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Heavy Oil

Controlled Document

Quest CCS Project

Quest Operating Reliability Data Start-up to 2015 Year End

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1	Feb 22, 2016	Comments Incorporated	Josip Vaci	Patrick Allen Brian Licis Stephen Tessarolo Scott Cornelius	
2	Nov 30, 2016	Clarifications on Failure Rate and causes of failure	Josip Vaci		

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Date	Role	Name	Signature or electronic reference (email)
Feb 22, 2016	Reliability Engineer	Josip Vaci	Feb 22, 2016 email

Summary

The unplanned downtime from startup on Aug 23, 2015 to Dec 31, 2015, was 1.3% (or 98.7% availability). The planned downtime was 0.4% for the same period. Line Block Valve 3 and C-24701 anti-surge valve functional failures were the causes of the unplanned downtime. Component failure rate for pumps averaged 3.1 years Mean Time Between Failures, while CO2 Compressor availability was 100% during the same operating period.

Keywords

Reliability, Unplanned Downtime, Planned Downtime, Availability, Unexpected, Expected, Component Failure Rate, MTTF, MTBF

None

Detailed Report - Actual Operating Data

This report seeks to document actual Quest Carbon Capture operating unit availability and component failure rate data from Quest startup on Aug 23, 2015 to year end, Dec 31, 2015.

The unplanned downtime (unexpected down-time) during the initial 130 day operating period was 1.3% (or 98.7% availability) compared with a predicted availability of 95.4%[1]. Unplanned downtime was caused by Line Block Valve 3 failing closed due to low battery voltage and C-24701 anti-surge valve opening, causing compressor to run on recycle with subsequent trips of the pipeline.

The planned downtime (expected down-time) was 0.4% during the 2015 operating period. A 12-hour planned outage was taken to replace UV-24701 positioner (C-24701 anti-surge valve), as well as a compressor casing drain leak repair.

Component failure rate for process pumps[2] achieved an overall MTBF of 3.1 years, and due to spared operation did not lead to unit unplanned downtime. C-24701 compressor availability[5] was 100% during the 2015 operating period while Flue Gas Recycle machines in HMU1,2,3 (C-24103, C-24203, C-44105) achieved 99.5, 99.8, 99.9% availability[5], respectively.

A listing of equipment can be seen below in Table 1. Significant components are listed, basis the modeling study[1] along with some additional components including non-critical auxiliary pumps.

None

Table 1 – Quest Carbon Capture Component[4] Failure Data for operating period Aug 23, 2015 to Dec 31, 2015.

