

CoilDataTM

Coiled Tubing Online

Using historical data to reduce future operational costs

ICoTA-Canada Roundtable

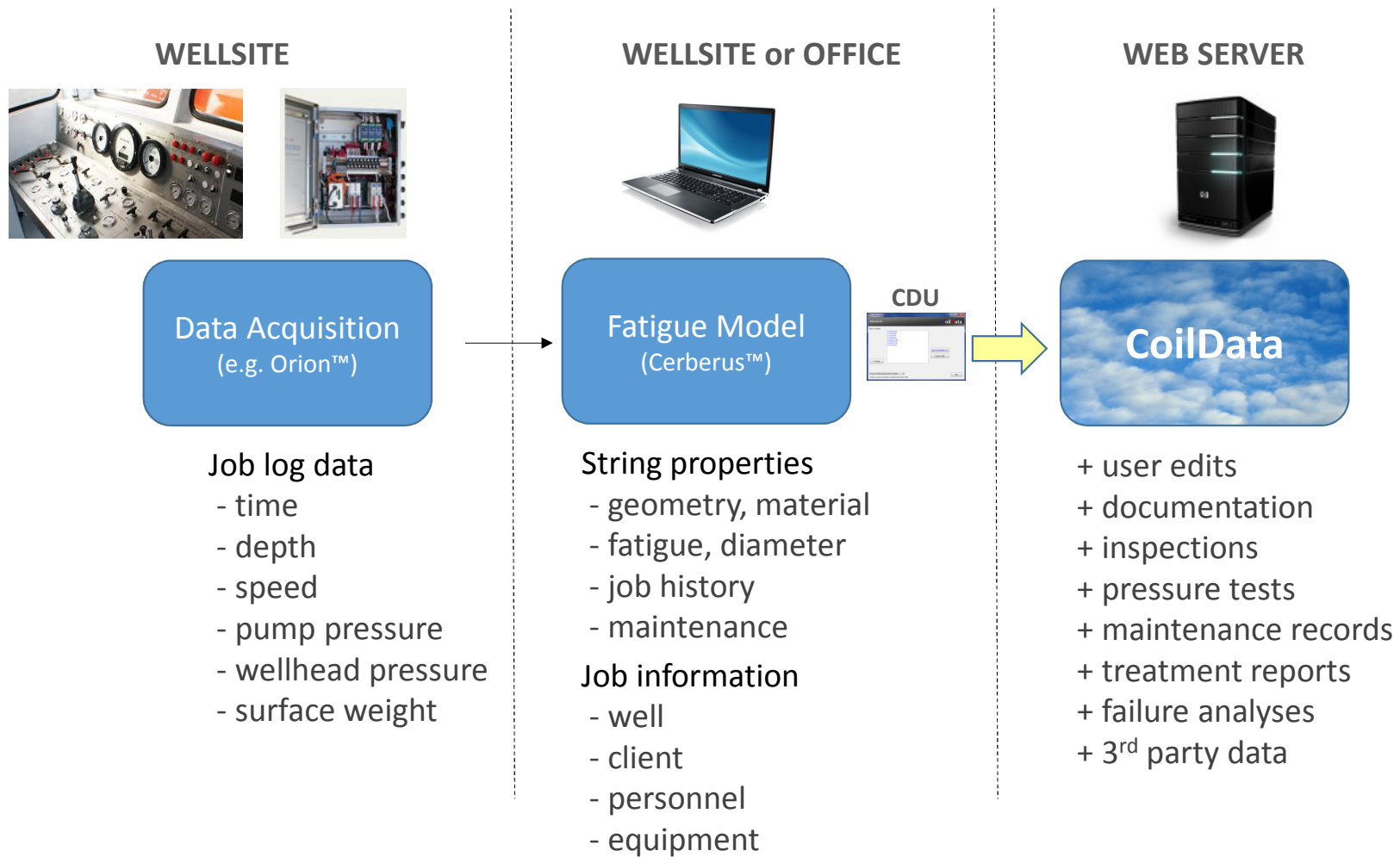
October 2014

"In information management and decision making... an unacceptable amount of time is lost searching for data, integrating it from multiple sources, and preparing it for analysis... The time that could otherwise have been spent making operational decisions is lost to activity that has nothing to do with engineering... Decisions based on data-derived information drive actions and create value".

'Reducing the Data Commute Heightens E&P Productivity'
Journal of Petroleum Technology, Sept 2009

CoilData (formerly Aradia)

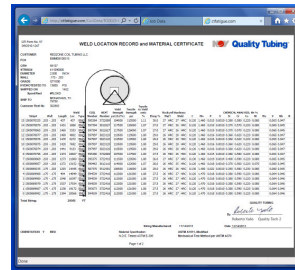
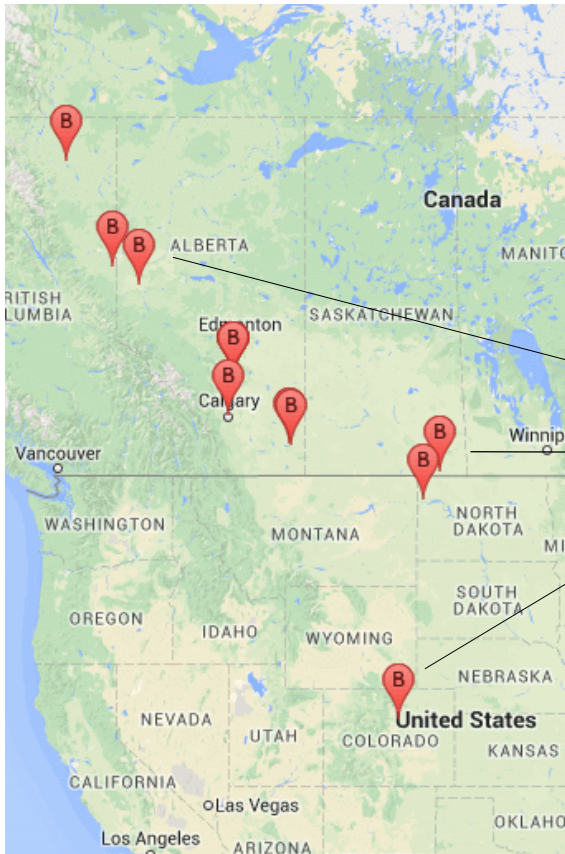
- Web-based string management and job planning system
- Data storage in the “Cloud”
- Linked to Cerberus™ software (NOV-CTES)
- Used by 25 service companies worldwide (8 in Canada)
- B2B portal for pipe manufacturers and operators
- 2,650 strings and 75,060 jobs covering 4 year period
- Data confidential to each company – no shared analysis
- Framework for sharing documents and data when desired



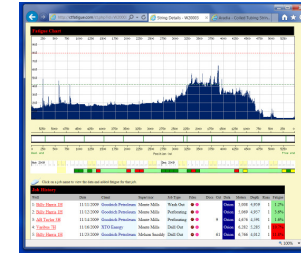
Slide 4

D1

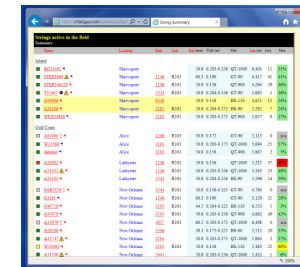
Doug, 10/22/2014



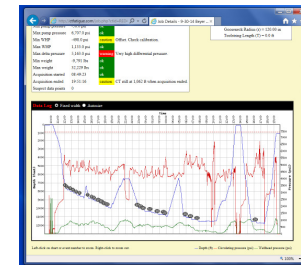
Pipe Supplier (via B2B portal)
3rd Party



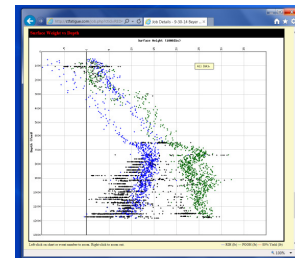
Supervisor



Ops Manager
Dispatcher
Sales Engineer
Technical Engineer



Management

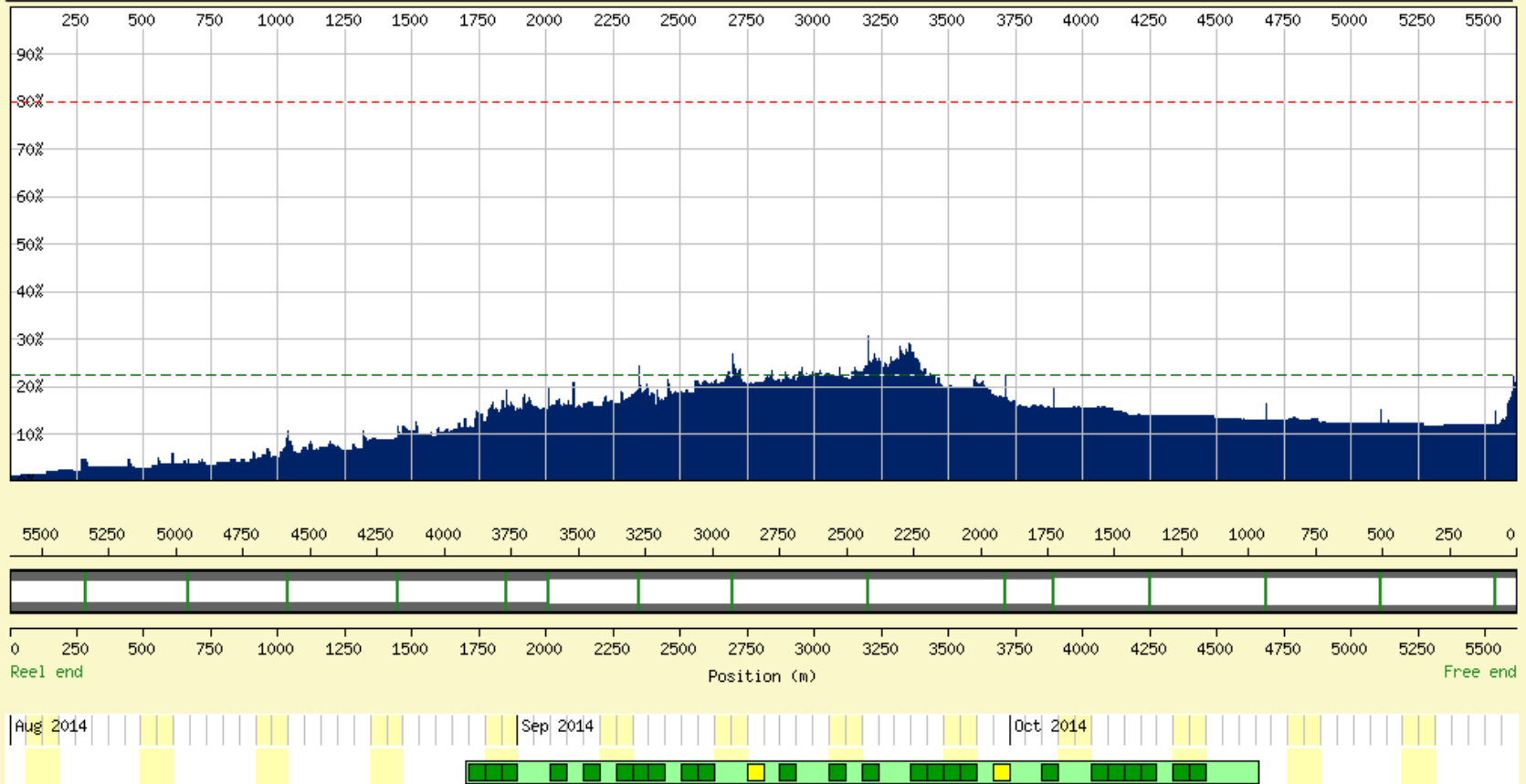


Operator (via client interface)

