

#allin

CORRESPONDENCES



John Spelic

Tallgrass





Optimizing Turbine Overhaul Scheduling

John Spelic

Manager—Automation & Equipment Analysis

Tallgrass Energy



Tallgrass





Challenge—Background

- 13 compressor stations w/ turbines
 - 2-4 units per station
- 31 turbines on two pipelines
- Unpredictable runtime accumulation
 - Ever-changing pipeline conditions
 - "Random" start/stop sequence





Challenge—Background

- Typical Overhaul Cost: ~ \$3 million
- Established Target for Time Between Overhaul (TBO)

	2025	2026	2027	2028	2029	2030	Total
Unmanaged Overhaul Projection before Seeq	2	5	4	1	2	1	15

- Natural vs Managed Approach
- Main Goal: Consistent Yearly Overhaul Costs



Challenge (cont'd)

						Current Strategy			Scenarios	-		
		Hours			hours							
	Current OH	as of	rolli	ng 12 mo	last 12		Solve	Solve For		Maximize		
Unit	Threshold	9/18	aver	age	months	Projected OH Date	For %	Hours	Solve for OH Date	OH Date	Delta (days)	
						1		1				
A #1	40500	13177		58.88%	5158	7/17/2030	75%	6533	2/11/2030	1777.96	-473.9610769	
A #2	30000	25466		34.78%	3047	9/26/2026	19%	1672	12/3/2036	4264.30	1924.323213	
B #1	30000	3305		0.00%	0							
B #2	30000	20700		0.00%	0							
C #4	35000	30316		97.00%	8497	10/19/2025	97%		5/24/2026			
C #5	45000	29759		98.49%	8628	1/5/2027	98%		1/9/2027			
C #6	45000	35684		93.48%	8189	5/21/2026	93%		7/7/2026			
D #1	36000	23488		54.09%	4738	11/20/2027	53%	4643	10/20/2028	1298.11	26.08281498	
D #2	45000	23120		96.88%	8487	10/28/2027	98%	8585	10/18/2027	930.27	-10.71999673	
D #3	45000	26506		87.33%	7650	8/31/2027	98%	8585	5/27/2027	786.31	-96.08394024	
D #4	45000	20104		96.68%	8469	3/8/2028	86%	7534	7/20/2028	1206.20	133.2248117	
E #1	30000			0.00%	0							
F #1	30000	10480		21.43%	1877	8/22/2035			8/17/2043	1#	1 Second	ON: Second OFF
F #2	30000	10218		17.45%	1529	3/6/2038			12/25/2047			
G #1	33000	22477		9.38%	822	1/15/2038			8/18/2052	J #.	2 Last ON	; FIRST OFF
G #2	30000	5204		2.45%	215	7/2/2140			3/23/2210) #	3 First ON	I: Last OFF
H #1	30000	10449		7.01%	614	1/25/2057			610	$\sqrt{2}$		
H #2	30000	7710		8.63%	756	9/17/2054			10/2074			
J #1	45000	10396		83.14%	7283	12/30/2029	76%		6/11/2030	1897.15	162.9104849	
J #2	32000	10651		76.28%	6682	6/10/20	70%	JI32	7/17/2029	1568.39	129.0954911	
J #3	33500	18333		84.69%	$\langle \rangle$	4	98%	8585	10/9/2027	921.22	-144.7571906	
K #1	30000	25833		0.00%	2	244%						
K #2	30000	24743		0.00%	0							
K #3	30000	23491		0.00%	0							
L #1	40000	21571		97.93%	8579	5/25/2027	90%	7924	7/19/2028	1205.81	92.00524146	
L #2	45000	21681		91.29%	7997	2/29/2028	98%	8585	12/18/2027	991.45	-72.87441655	connect
L #3	45000	27673		97.24%	8518	4/13/2027	98%	8585	4/7/2027	736.69	-5.777299532	

Challenge (cont'd)

- Developed the ideal unit sequencing configuration for each site
 - U1 First ON, Last OFF; U3 Last ON, First OFF, etc
 - Provided recommendations to Ops and OCC
- Monthly Review of runtime data
 - Manually updated spreadsheet with current engine hours
 - OEM software that required manually selecting units, tags, and timeframe.



Challenge

It would be nice if, within one platform, we could...