CO2 Capture Unit Equipment	Tag ID	MTBF[2,3,5]	Failure Rate[6]	Comments
Amine Absorber #1	V-24118	no failures	0	
Absorber #1 Water Wash Vessel	V-24119	no failures	0	
Absorber #1 Circulating Water Pump	P-24108A	0.4 yrs	2.8 per year	Bearing isolator misalignment, causing noise and vibration. Repaired isolator.
Absorber #1 Circulating Water Pump	P-24108B	no failures	0	
Absorber #1 Circulating Water Cooler	E-24129	no failures	0	
Amine Absorber #2	V-24218	no failures	0	
Absorber #2 Water Wash Vessel	V-24219	no failures	0	
Absorber #2 Circulating Water Pump	P-24208A	no failures	0	
Absorber #2 Circulating Water Pump	P-24208B	no failures	0	
Absorber #2 Circulating Water Cooler	E-24229	no failures	0	
Amine Absorber #3	V-44118	no failures	0	
Absorber #3 Water Wash Vessel	V-44119	no failures	0	
Absorber #3 Circulating Water Pump	P-44108A	0.4 yrs	2.8 per year	Bearing isolator misalignment, causing noise and vibration. Repaired isolator.
Absorber #3 Circulating Water Pump	P-44108B	no failures	0	
Absorber #3 Circulating Water Cooler	E-44129	no failures	0	
Lean/Rich Amine Exchangers	E-24602A	no failures	0	
Lean/Rich Amine Exchangers	E-24602B	no failures	0	
Amine Stripper	V-24601	no failures	0	
Stripper Reboiler	E-24603A	no failures	0	
Stripper Reboiler Condensate Pot	V-24603A	no failures	0	
Stripper Reboiler	E-24603B	no failures	0	
Stripper Reboiler Condensate Pot	V-24603B	no failures	0	
Lean Amine Pump	P-24601A	no failures	0	
Lean Amine Pump	P-24601B	no failures	0	
Lean Amine Pump	P-24601C	no failures	0	
Stripper Overhead Condenser	E-24601A	no failures	0	
Stripper Overhead Condenser	E-24601B	no failures	0	
Stripper Reflux Drum	V-24602	no failures	0	
Stripper Reflux Pump	P-24603A	no failures	0	
Stripper Reflux Pump	P-24603B	no failures	0	
Lean Amine Cooler	E-24604A	no failures	0	
Lean Amine Cooler	E-24604B	no failures	0	
Lean Amine Trim Cooler	E-24605A	no failures	0	
Lean Amine Trim Cooler	E-24605B	no failures	0	
Lean Amine Charge Pump	P-24602A	no failures	0	
Lean Amine Charge Pump	P-24602B	no failures	0	
Lean Amine Charge Pump	P-24602C	no failures	0	
Stripper Inlet Valve 1		no failures	0	
Stripper Inlet Valve 2		no failures	0	
AMINE RE-INVENTORY PUMP	P-24604	no failures	0	
AMINE MAKE-UP PUMP	P-24605	no failures	0	
AMINE DRAIN PUMP	P-24607	no failures	0	
P-24608A REC CLEAN COND PUMP	P-24608A	0.4 yrs	2.8 per year	Bearing isolator misalignment, causing noise and vibration. Replaced isolator.
P-24608B REC CLEAN COND PUMP	P-24608B	no failures	0	
P-24609A WATER MKUP PUMP	P-24609A	no failures	0	

None

CO2 Capture Unit Equipment – cont'd	Tag ID	MTBF[2,3,5]	Failure Rate[6]	Comments
P-24609B WATER MKUP PUMP	P-24609B	no failures	0	
P24610A DEMIN PUMP	P-24610A	no failures	0	
P24610B DEMIN PUMP	P-24610B	no failures	0	
P-24611A COOLING WATER BOOSTER PUMP	P-24611A	no failures	0	
P-24611B COOLING WATER BOOSTER PUMP	P-24611B	no failures	0	
CO2 Compression & Dehydration System Equipment				
6th Stage Cooler Fan/Motor	E-24706-1	no failures	0	
6th Stage Cooler Fan/Motor	E-24706-2	no failures	0	
6th Stage Cooler Fan/Motor	E-24706-3	no failures	0	
CO2 8-Stage Compressor Driver	C-24701	no failures[5]	0	Multiple trips of pipeline caused by UV-24701 [C-24701] anti-surge valve opening, with compressor running on recycle.
Compression 1st Stage Cooler	E-24701	no failures	0	
Compression 2nd Stage Cooler	E-24702	no failures	0	
Compression 3rd Stage Cooler	E-24703	no failures	0	
Compression 4th Stage Cooler	E-24704	no failures	0	
Compression 5th Stage Cooler	E-24705	no failures	0	
Compression Aftercooler Fan/Motor	E-24707A-1	no failures	0	
Compression Aftercooler Fan/Motor	E-24707A-2	no failures	0	
Compression Aftercooler Fan/Motor	E-24707A-3	no failures	0	
Compression Aftercooler Fan/Motor	E-24707B-1	no failures	0	
Compression Aftercooler Fan/Motor	E-24707B-2	no failures	0	
Compression Aftercooler Fan/Motor	E-24707B-3	no failures	0	
Compressor	C-24701	no failures	0	
Compressor 2nd Stage KO Drum	V-24702	no failures	0	
Compressor 3rd Stage KO Drum	V-24703	no failures	0	
Compressor 4th Stage KO Drum	V-24704	no failures	0	
Compressor 5th Stage KO Drum	V-24705	no failures	0	
Compressor 6th Stage KO Drum	V-24706	no failures	0	
Compressor 7th Stage KO Drum	V-24707	no failures	0	
Compressor 8th Stage KO Drum	V-24708	no failures	0	
Compressor Suction KO Drum	V-24701	no failures	0	
Lean TEG Cooler	E-24804A	no failures	0	
Lean TEG Cooler	E-24804B	no failures	0	
Lean TEG Cooler	E-24804C	no failures	0	
Lean TEG Cooler	E-24804D	no failures	0	
Lean TEG Cooler	E-24804E	no failures	0	
Lean TEG Filter	V-24804A	no failures	0	
Lean TEG Filter	V-24804B	no failures	0	
Lean/Rich TEG Exchanger	E-24803	no failures	0	
TEG Absorber	V-24801	no failures	0	
TEG Flash Drum	V-24803	no failures	0	
TEG Inlet Scrubber	V-24707	no failures	0	
TEG Lean Pump	P-24801A	no failures	0	
TEG Lean Pump	P-24801B	no failures	0	