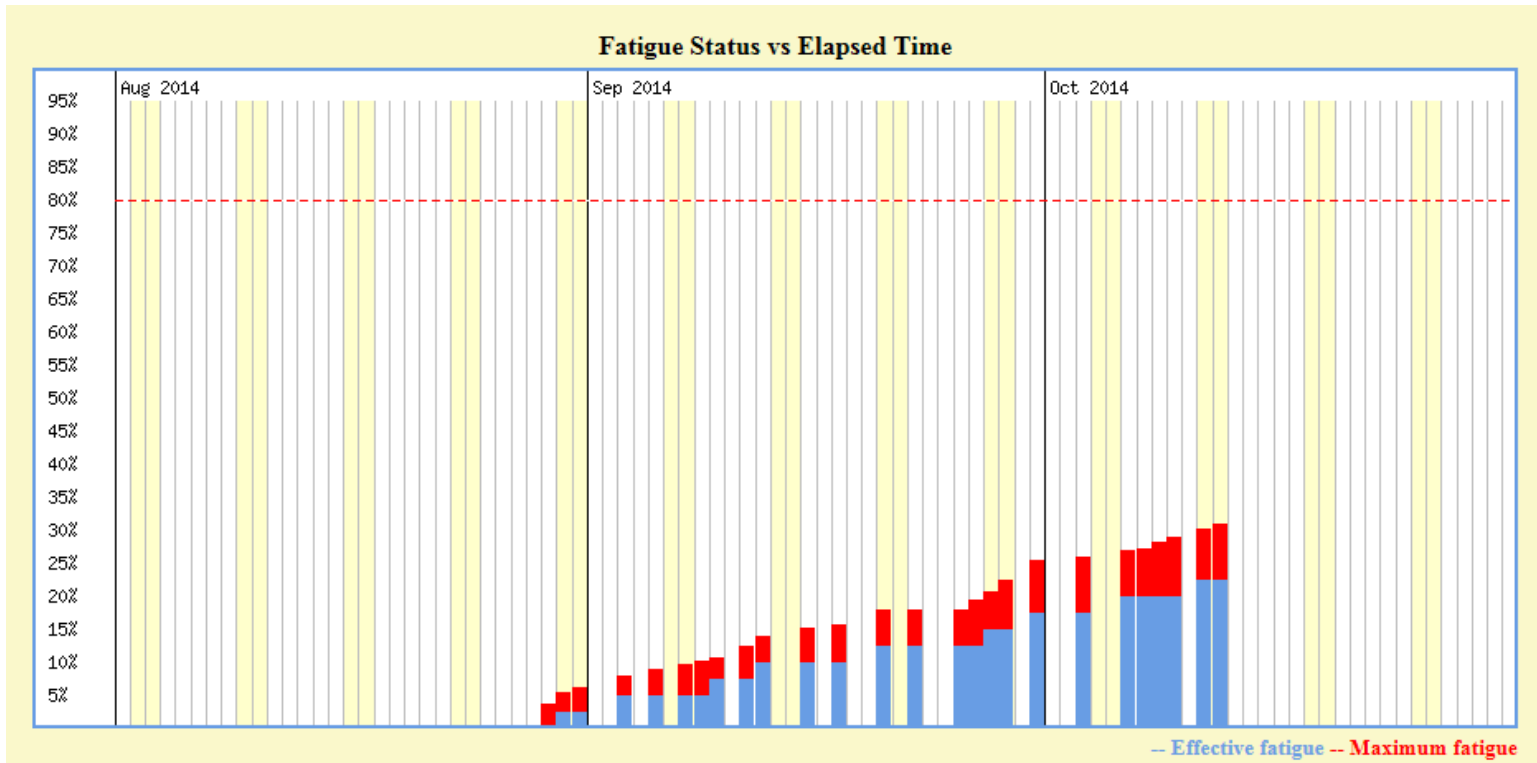
Timeline:

- Schedule & Dispatch (future)
- String Status and Job Analysis (current)
- **String and Job History** (past)

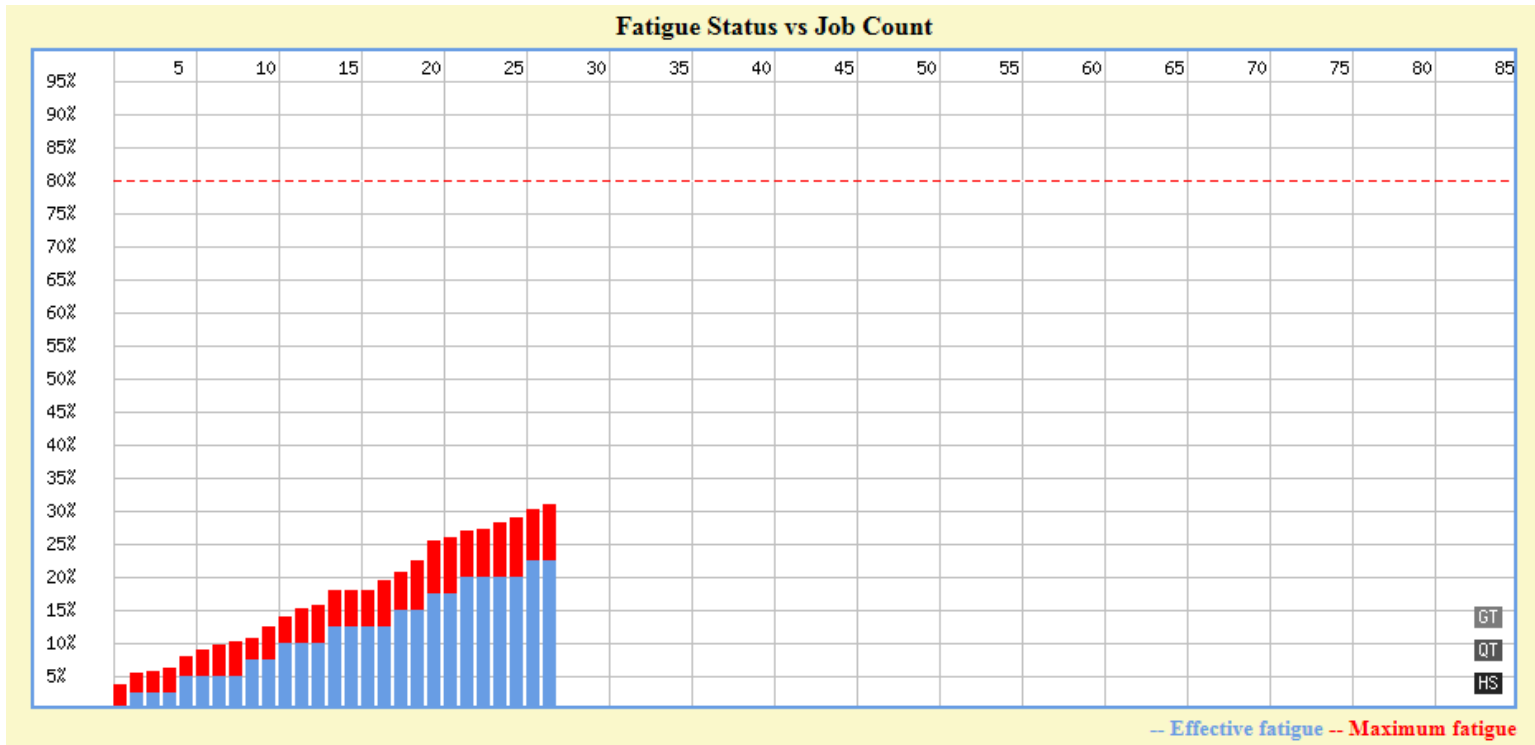
Fatigue Chart



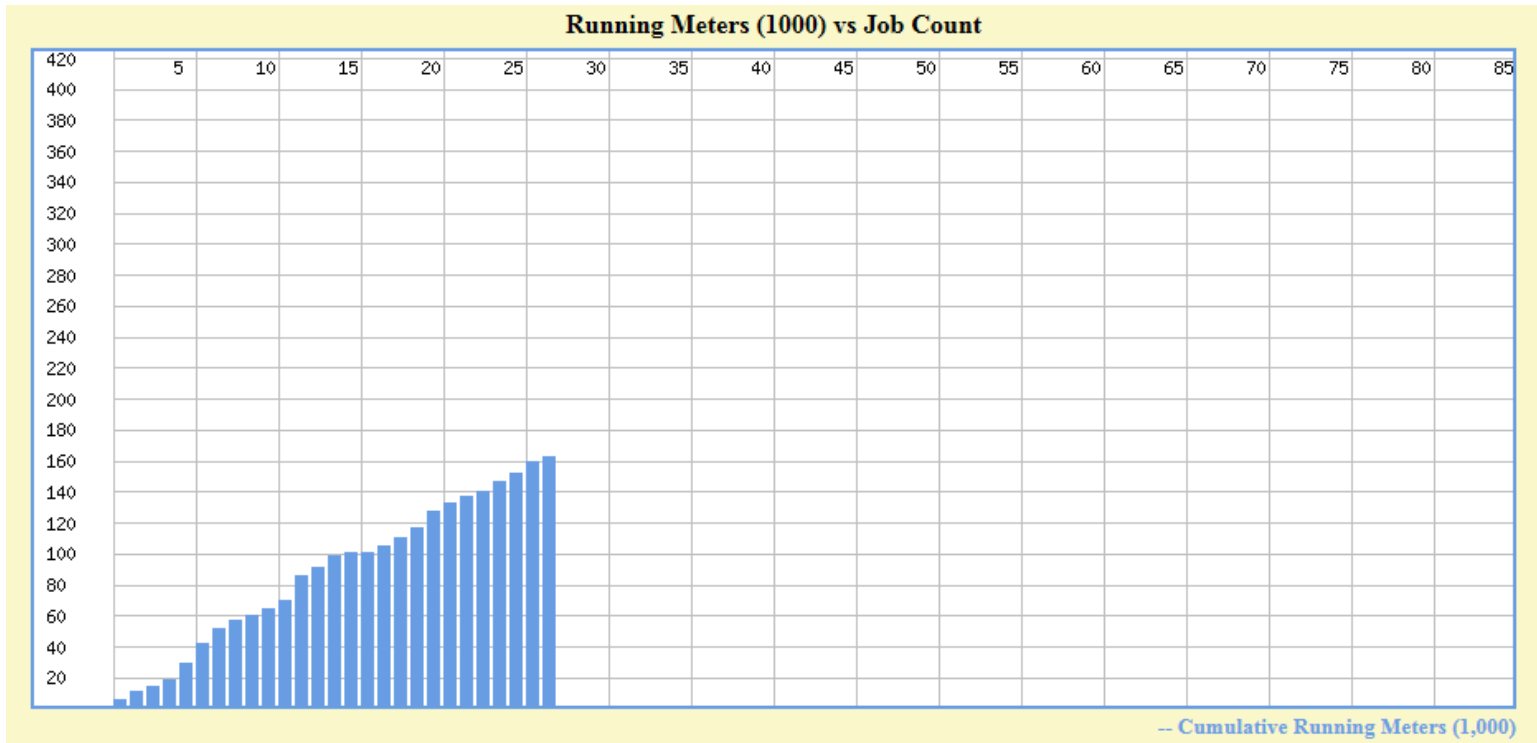
Fatigue (%) vs Position (m)
for an example 2.00" (50.8mm) string after 26 jobs