- view engine hours and unit statuses
- view automatically updated runtime visuals any time for any station.
- improve our reaction time to an undesirable station operating configuration.
- quickly determine who can best rectify the undesirable configuration—Field Operations or Operations Control Center (OCC)



Solution – Hours, Statuses, & Automatically Update



10

Solution – Who to Contact

- OCC or Field Ops?
- Status
 - Starting
 - Stopping
 - Available
 - Unavailable
 - On-Remote
 - On-Local
 - Error



Solution – Contact	OCC	Edit Notificat 🛣 🤇	Overview » Identify » Value Search	7
U3: First ON, Last OFF		Condition: Unit 3 Subop Schedule: Every 15 minu Server load may impact	Unit 3 Suboptimal > 2h	+:
M Trend M Trend M Calendar Capsule Compare One Lane One Y-Axis Ra fx	Unit 3 Desired	Additional email conter	Unit 3 Sub-Optimal (h) COLKWPDMZPIAF_AFDB * Pipelines * REX * Co mpressor Stations * Unit 1	~
Va	riables ame Item	#3 has been ir This configuration do See more information <u>based</u>	Select a search type ⊘ Simple ○ Advanced	
\$a 6 \$k	Dit 1 Ru COLKWPDM Stations » Unit 2 Ru Unit 2 Ru	Include capsule proper Start	> greater than	
Sting Sting Onote Avble Sting	Z COLKWPDM Stations » Unit 3 Ava COLKWPDM Stations »	 End Duration Asset Full Path 	2	A v∙
Sting Onote Avble Sting Onote	rmula ⑦	Custom property	 Ignore short capsules/gaps 	i i
Avble 3:00 pm 6:00 pm 9:00 pm 12/28/2024 1:44 PM MS1	<pre>1 \$a.intersect(\$ 2 or \$b.intersec</pre>	John Spelic × Sn	Cancel Execute	-
2			conne	at

Solution—Improved Reaction Time

_						4	//	8.14	an a				
SA S	eeq Alerts <a< th=""><th>lerts@seeq.com</th><th>></th><th></th><th>9</th><th>S Reply</th><th>Reply All</th><th></th><th>orward</th><th></th><th></th></a<>	lerts@seeq.com	>		9	S Reply	Reply All		orward				
	🛛 🥝 Spelic, John	; 🛑 Sneed, James							Sun 12/2	9/2024 3	:00 AM		
i You replie	d to this messag	e on 12/29/2024 9:40 how this message is	AM. displayed. click	chere to view it in a web browser.									
EXTERNAL: This email originated from an external source. Only open attachments or click on links if you are expecting them. Report any suspicious emails using Phish Alert on													
your email toolbar.													
The Discost state 1		****							- 11	2	a 9		
######################################	as been in "Av	ailable" status fo	or two hours	while another a set on the runnin	ig. Th	is configura	tion does not s	upport	Tallgra	ss' ove	rhaul		
optimizatio	n goals.												
See more in	formation in	Seeq: <u>REX Turbi</u>	ne Overhau	l Optimizer Alerts - 💶 🛛 #3 FonLoff	Avail	-based							
		1224											
New capsu	les detecte	d for Unit 3 Sul	ooptimal≍	> 2h:									
Start	End	Duration	Asset	Full Path									
Dec 29,	Dec 29,		Unit 1,	COLKWPDMZPIAF_AFDB >> Pipel	ines >	> REX >> Col	mpressor Stati	ons >> 📗		-> Unit	1,		
2024	2024	00:00:00.000	Unit 2,	COLKWPDMZPIAF_AFDB >> Pipeli	ines >	> REX >> Col	mpressor Stati	ons >> 🛛	is. Annual >	> Unit	2,		
12:54 AM	12:54 AM		Unit 3	COLKWPDMZPIAF_AFDB >> Pipel	ines >	-> REX -> Co	mpressor Stati	ons >>	inital:	>> Unit	3		
NOTE: The s	tart time, end	d time, and any p	property for	the rows listed in italics are subject	ct to c	hange.							





Results

Now we can...

- view engine hours and unit statuses in one platform
- view automatically updated runtime visuals any time for any station.
- improve our reaction time to an undesirable station operating configuration.
- quickly determine who can best rectify the undesirable configuration—Field Operations or Operations Control Center (OCC)



Results

	2025	2026	2027	2028	2029	2030	Total
Unmanaged Overhaul Projection before Seeq	2	5	4	1	2	1	15

	2025	2026	2027	2028	2029	2030
Unmanaged Overhaul Projection before Seeq	2	5	4	1	2	1
Managed Overhaul w/Seeq Current Projection	1	4	4	2	2	2
Managed Overhaul w/Seeq Targeted Projection	1	3	3	3	3	2

	2025	2026	2027	Total
Savings (Millions) Unmanaged - Current	\$3	\$3	\$ 0	\$6
Savings (Millions) Unmanaged - Targeted	\$3	\$6	<mark>\$</mark> 3	\$12

\$6M savings already achieved / extremely likely for 2025-2026 \$12M savings possible and likely for 2025-2027!



Results

Why does shifting overhaul costs matter?

