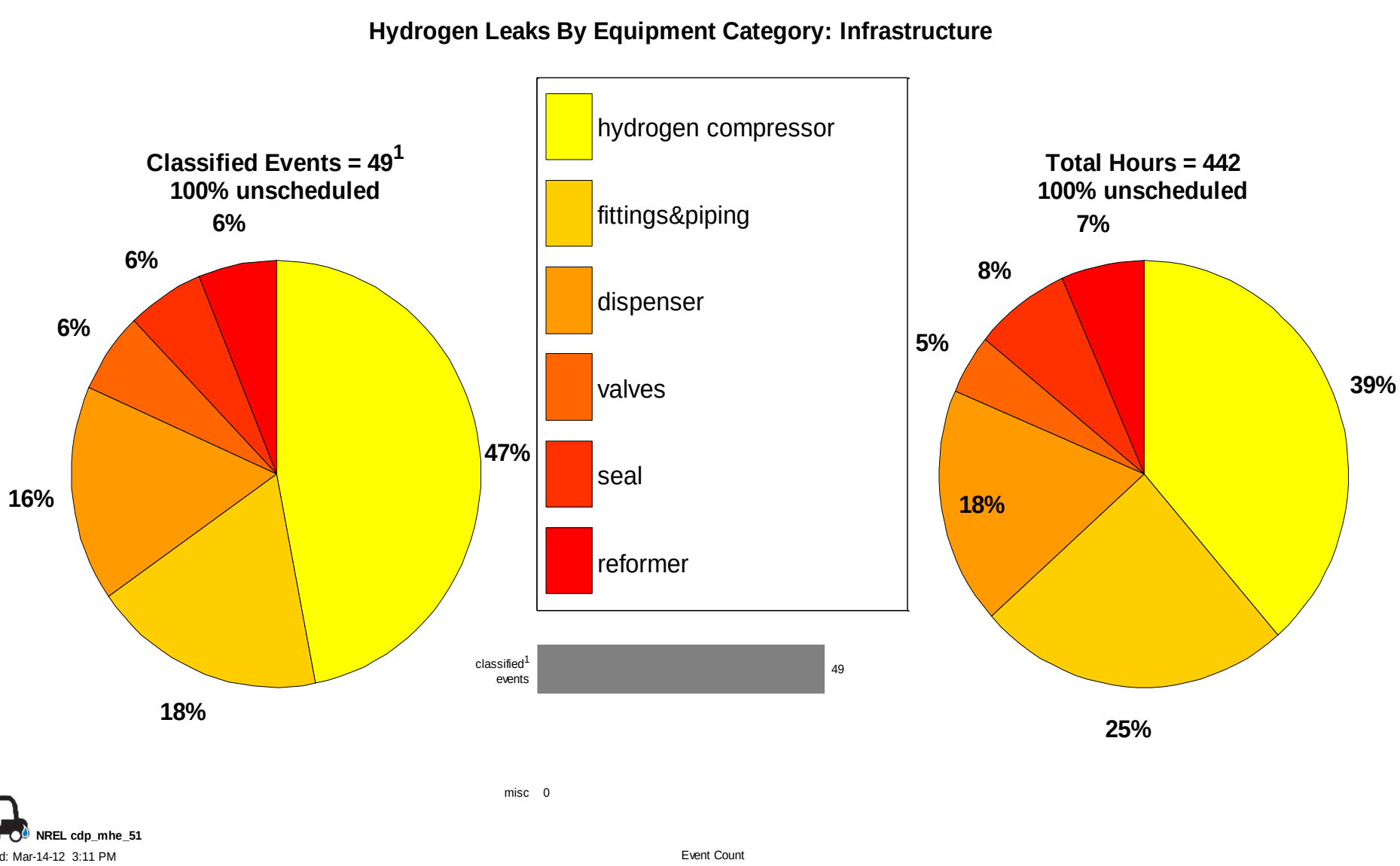
Hydrogen Leaks - Detailed



Approach – Process Hazard Analysis

- A PHA was conducted for the installation of 2nd H_2 fueling station at NREL (Internally funded)
- Hazards were identified by NODE and analyzed for SEVERITY, LIKELIHOOD to obtain the overall RISK (H, M, L, R)

			LIKELIHOOD					
SEVERITY	Category	Descriptive Word	A Frequent	B Reasonably Probable	C Occasional	D Remote	E Extremely Remote	F Impossible
	I	Catastrophic						
	II	Critical						
	III	Marginal						
	IV	Negligible						

PHA Weighted Results

- Each node was analyzed for process upset conditions (pressure high, flow low, etc…)
- In the context of safeguards, the consequences were ranked by SEVERITY and LIKELIHOOD to arrive at a RISK level
- High risks were weighted by 4, Medium by 3, and so on

Node Description	RISK				Node Total Risk
	High	Medium	Low	Routine	
Compressor	0	0	7	9	23
Hose	0	2	3	0	12
Nozzle	0	0	5	1	11
Cascade Tanks	0	0	2	5	9
Control Electronics	0	0	2	4	8
Air System	0	0	0	5	5
Cryo Storage	0	0	0	1	1

RD&D Challenges

Compressor reliability (Cost)

- Lifetime of diaphragms, CV and seals

Hose reliability (Safety, Cost)

- Improve lifetime to avoid frequent hose replacement

Nozzle (Cost)

- Lifetime of diaphragms, CV and seals

More information available

- www.nrel.gov/hydrogen/proj_tech_validation.html
- or search for “NREL CDP”