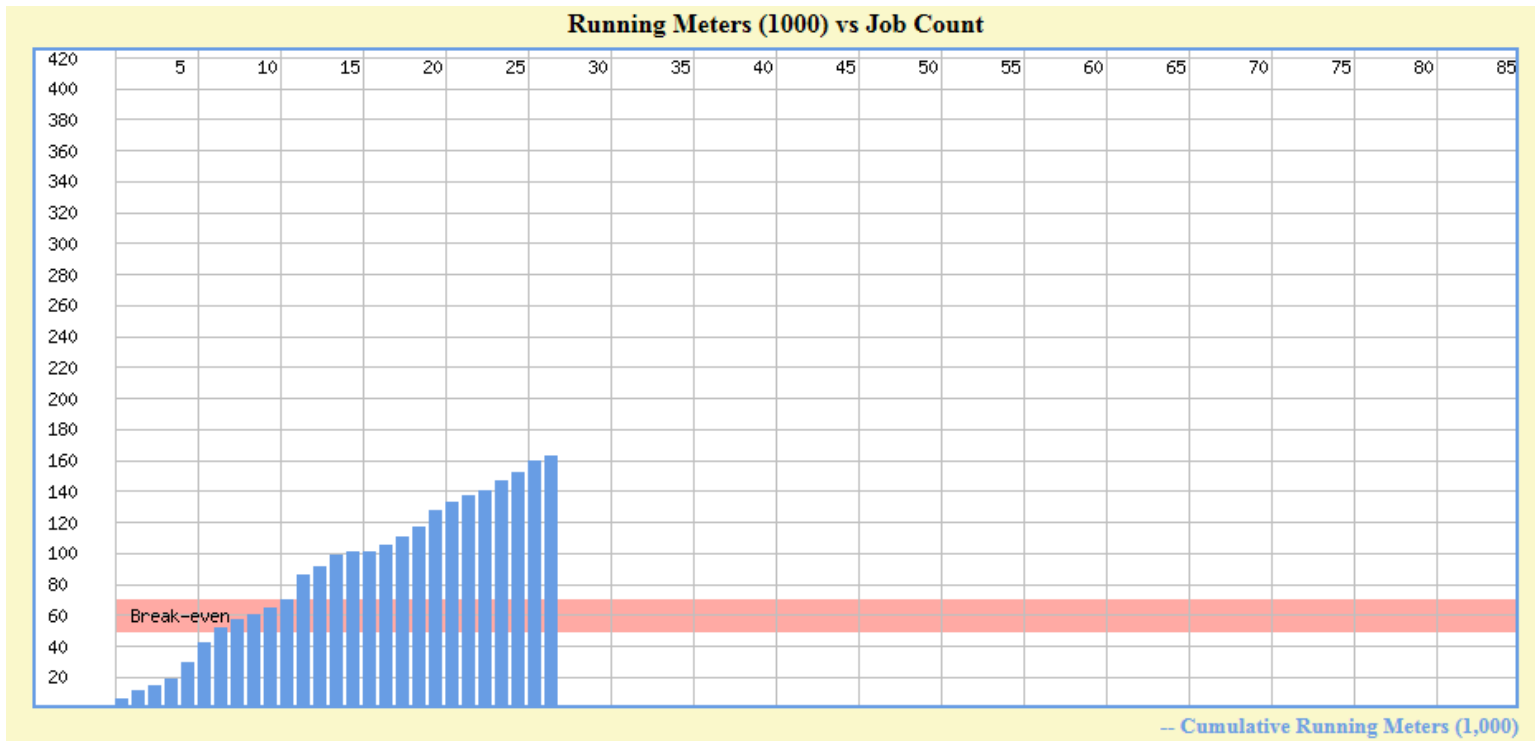
Fatigue (%) vs Elapsed Time



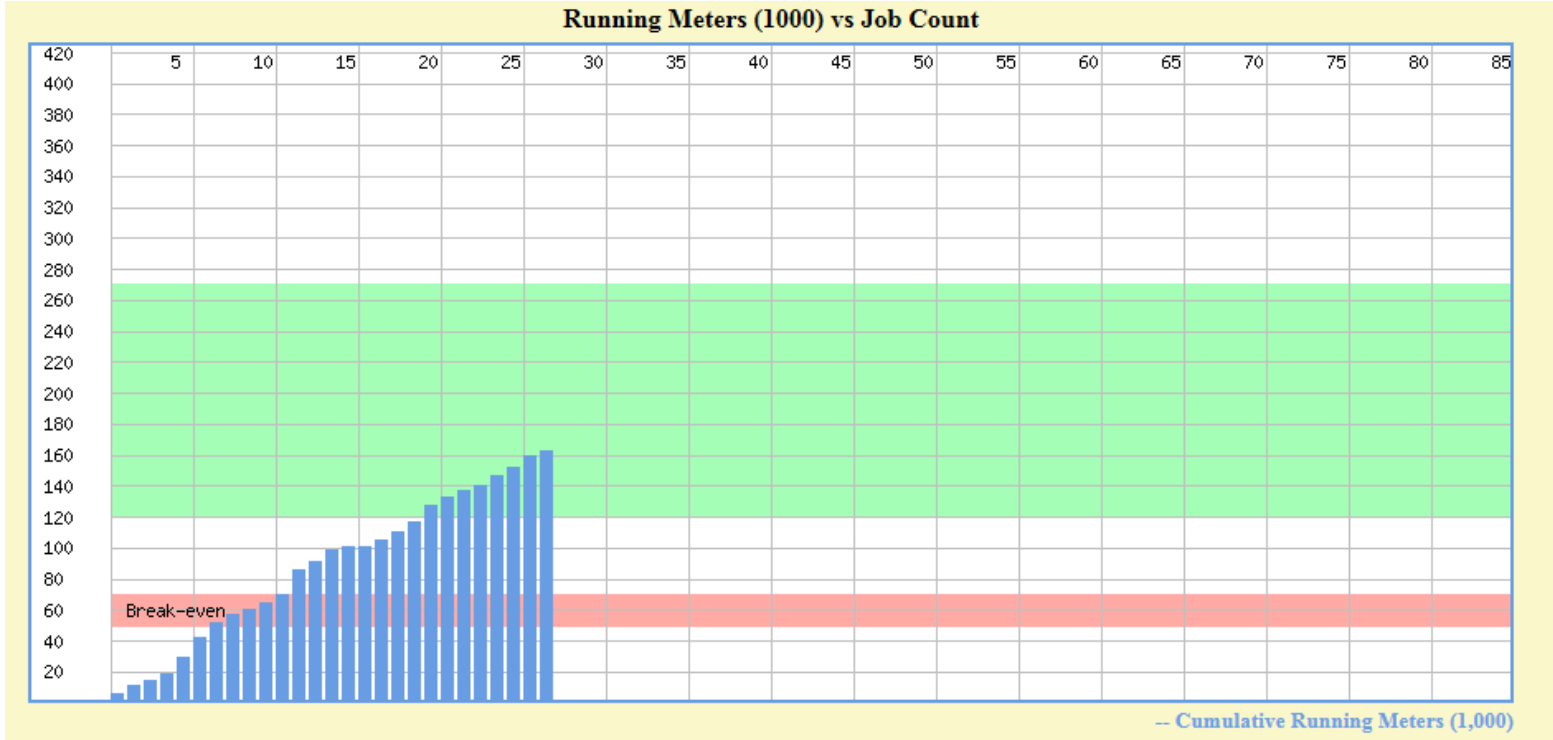
Fatigue (%) vs Job Count
 showing maximum and effective fatigue



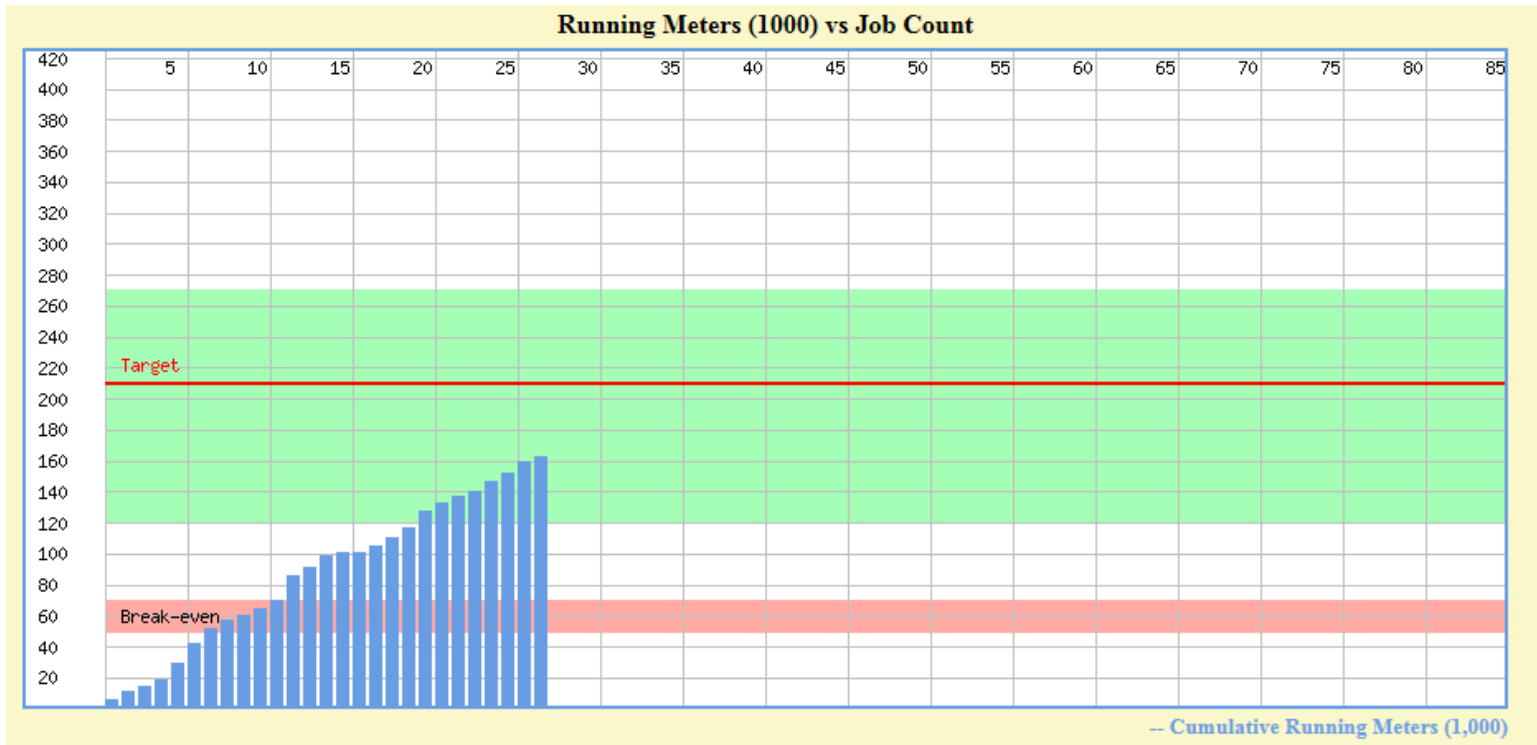
Running Meters vs Job Count



Running Meters vs Job Count
 showing approximate break-even threshold

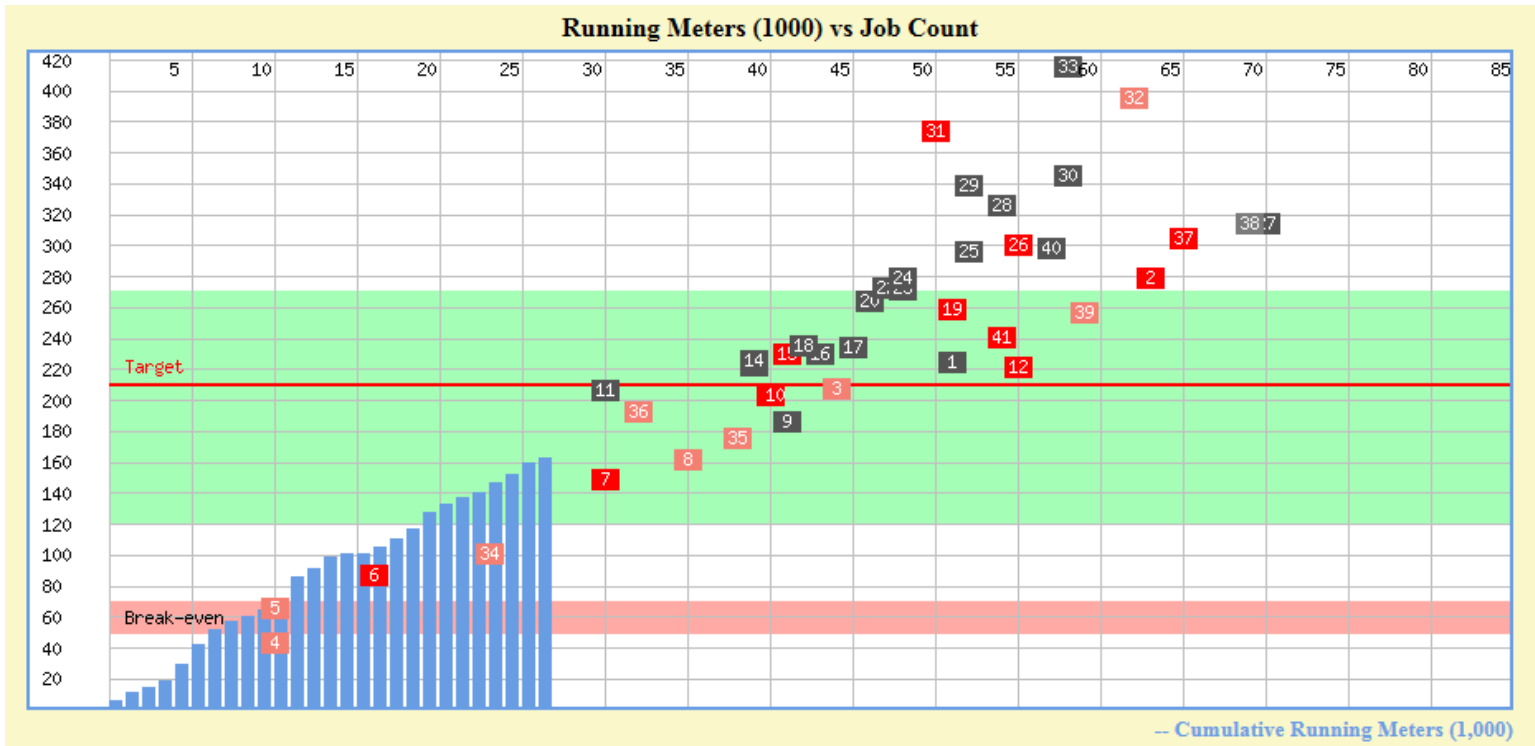


Running Meters vs Job Count
 showing expected range for given string type
 based on historic data

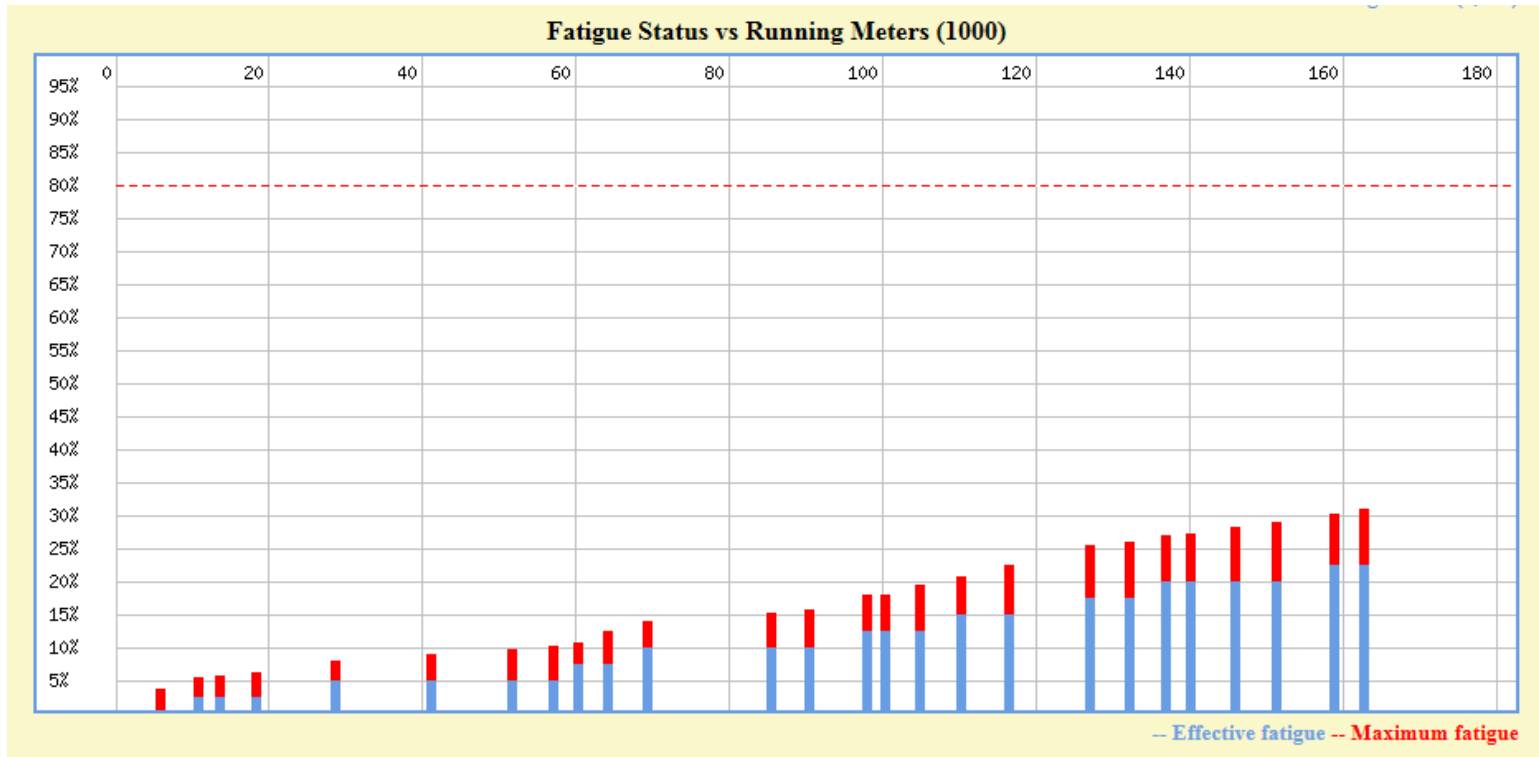


Running Meters vs Job Count
 showing target for given string type
 based on historic data

