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POLICY

APA Group

Transmission Operations

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RBP Compressor Operating Philosophy

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1 INTRODUCTION

1.1 Overview

The Roma Brisbane Pipeline consists of approximately 400km of DN250 pipeline fully looped with DN400 pipeline.

The DN400 pipeline originally had three Solar S20 compressors at Condamine, Dalby (unit 1) and Gatton and an MAOP of 8MPa which was upgraded to 9.6MPa MOP in 2012 along with the addition of a Solar C50 compressor at Dalby (unit 2) compressor station. The RBP DN250 pipeline has MAOP of 7.136MPa and three Solar S20 compressors at Yuleba, Oakey and Kogan. In 2015, the Yuleba, Condamine, Dalby unit 1 and Gatton compressors were decommissioned.

This has resulted in the RBP currently operating with only Dalby unit 2 on RBP DN400 pipeline, and Oakey and Kogan compressors on the DN250 pipeline.

1.2 Purpose of Report

The purpose of this report is to outline the high level compressor operating strategy and maintenance philosophy of the Roma Brisbane Pipeline system. The operating strategy and maintenance philosophy is based on pipeline throughput and contractual MDQ's current as of November 2015. This document needs to be updated if and when the operating conditions of the RBP undergo any significant changes which could affect the operating hours or loading of the compressors. Changes in conditions can include an increase or decrease in pipeline flowrates, upgrades or limitations on pipeline MOP, and significant changes in gas quality or temperatures. In general, a minimum of five year review is recommended.

1.3 Compressor Equipment

The table below provides an overview of the compressors currently installed on the RBP. This operating philosophy is based on operation of Dalby unit 2, Oakey and Kogan compressors only. The decommissioned compressors are excluded from the scope of this report.

Table 1: RBP Compressor Details

	Decommissioned				Retained for Operation		
Compressor	Yuleba	Condamine	Dalby Unit 1	Gatton	Dalby Unit 2	Oakey	Kogan
Pipeline	RBP DN250	RBP DN400	RBP DN400	RBP DN400	RBP DN400	RBP DN250	RBP DN250
Engine Model	T1602 Solar Turbine Saturn 20 engine	T1602 Solar Turbine Saturn 20 engine			Solar Turbine Centaur 50 engine	T1602 Solar Turbine Saturn 20 engine	
Compressor Model	Solar C168	Solar C160			Solar C33-2	Solar C168	
Capacity	1.2MW	1.2MW			4.0-6.0 MW	1.2MW	
Compression Ratio	1.0-1.5	1.0-1.5			1.5-2.0	1.0-1.5	
Staging	3DT, 3DT, 3CE	1ET, 1EE			2C, 1C	3DT, 3DT, 3CE	
Compressor Hours (May	4,618	20,779	68,950	15,584	19,749	45,738	15,821

31st 2015)							
Power Turbine Hours (May 31st 2015)	15,446	Turbine removed	50,473	7,774	19,749	38,408	36,612
Package Hours (May 31st 2015)	138,090	164,086	220,711	124,102	19,749	208,378	170,241

This report covers the operation and maintenance of the compressor package consisting of the turbine engine, gas compressor, electrical control system, and ancillaries such as lube and seal oil system, air compressors, dry gas seal (Dalby unit 2), fuel and start gas systems.

1.4 Commercial Requirements of Pipeline

The average throughput of the RBP Pipeline as of mid-2015 is 147 TJ/day. The peak flowrate in the first half of 2015 was 216 TJ/day, due to Oakey Power station taking 77TJ/day. Oakey Power station has a firm plus interruptible supply contract with APA. Firm MDQ is around 30TJ/day and can be supplied without compression on RBP. Compression will be required when Oakey takes firm and interruptible service for more than two days consecutively. The flow throughput has been falling due to Swanbank Power station going offline in 2014, and BP has now ramped down flows to almost 0 TJ/day.

However BP still has a contractual MDQ of 35-40 TJ/day until 2021, which BP can sell or swap to other customers on the RBP pipeline. Swanbank is expected to start taking gas from Dec 2017 at MDQ of 52 TJ/day. Hence, while the RBP may be experiencing lower flow throughput at present, it needs to maintain its capacity to supply more gas in the next few years. This requires the pipeline to maintain the integrity of its compressors.

2 OPERATING PHILOSOPHY

This section gives a general overview of the normal mode of operation of the RBP Pipeline system and compressors by APA's system controllers in the Integrated Operating Centre (IOC) in Brisbane.

2.1 Pipeline Operation

The RBP DN400 pipeline receives gas at the inlet station Wallumbilla (RBP) from Run 3. The pipeline is controlled based on pressure control at the inlet of Wallumbilla Run 3. Currently there is no flow to the DN400 pipeline via Run 4 but can supply gas in future. Flowrates from run 7 Spring Gully to RBP DN400 vary between 10 – 70TJ/day.