- Levelized costs benefit Tallgrass
 - Stable financial planning and risk management is attractive to investors.
 - Better overall strategic decision making and long-term sustainability.
 - Ability to invest short-term savings in other parts of the business.



Next Steps

Convert spreadsheet to Seeq Organizer

					Current	Strategy	Prior St	rategy			Scenarios		
				hours									
	Current OH	Hous as	rolling 12 mo	last 12	Projected	Modified OH	Adjusted OH	Adjusted	Solve	Solve For		Maximize	
Unit	Threshold	of 9/18	average	months	OH Date	Threshold	Threhshold	OH Date	For %	Hours	Solve for OH Date	OH Date	Delta (days)
A #1	40500	13177	58.88%	5158	7/17/2030	45000	45000	5/31/2031	75%	6533	2/11/2030	1777.96	-473.9610769
A #2	30000	25466	34.78%	3047	9/26/2026	45000	45000	8/27/2031	19%	1672	12/3/2036	4264.30	1924.323213
B #1	30000	3305	0.00%	0		45000	45000						
B #2	30000	20700	0.00%	0		45000	45000						
C #4	35000	30316	97.00%	8497	10/19/2025	40050	40050	5/24/2026	97%		5/24/2026		
C #5	45000	29759	98.49%	8628	1/5/2027	45000	45000	1/5/2027	98%		1/9/2027		
C #6	45000	35684	93.48%	8189	5/21/2026	46000	45000	5/21/2026	93%		7/7/2026		
D #1	36000	23488	54.09%	4738	11/20/2027	40000	40000	9/24/2028	53%	4643	10/20/2028	1298.11	26.08281498
D #2	45000	23120	96.88%	8487	10/28/2027	45000	45000	10/28/2027	98%	8585	10/18/2027	930.27	-10.71999673
D #3	45000	26506	87.33%	7650	8/31/2027	45000	45000	8/31/2027	98%	8585	5/27/2027	786.31	-96.08394024
D #4	45000	20104	96.68%	8469	3/8/2028	45000	45000	3/8/2028	86%	7534	7/20/2028	1206.20	133.2248117
E #1	30000		0.00%	0		45000	45000						
F #1	30000	10480	21.43%	1877	8/22/2035	45000	45000	8/17/2043			8/17/2043		
F #2	30000	10218	17.45%	1529	3/6/2038	45000	45000	12/25/2047			12/25/2047		
G #1	33000	22477	9.38%	822	1/15/2038	45000	45000	8/18/2052			8/18/2052		
G #2	30000	5204	2.45%	215	7/2/2140	45000	45000	3/23/2210			3/23/2210		
H #1	30000	10449	7.01%	614	1/25/2057	45000	45000	6/25/2081			6/25/2081		
H #2	30000	7710	8.63%	756	9/17/2054	45000	45000	7/16/2074			7/16/2074		
J #1	45000	10396	83.14%	7283	12/30/2029	45000	45000	12/30/2029	76%	6658	6/11/2030	1897.15	162.9104849
J #2	32000	10651	76.28%	6682	6/10/2028	37000	37000	3/10/2029	70%	6132	7/17/2029	1568.39	129.0954911
J #3	33500	18333	84.69%	7419	4/17/2027	40000	40000	3/1/2028	98%	8585	10/9/2027	921.22	-144.7571906
K #1	30000	25833	0.00%	0		45000	45000						
K #2	30000	24743	0.00%	0		45000	45000						
K #3	30000	23491	0.00%	0		45000	45000						
L#1	40000	21571	97.93%	8579	5/25/2027	47750	47750	4/18/2028	90%	7924	7/19/2028	1205.81	92.00524146
L#2	45000	21681	91.29%	/997	2/29/2028	45000	45000	2/29/2028	98%	8585	12/18/2027	991.45	-/2.8/441655
L #3	45000	27673	97.24%	8518	4/13/2027	45000	45000	4/13/2027	98%	8585	4/7/2027	736.69	-5.777299532
M #1	30000		15.59%	1366	3/13/204/	45000	45000	3/3/2058			3/3/2058		
M #2	30000		0.09%	8	10/4/5//2	45000	45000	////646			/////646		
N #1	30000		0.00%	0		45000	45000						
N #2	30000	11050	0.00%	0		45000	45000						
0#1		11859	#N/A	#N/A		45000	45000						
U #2		15214	#N/A	#N/A		45000	45000						

	2025	2026	2027	2028	2029	2030	Total	
Unmanaged Overhaul Projection before Seeq	2	5	4	1	2	1	15	
Managed Overhaul w/Seeq Current Projection	1	4	4	2	2	2	15	nnear
Managed Overhaul w/seeq Targeted Projection	1	3	3	3	3	2	15	meq



18

connect

Questions?



connect

Thank You