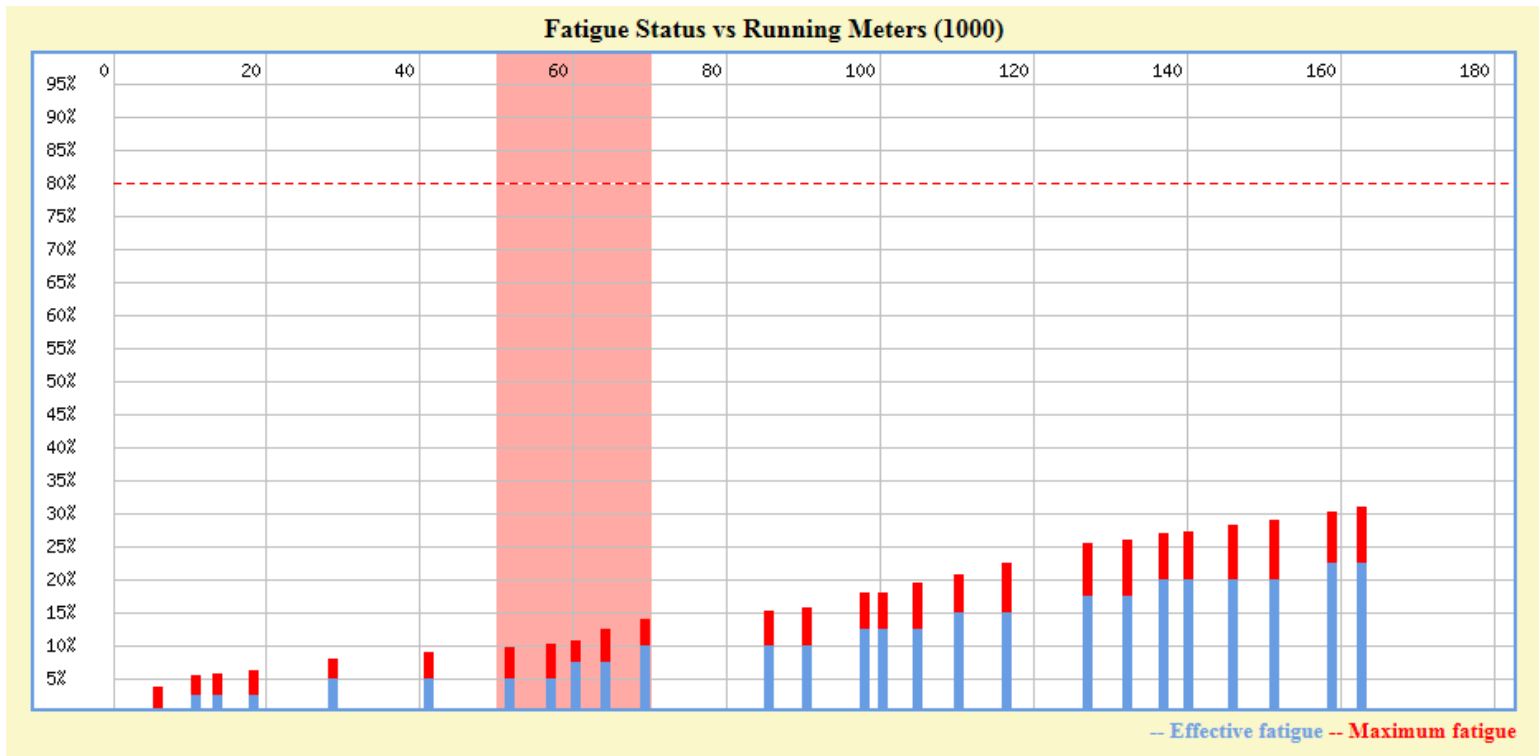
- 33 Retired
- 32 Damaged
- 25 Pinholed or Parted



Running Meters vs Job Count
 showing outcomes for 41 retired strings
 of the same diameter and material