None

CO2 Compression & Dehydration System Equipment – cont'd	Tag ID	MTBF[2,3,5]	Failure Rate[6]	Comments
TEG Stripper	V-24802	no failures	0	
TEG Stripper Condenser	E-24801	no failures	0	
TEG Stripper Reboiler	E-24802	no failures	0	
TEG Stripper Reboiler Condensate Pot	V-24805	no failures	0	
TEG Surge Drum	V-24806	no failures	0	
Pipeline Injection Equipment				
Line Block Valve 1	LBV1	no failures	0	
Line Block Valve 2	LBV2	no failures	0	
Line Block Valve 3	LBV3	0.4 yrs	2.8 per year	Fail closed due to low battery voltage. Solar charger and battery bank inadequately sized in terms of accounting for environmental conditions, system energy loss, accurate solar radiance data, and battery de-rating factors.
Line Block Valve 4	LBV4	no failures	0	
Line Block Valve 5	LBV5	no failures	0	
Line Block Valve 6	LBV6	no failures	0	
CO2 Particle Filter	S-70201	no failures	0	
CO2 Particle Filter	S-70202	no failures	0	
CO2 Particle Filter	S-70203	no failures	0	
Well Site #1		no failures	0	
Well Site #2		no failures	0	
Well Site #3		no failures	0	
Non-Critical and Auxilliary Pumps				
P-24606 ANTI FOAM INJECTION PUMP	P-24606	no failures	0	
SP-246026 SAFETY SHOWER	P-246101	no failures	0	
STORM WATER PUMP	P-24612	no failures	0	
LUBE OIL PUMP MOUNTED ON COMPRESSOR	P-24701	no failures	0	
SCE-AUXILIARY OIL PUMP FOR LUBE OIL SKID	P-24702	no failures	0	
HYDRAULIC PUMP	P-24703	no failures	0	
MANUAL HYDRAULIC PUMP	P-24704	no failures	0	

References and Notes

[1] Reliability, Availability and Maintainability Report addressing

sparing, RRM and turndown – Doc No. 07-0-NA-8239-0002 – Aaron Balaban - Issued 2014-08-22

[2] Following Shell methodology, auxiliary pump failure data is not utilized when calculating overall pump MTBF (Mean Time Between Failures), but is presented in this report for additional information. Pump MTBF excludes any repairs to driver, auxiliary lube oil skid, process control systems, and process and utility piping. Failures of excluded components that translated into shutdown or slowdown greater than 25% unit capacity to be reported in Table 1 in the adjacent 'Comments' section (none in 2015 operating period).

[3] For vessels, exchangers, fan/motors (everything except pumps, compressor), MTBF is taken to mean functional failure of equipment, necessitating shutdown or a slowdown greater than 25% of unit capacity in order to repair.

[4] Component taken to mean equipment plus typical instrumentation (level alarms, pressure control, high temperature, etc.), in order to represent overall reliability figure.

[5] Following Shell methodology, compressor availability excludes any repairs to driver, process control systems, process and utility piping. Failures of excluded components that translated into shutdown or slowdown greater than 25% unit capacity are reported in Table 1 in the adjacent 'Comments' section.

[6] Failure rate expressed as failures per year, (1 divided by MTBF).