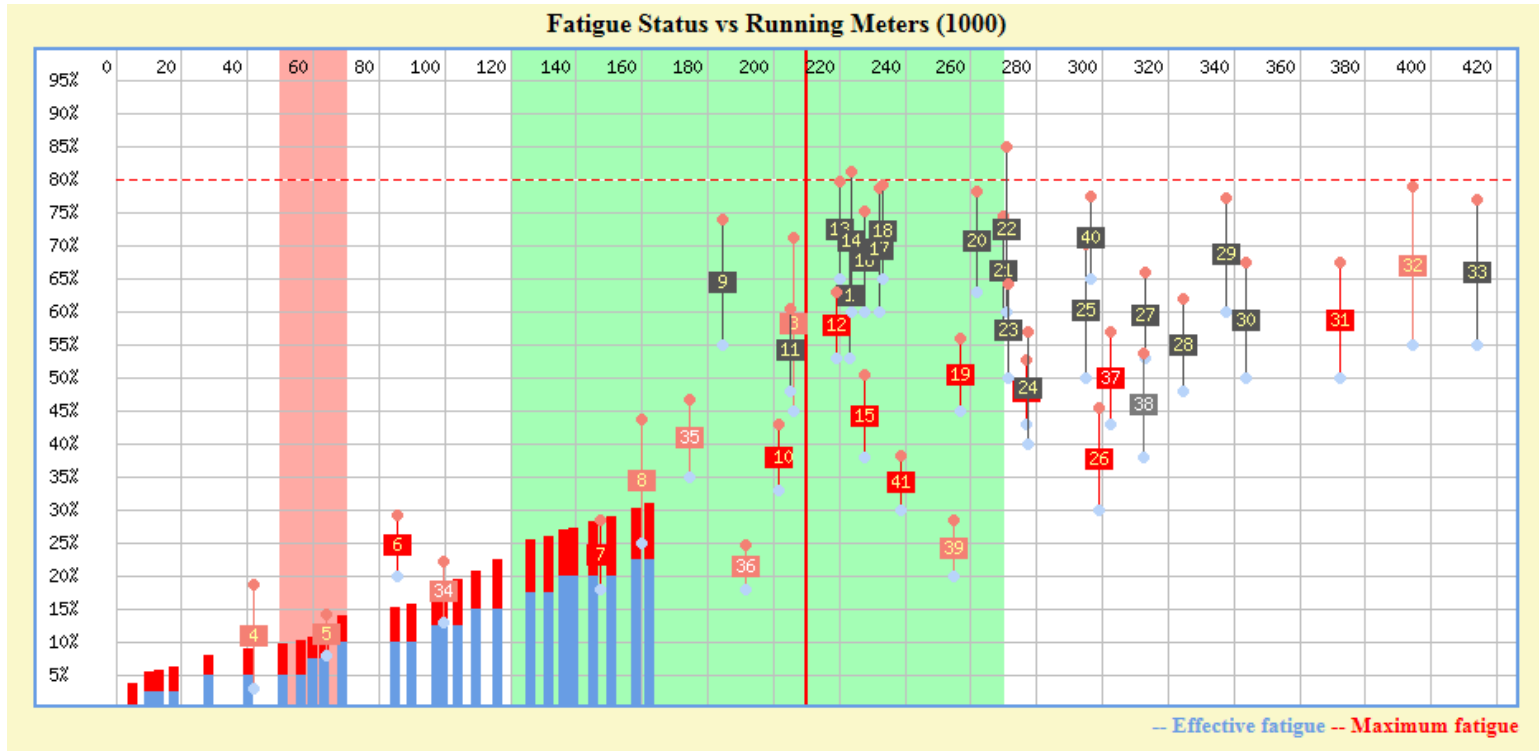


Fatigue (%) vs Running Meters
for an example string

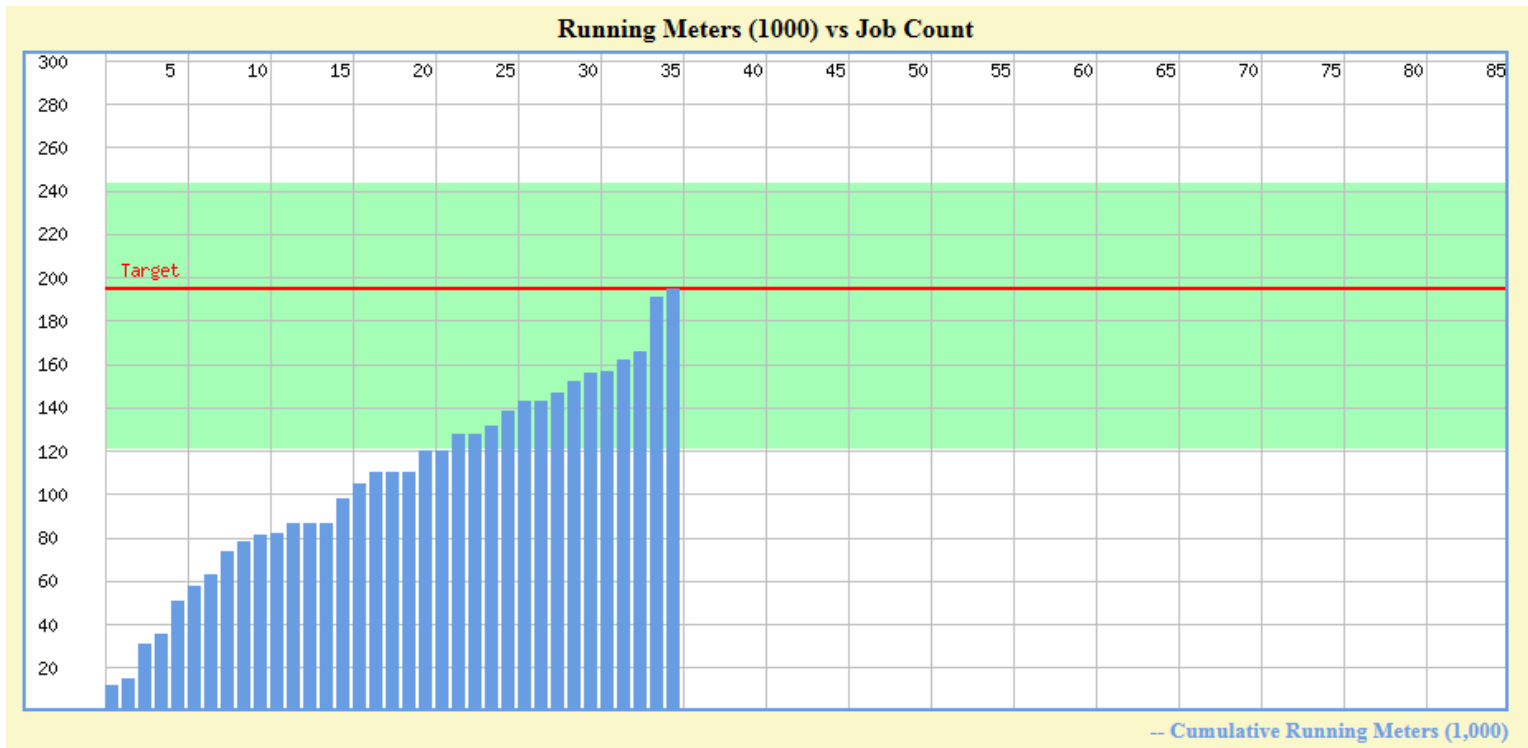


Fatigue (%) vs Running Meters
 showing approximate break-even range

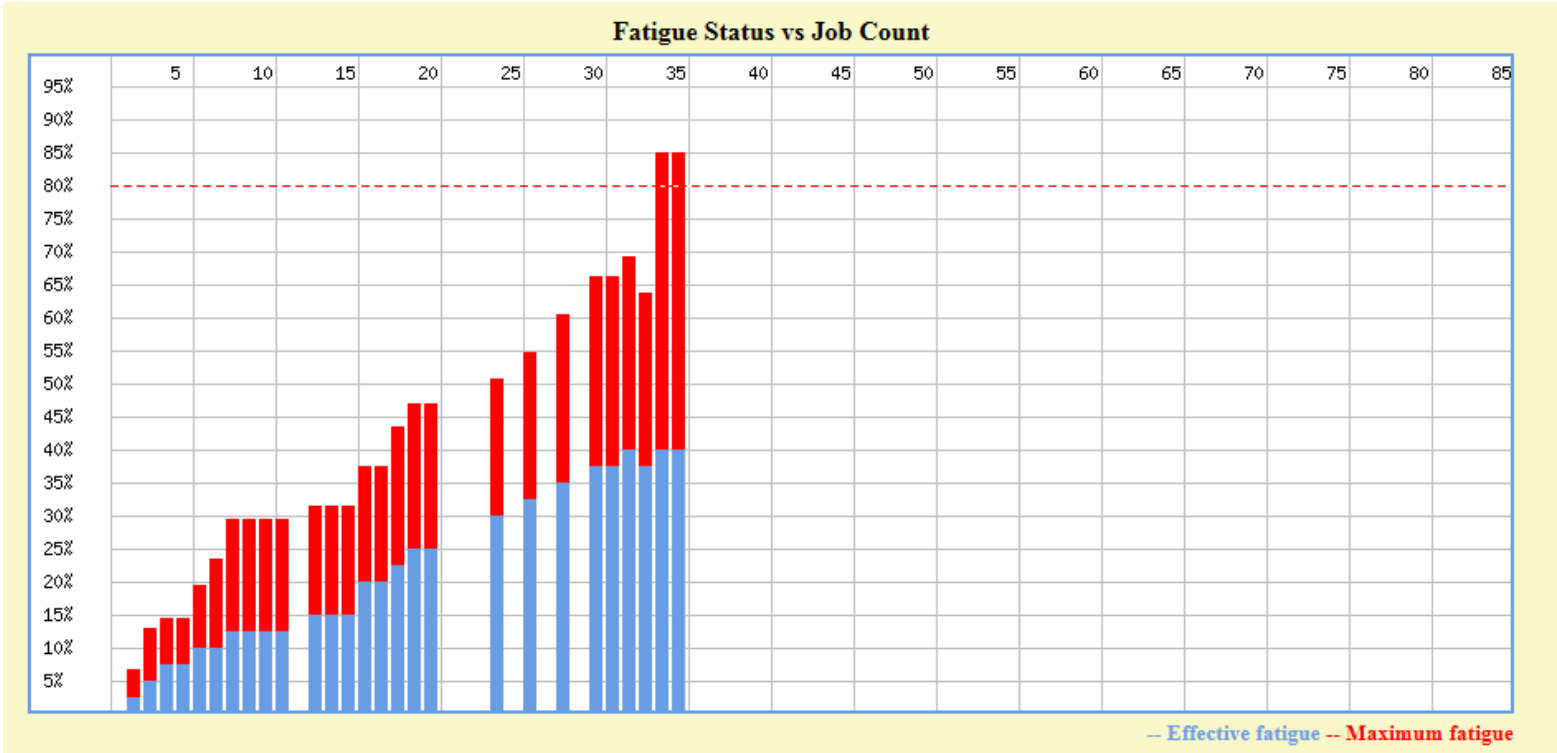
- 33 Retired
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- 26 Pinholed or Parted



Fatigue (%) vs Running Meters
 showing outcomes for 41 retired strings

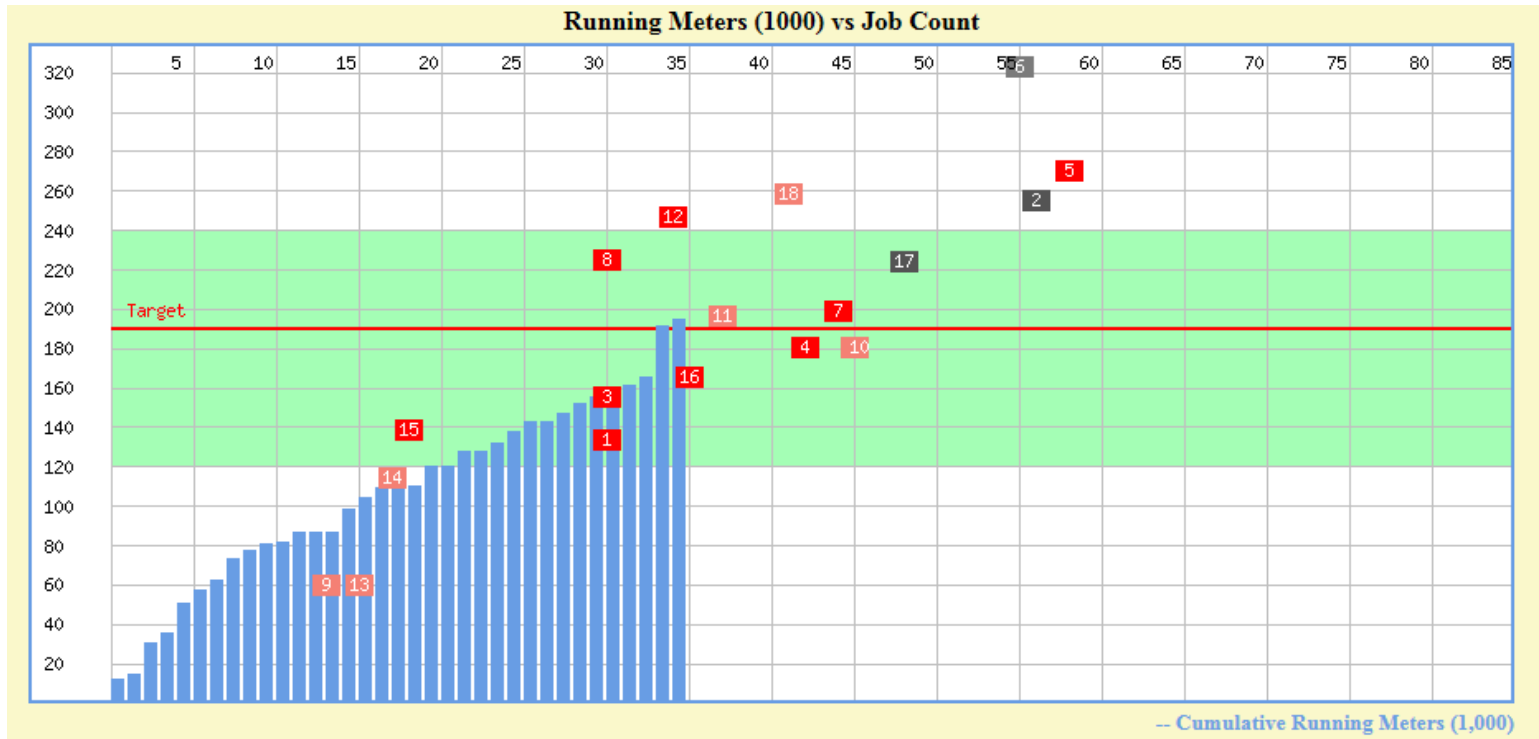


Running Meters vs Job Count
for an example 2-3/8" (60.3mm) string after 35 jobs



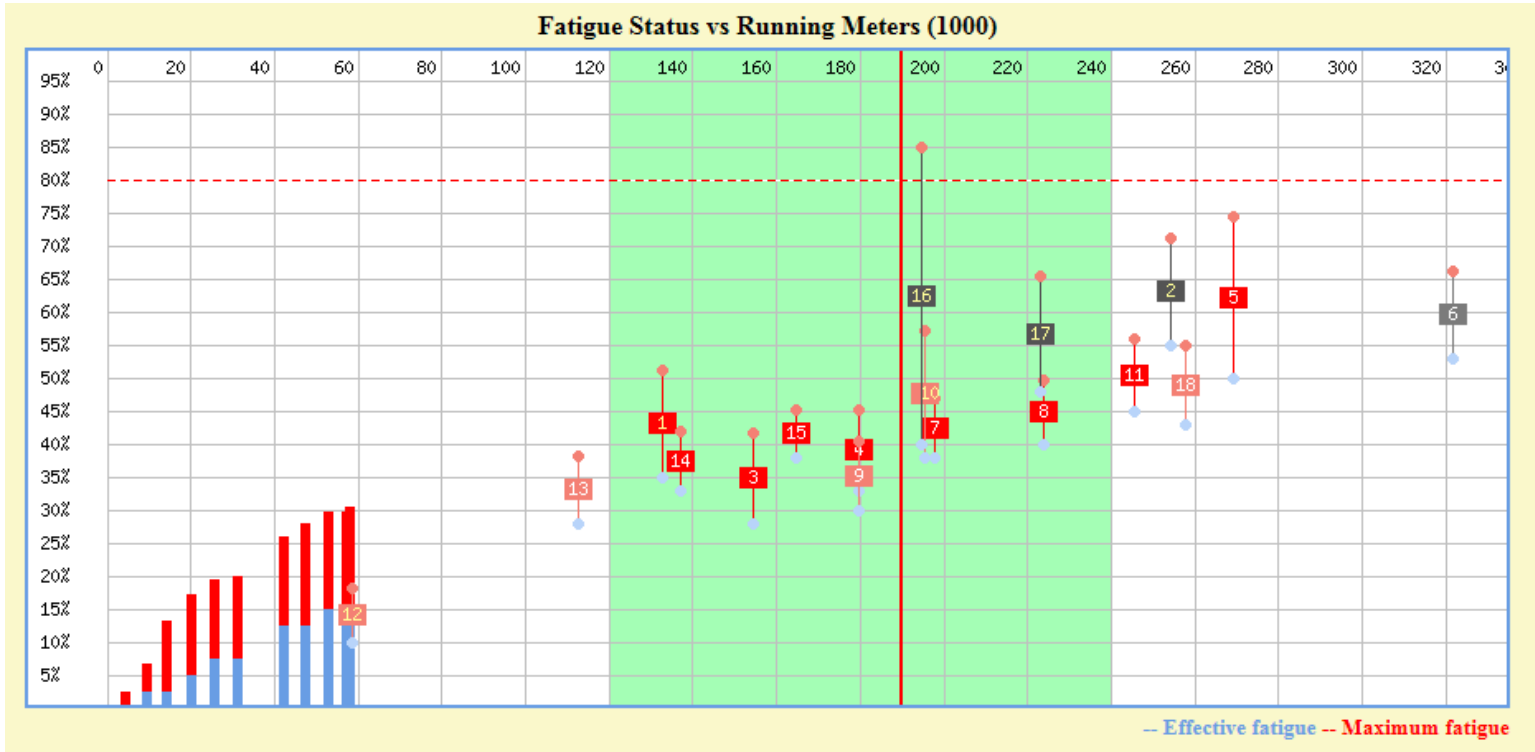
Fatigue (%) vs Job Count
 showing maximum fatigue increasing more rapidly than effective fatigue (spikes)

- 33 Retired
- 32 Damaged
- 25 Pinholed or Parted



Running Meters vs Job Count
 showing abnormal number of fatigue or
 damage related failures

- 33 Retired
- 32 Damaged
- 25 Pinholed or Parted



Running Meters vs Fatigue (%)
 showing retirements consistently occurring
 at relatively low fatigue levels

Retired String Distribution							All Strings
sorted by cause							
All Strings	31.8	38.1	44.5	50.8	60.3		
80 kpsi	3	12					15
90 kpsi	6		1	12			19
100 kpsi			1	30	2		33
110 kpsi				10			10
	9	12	2	52	2		77 of 77 (100.0%)

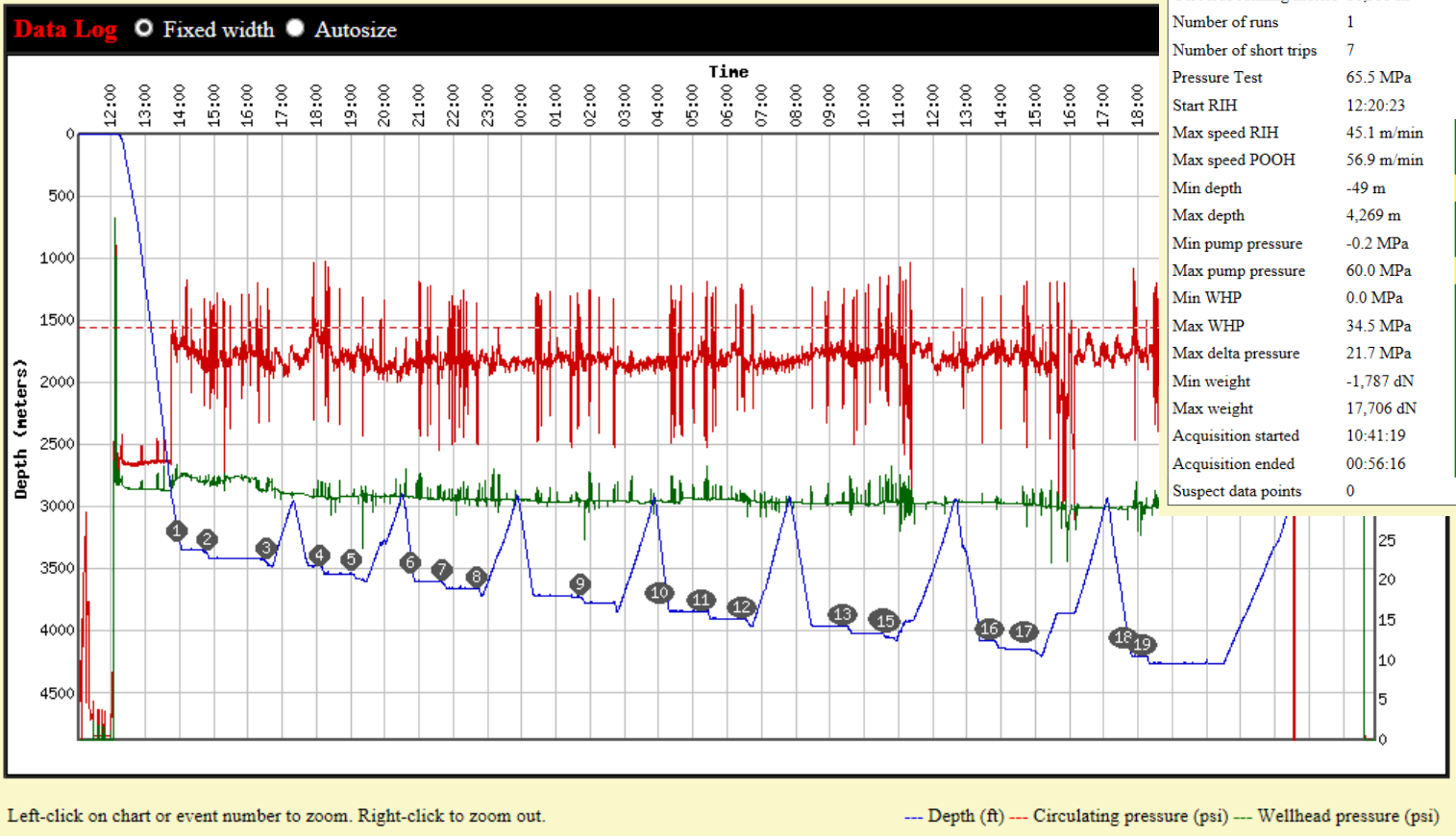
Retired String Distribution							Pinholed and Parted
sorted by cause							
All Strings	31.8	38.1	44.5	50.8	60.3		
80 kpsi	1	2					3
90 kpsi				4			4
100 kpsi				3	1		4
110 kpsi				5			5
	1	2		12	1		16 of 77 (20.8%)

Reason String Retired			Reason String Retired		
Raw data			Interpreted data		
High fatigue	19	24.7%	High fatigue	23	33.8%
Normal	12	15.6%	Parted	9	13.2%
Parted	9	11.7%	Pinholed	7	10.3%
Pinholed	7	9.1%	Major damage	6	8.8%
Major damage	6	7.8%	Butt weld	6	8.8%
Butt weld	6	7.8%	Oversize	5	7.4%
Other	5	6.5%	Other	5	7.4%
Oversize	5	6.5%	Minor damage	3	4.4%
Minor damage	3	3.9%	Hung off	2	2.9%
Hung off	2	2.6%	Lost downhole	2	2.9%
Lost downhole	2	2.6%	Expended		36.8%
Scrapped	1	1.3%	Damage related		22.1%
			Fatigue failures		23.5%
			Fatigue related		64.7%

Retired Strings Statistics (example)
 showing number of fatigue and damage related failures

Failure Analysis

- Detailed information is needed about each failure to draw appropriate conclusions, e.g. was there an investigation, was there a material defect, did it fail at a weld etc.
- Non-representative cases need to be 'weeded out'
- Well-documented cases can be labelled 'Prime Example', both good and bad outcomes.
- Would such cherry-picking distort the conclusions?
- Is there an acceptable process for sharing information that would not conflict with commercial and privacy concerns?

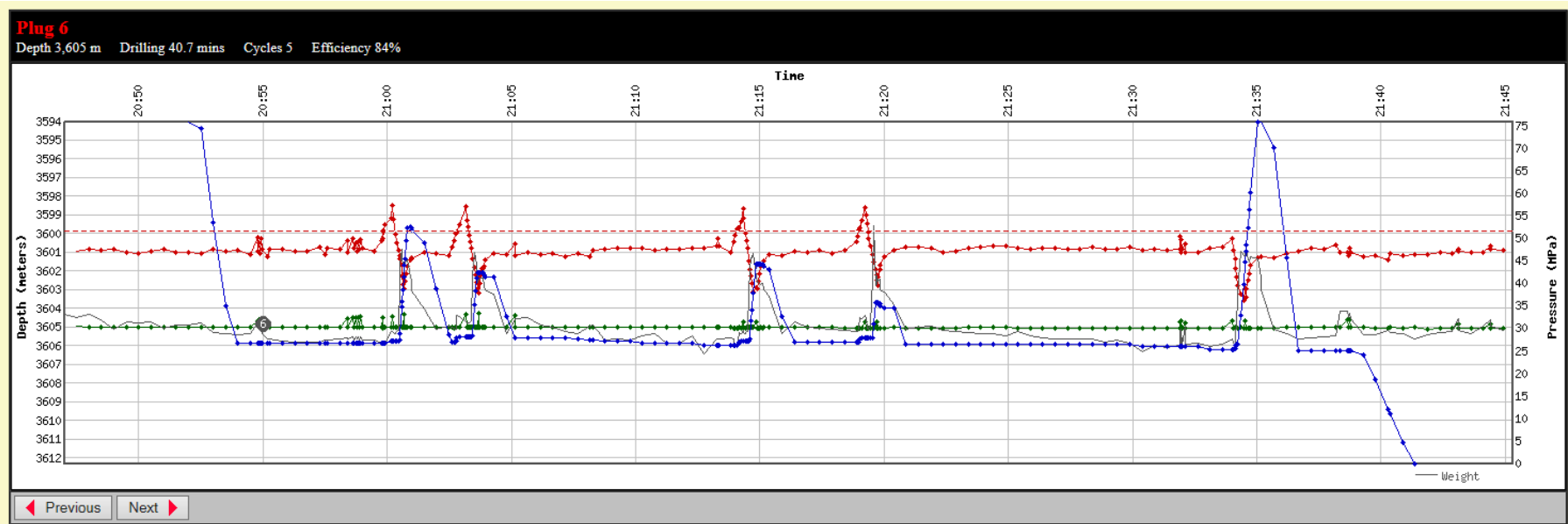


Data Analysis

Detected date format is mm/dd/yyyy

CoilData running meters	11,509 m	
Cerberus running meters	11,555 m	
Number of runs	1	
Number of short trips	7	
Pressure Test	65.5 MPa	From 12:04:17 to 12:05:37 (80 secs)
Start RIH	12:20:23	
Max speed RIH	45.1 m/min	ok
Max speed POOH	56.9 m/min	ok
Min depth	-49 m	caution Negative surface depth may indicate offset.
Max depth	4,269 m	ok
Min pump pressure	-0.2 MPa	ok
Max pump pressure	60.0 MPa	caution Pump pressure above 52 MPa exceeds model range.
Min WHP	0.0 MPa	ok
Max WHP	34.5 MPa	ok
Max delta pressure	21.7 MPa	ok
Min weight	-1,787 dN	ok
Max weight	17,706 dN	ok
Acquisition started	10:41:19	ok
Acquisition ended	00:56:16	ok
Suspect data points	0	

Example: 19 Plugs in 28 hours, average pressure 47MPa, 7 short trips, max added fatigue = ?



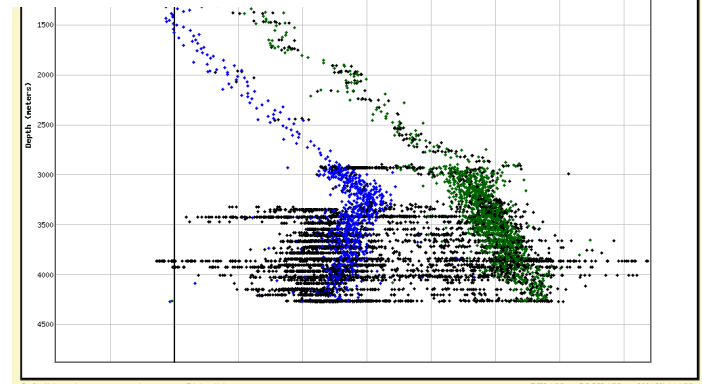
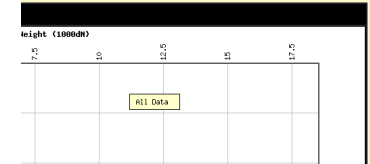
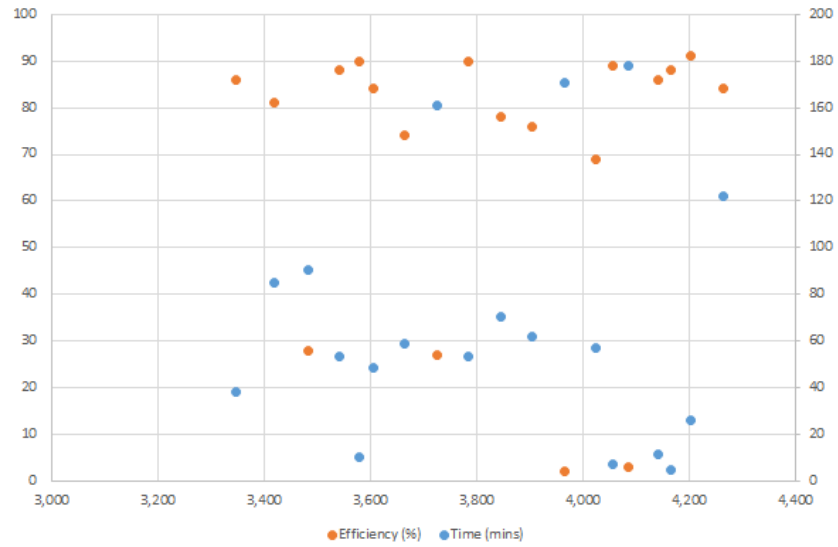
Example: Plug drilling detail, showing 5 cycles over 48 minutes (84% efficiency)

Plugs
detected automatically by CoilData

[edit]

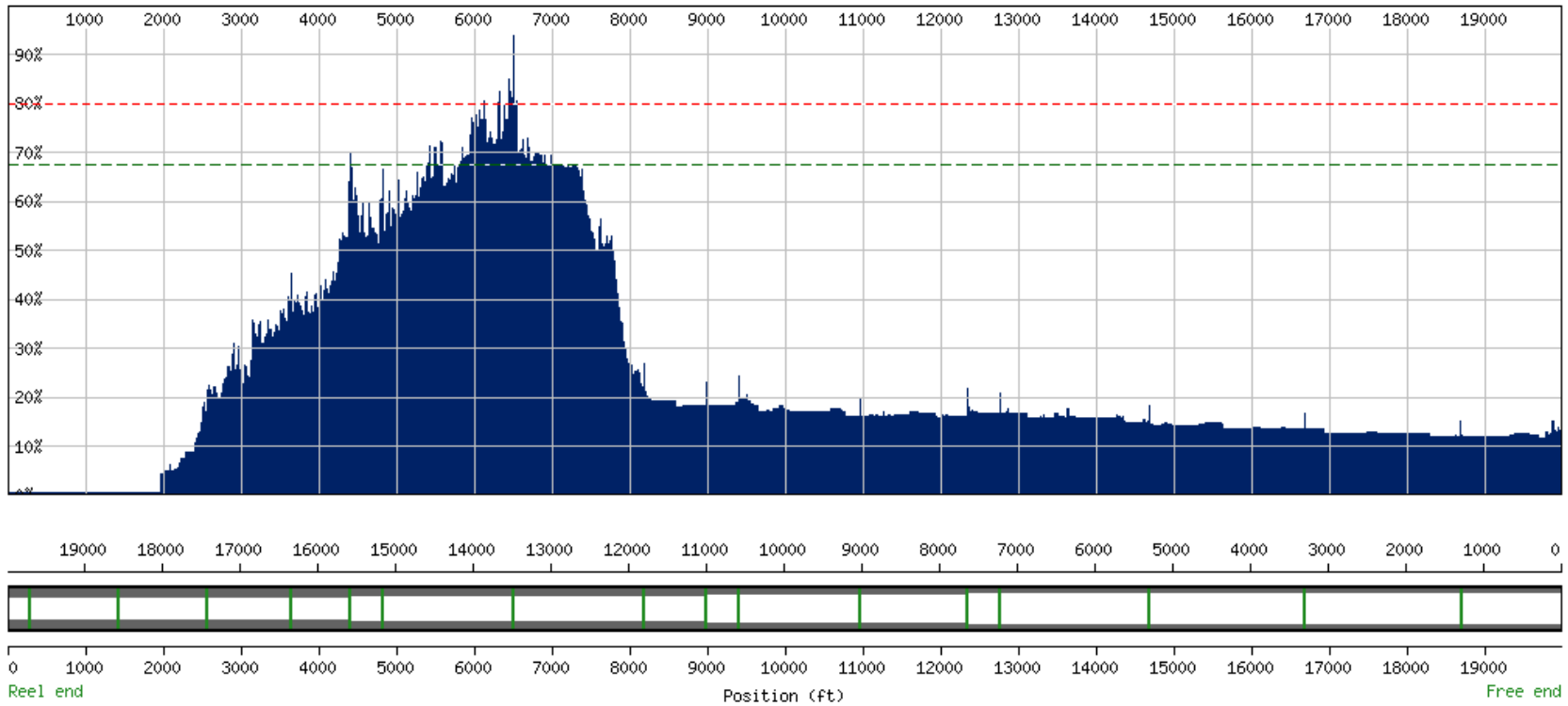
Plug	Depth (m)	Drill Time (mins)	Total Time (mins)	Cycles	Eff (%)	Pump Pressure (MPa)			
1	3,348	33.1	38.1	2	86	44	49	58	zoom
2	3,420	69.3	85.2	11	81	33	48	57	zoom
3	3,484	25.4	90.7	2	28	40	49	60	zoom
4	3,543	47.2	53.4	4	88	40	49	60	zoom
5	3,580	9.1	10.1	0	90	48	49	50	zoom
6	3,605	40.7	48.3	5	84	36	47	57	zoom
7	3,664	43.8	58.6	7	74	37	48	56	zoom
8	3,725	44.7	161.1	5	27	37	48	56	zoom
9	3,784	48.0	53.3	4	90	37	48	56	zoom
10	3,845	55.7	70.6	10	78	37	48	57	zoom
11	3,905	47.5	62.2	6	76	39	48	57	zoom
12	3,966	4.8	171.0	1	2	40	48	57	zoom
13	4,025	39.8	57.2	7	69	37	48	58	zoom
14	4,056	6.5	7.3	0	89	48	49	52	zoom
15	4,086	6.2	178.1	1	3	30	47	60	zoom
16	4,142	10.0	11.6	1	86	39	48	56	zoom
17	4,167	4.5	5.1	0	88	46	47	48	zoom
18	4,204	23.6	25.9	1	91	38	48	59	zoom
19	4,265	103.4	122.3	9	84	39	49	58	zoom

Plug Drilling Efficiency (%) vs Depth (m)



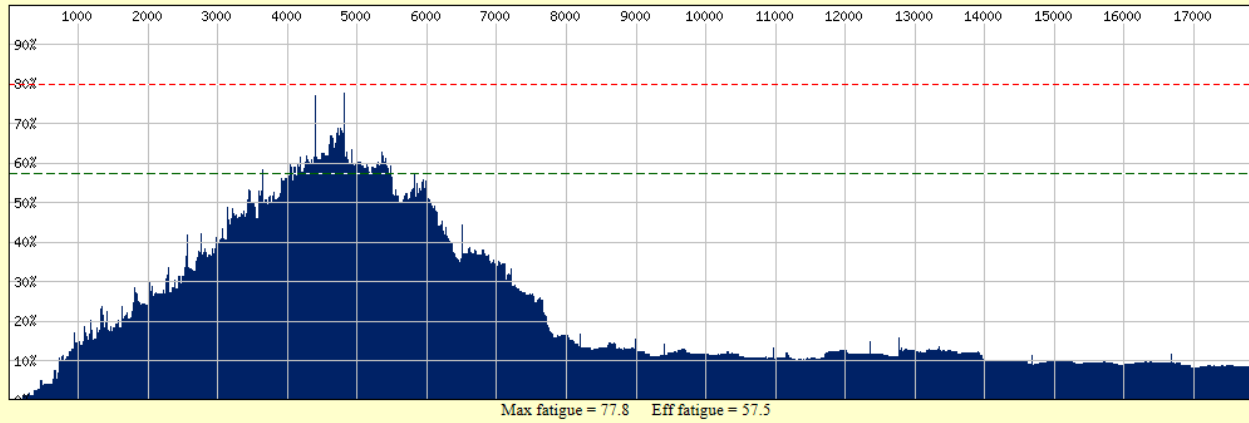
Left-click on chart or event number to zoom. Right-click to zoom out. — RIH (dN) — POOH (dN) — 80% Yield (dN)

Fatigue Chart

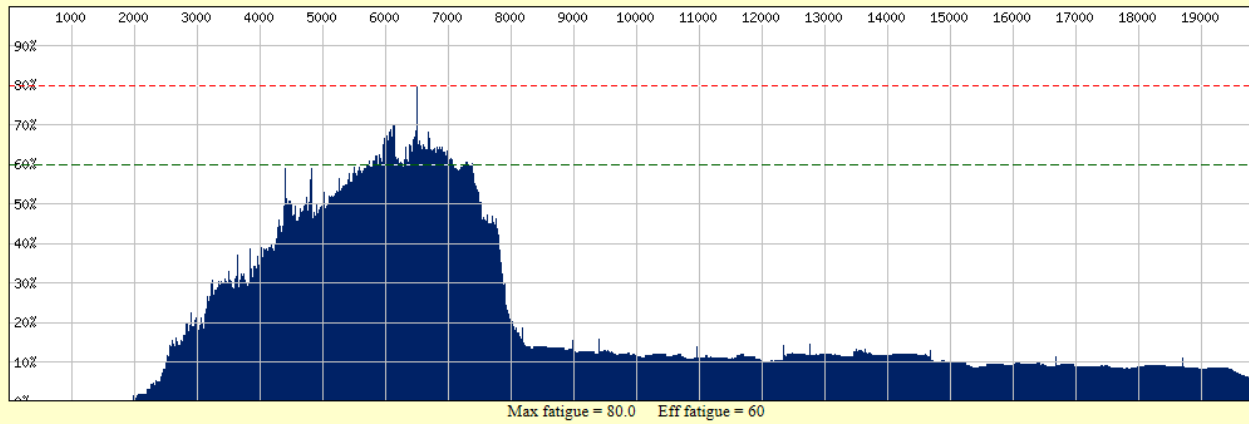


Example string fatigue chart after 22 jobs showing fatigue crowded into one section of the string largely as the result of frequent short trips and insufficient cuts

Aradia Fatigue Simulation - using modified data

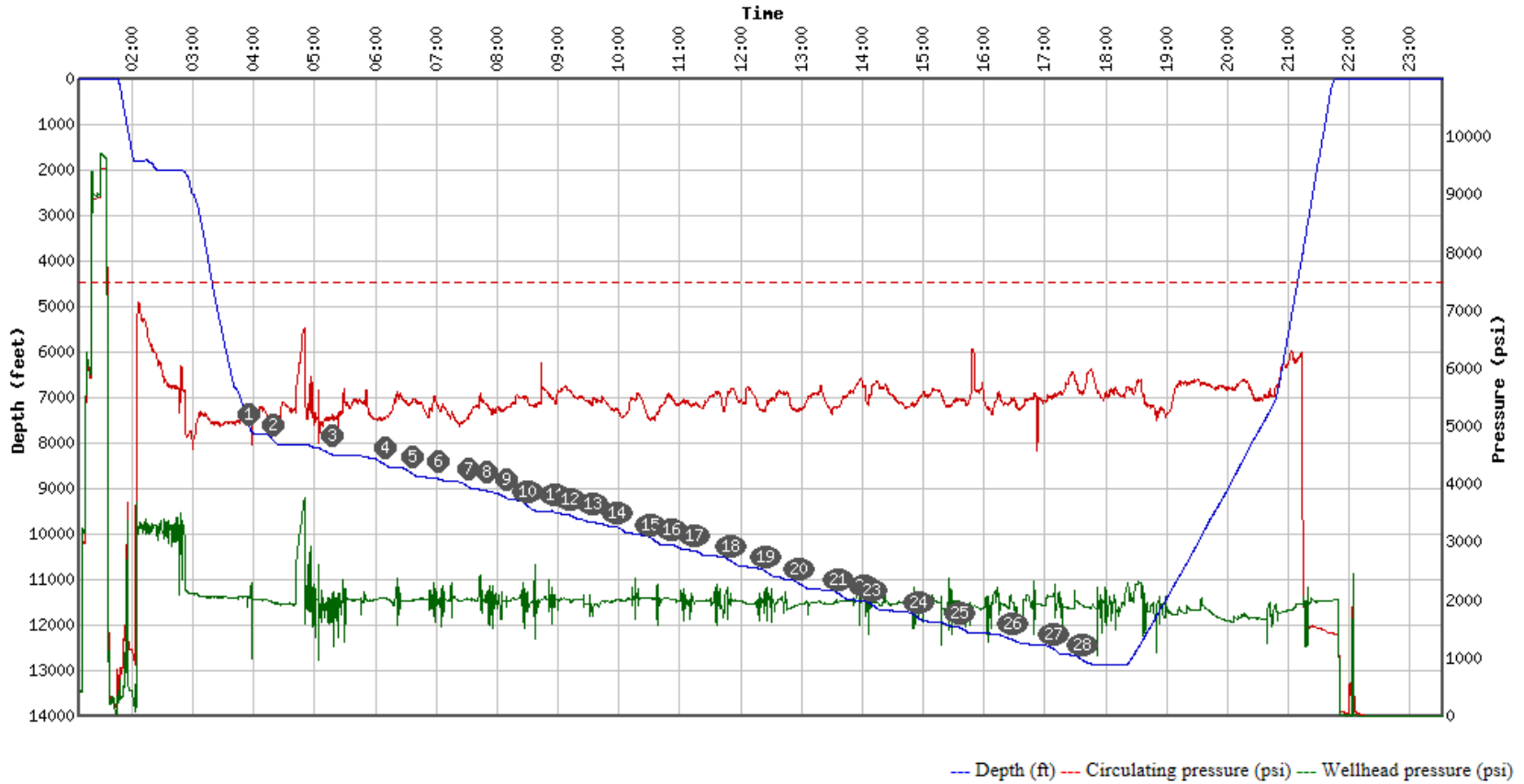


Aradia Fatigue Simulation - using original data



Results with no pipe cuts (below) vs 30m cuts after every job (top)

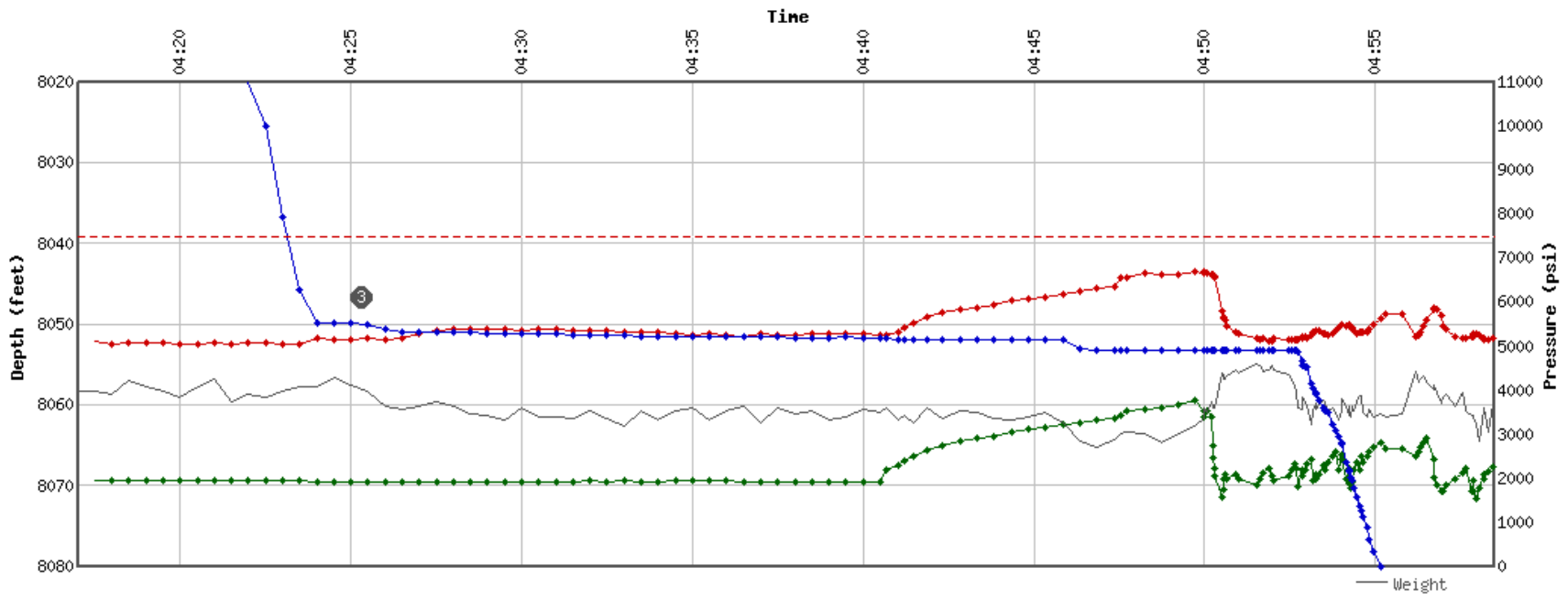
Data Log



28 Plugs in 14 hours, average pressure 5500psi, no short trips, max added fatigue = 1.3%

Plug 3

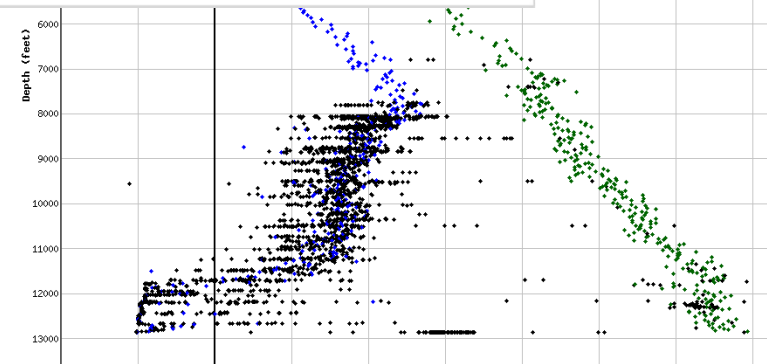
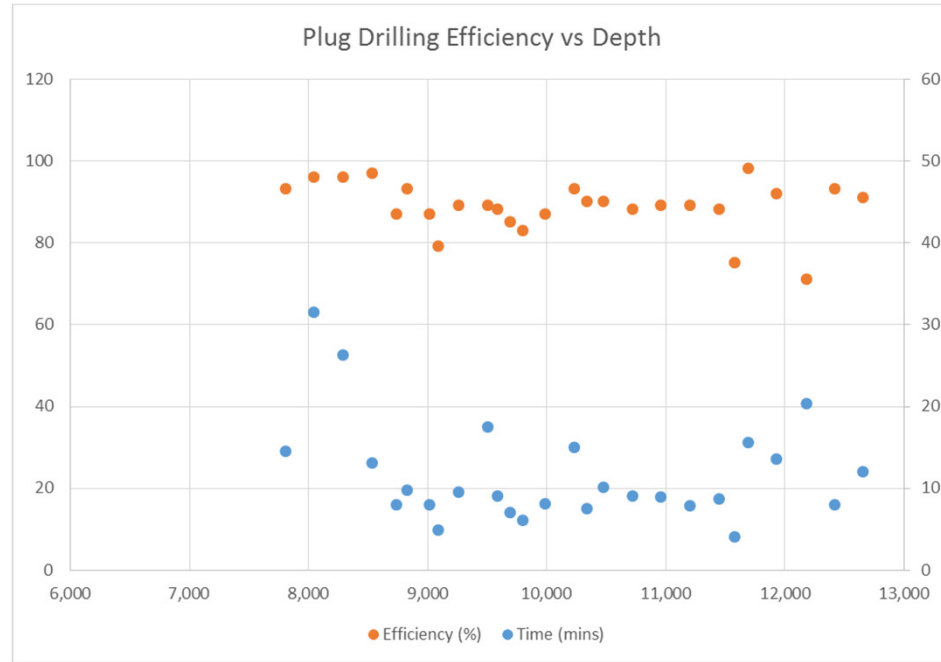
Depth 8,050 ft Drilling 30.5 mins Cycles 0 Efficiency 96%



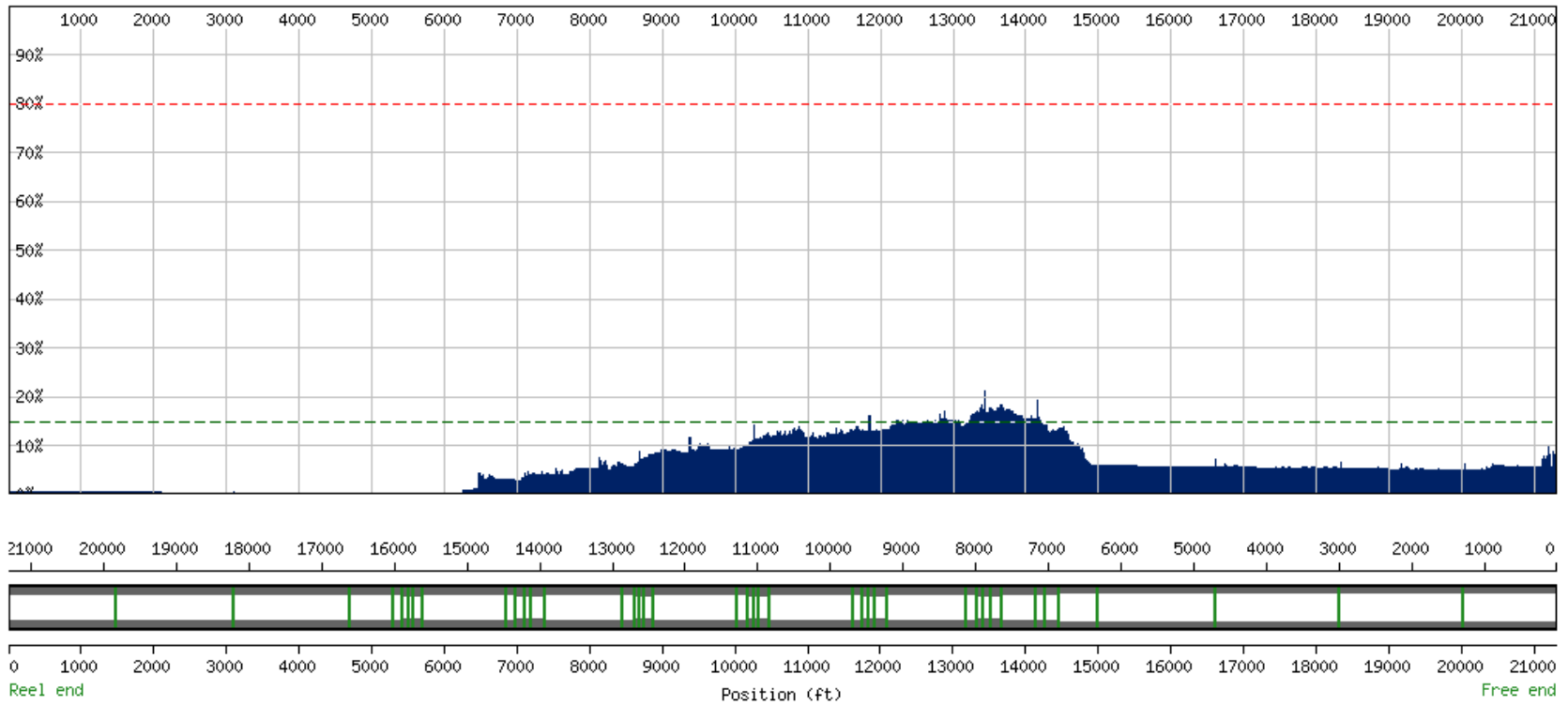
Example: Plug drilling detail, showing no cycles over 30.5 minutes (96% efficiency)

Plugs
detected automatically by CoilData

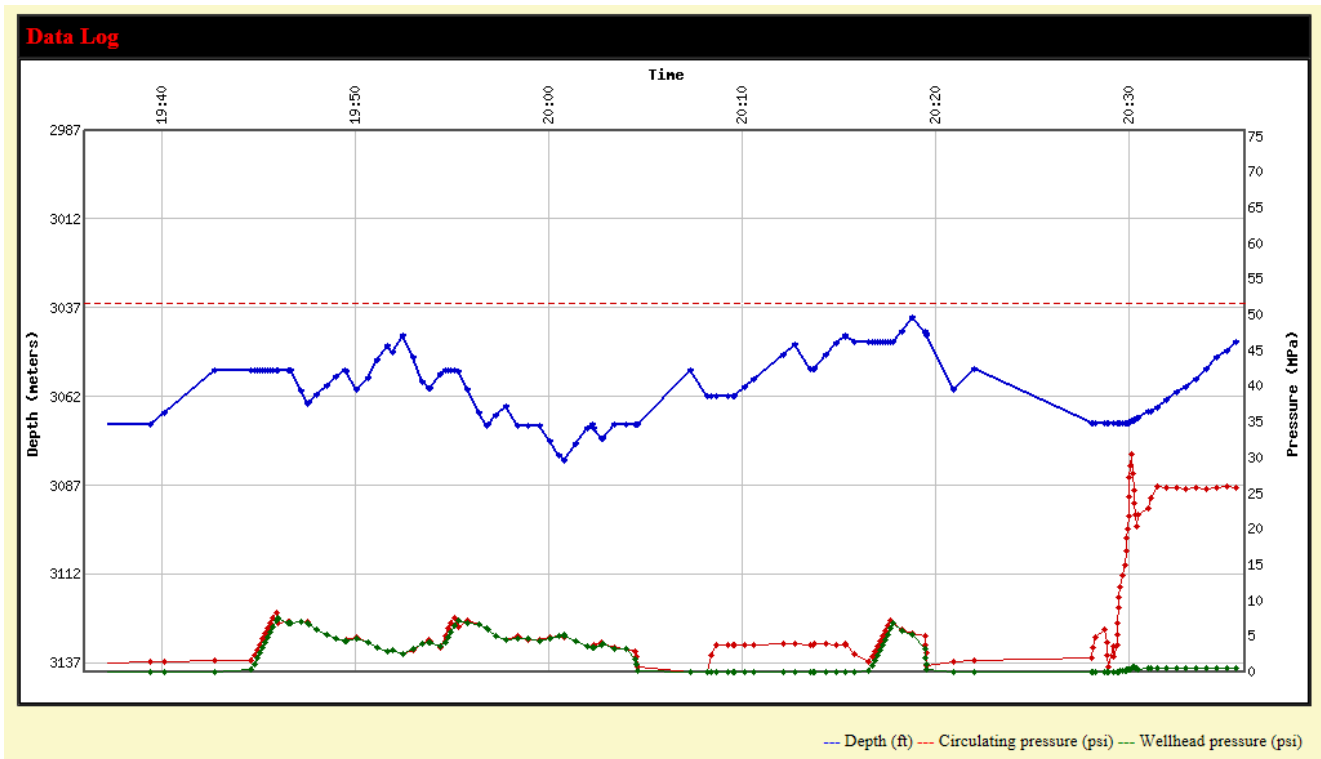
Plug	Depth (ft)	Drill Time (mins)	Total Time (mins)	Cycles	Eff (%)	Pump Pressure (psi)		
1	2,007	27.3	28.0	0	97	5,263	5,769	6,141
2	7,808	13.5	14.5	0	93	5,126	5,273	5,356
3	8,050	30.5	31.5	0	96	5,152	5,633	6,715
4	8,292	25.3	26.3	0	96	4,978	5,401	5,676
5	8,536	12.8	13.1	0	97	5,274	5,523	5,620
6	8,739	7.0	8.0	0	87	5,320	5,395	5,439
7	8,834	9.1	9.7	0	93	5,153	5,239	5,366
8	9,020	6.9	7.9	0	87	5,338	5,367	5,390
9	9,094	3.9	4.9	0	79	5,277	5,308	5,336
10	9,266	8.5	9.5	0	89	5,399	5,475	5,556
11	9,507	15.7	17.5	1	89	5,400	5,589	6,105
12	9,590	8.0	9.0	0	88	5,629	5,665	5,718
13	9,692	6.0	7.0	0	85	5,505	5,522	5,539
14	9,799	5.0	6.0	0	83	5,452	5,482	5,509
15	9,989	7.1	8.1	0	87	5,269	5,433	5,511
16	10,235	14.0	15.0	0	93	5,369	5,484	5,580
17	10,330	6.8	7.5	0	90	5,418	5,452	5,475



Fatigue Chart



Fatigue chart after 9 jobs (7 drilling, 1 fishing, 1 other)



Rogue supervisor or problems performing the job?

Job Analysis by Client All locations (last 24 months)						
Client	Jobs ¹	0-5%	5-10%	10%+	Orion	Fatigue ²
[REDACTED]	63	52	10	1	100%	3.3%
[REDACTED]	53	45	7	1	98%	3.2%
[REDACTED]	53	38	14	1	96%	3.5%
[REDACTED]	49	46	3	0	98%	2.6%
[REDACTED]	46	43	3	0	98%	2.2%
[REDACTED]	44	41	2	1	98%	2.4%
[REDACTED]	44	34	7	3	95%	3.8%
[REDACTED]	41	34	6	1	98%	3.0%
[REDACTED]	41	36	4	1	98%	2.6%
[REDACTED]	40	26	9	5	100%	4.8%
[REDACTED]	38	33	5	0	100%	2.3%
[REDACTED]	31	26	4	1	100%	2.8%
[REDACTED]	26	13	8	5	96%	6.8%
[REDACTED]	26	19	5	2	96%	3.8%
[REDACTED]	25	15	7	3	100%	5.6%
[REDACTED]	23	21	2	0	91%	2.4%

Job Analysis by Supervisor All locations (last 24 months)						
Supervisor	Jobs ¹	0-5%	5-10%	10%+	Orion	Fatigue ²
[REDACTED]	48	42	6	0	100%	★ 2.7%
[REDACTED]	33	24	6	3	100%	★ 3.7%
[REDACTED]	32	28	4	0	100%	★ 2.6%
[REDACTED]	27	24	3	0	100%	★ 2.8%
[REDACTED]	26	18	4	4	96%	4.6%
[REDACTED]	21	18	3	0	95%	3.1%
[REDACTED]	17	12	2	3	94%	4.8%
[REDACTED]	15	9	2	4	100%	5.7%
[REDACTED]	13	12	0	1	100%	3.2%
[REDACTED]	13	8	4	1	92%	5.6%
[REDACTED]	12	11	0	1	100%	3.4%
[REDACTED]	12	6	5	1	100%	4.8%
[REDACTED]	11	5	2	4	100%	8.2%
[REDACTED]	9	8	1	0	100%	2.9%
[REDACTED]	9	3	3	3	100%	8.7%

Identifying 'high fatigue' operators and supervisors

Summary

- Systematic tracking of strings and jobs enables a company to monitor trends and detect problem areas, with the ultimate aim of improving operational efficiency and reducing pipe costs.
- Online coiled tubing data provides the accessibility benefits of any internet service.
- There is no mechanism in place to share analysis between service companies, nor is that likely to be commercially acceptable.
- Sharing of certain data is possible between service companies, pipe manufacturers and operators, and with greater awareness could be exploited more than it currently is.