RBP DN400 pipeline also receives gas at Windibri, Argyle and Kogan North. The gas receipts at this station are at a higher pressure, and are able to supply the pipeline steadily. Gas is also received to the pipeline at Arubial inlet from the Peat Lateral. The supply to DN400 pipeline from Arubial is also steady, but there is an option to back off supply at Arubial if required due to the ability of Peat Lateral to store linepack for limited durations.

RBP DN250 pipeline currently does not receive any gas from Run 2 at Wallumbilla, but receives gas from the DN400 interconnect (Run 6) on pressure control. Run 1 is now supplying gas to RBP DN250 when AGL recommission the LPG plant.

The RBP pipeline system is normally controlled based on the discharge pressures at Bellbird Park and Ellengrove gate station, where a minimum discharge pressure, usually 4.3MPa, is maintained at both stations.

Additionally, Oakey Power station supply pressure needs to be at or above the contractual minimum of 3500kPa, and Gibson Island meter station at the end of the RBP Metro needs to be at or above a practical operating minimum of 2300kPa.

Gas is supplied to shippers on the RBP on flow control. Refer to section 1.4 for more details on RBP's commercial flowrate obligations.

2.2 Compressor Operation

The compressors are normally operated on discharge pressure control by the systems controllers. The compressors are operated so as to be able to maintain supply to Bellbird Park and Ellengrove gate station, at a minimum pressure of 4.3MPa normally, or as required. There is no flow control option on any of the compressors for systems controllers. However each compressor has an anti-surge control system whereby the anti-surge control valve will be opened at low flowrates at high suction pressures, in order to prevent the compressor from operating near the surge margin. The compressors have minimum suction pressure over-rides. The compressors also have low differential pressure, high discharge temperature and high discharge pressure shutdowns.

As Swanbank Power station has gone offline at present, the RBP Pipeline system operates with no compression, in general. Dalby compressor operates only when Oakey Power station receives gas above MDQ for more than one day consecutively. Kogan and Oakey compressors operate only when Dalby unit 2 compressor is offline for maintenance while Oakey Power station gas throughput is high.

Kogan and Oakey compressors operate together only, as the flow scenarios only require them to be in operation at the same time, or not at all. Kogan and Oakey compressors are not required to operate while Dalby unit 2 is operating.

It has been determined from flow modelling performed on Flowtran software that none of the compressors are critical to the operation of the RBP Pipeline system at current flowrates.

3 COMPRESSOR MAINTENANCE PHILOSOPHY

3.1 Compressor Classification

The Enterprise Asset Management (EAM) project has set out to standardise the maintenance regimes on all Solar turbine compressor packages throughout APA Group nation-wide. The EAM maintenance regime has sought to classify compressor packages based on their level of utilisation annually, and to prescribe maintenance strategies to suit the number of hours in operation each year. This would ensure that Solar turbines in infrequent usage are still adequately maintained even if the 4000 or 8000 hours of service (which would normally trigger servicing requirements), has not been reached yet.

The compressors in operation throughout APA have been classified as Master equipment, Intermittent equipment or Standby equipment. Master equipment refers to compressors in continuous operation and which operate more than 4000 hours per year. Intermittent equipment refers to compressors in low or intermittent usage, and which operate less than 4000 hours per year. Standby equipment refers to compressors which are only required for standby, and which are operate very few hours annually.

The Dalby Unit 2 compressor fits the profile of intermittent equipment as it is in operation less than 4000 hours per year. The Oakey and Dalby compressors fit the profile of Standby equipment. The EAM maintenance regimes come into effect from October 2015 on the RBP pipeline and equipment.

Table 2: Compressor classification

Operating Duty Classification	Compressors (RBP)	Minimum Hours	Maximum Hours
Master	Nil	4,000	-
Intermittent	Dalby Unit 2	1,000	3,999
Standby	Oakey and Kogan	-	999

Any significant changes to operating parameters on the RBP Pipeline should trigger a Management of Change (MOC) request by IOC which will require review of the compressor classification.

3.2 Turbine Overhauls Strategy

APA is a participant of the Solar Engine Exchange program, which allows a turbine due for overhaul to be replaced by an exchange engine provided by Solar, resulting in minimisation of downtime. Solar recommended unit overhaul is at every

30,000-35,000 hours of service depending on the model. However APA has decided on targeting overhaul at every 50,000 hours for all Solar units, subject to satisfactory results from condition monitoring by Engineering, which will commence at 32,000 hours of service. The implications of deviating from manufacturer recommended overhaul hours need to be investigated further with the OEM. The compressor disc has a service life of 120,000 hours and APA Group needs to ensure this is not exceeded on any of its units on the RBP while overhaul is being delayed further than the manufacturer recommended 30,000 hours of service.

Both Oakey and Kogan have been in operation for over 32,000 hours of service at present, and are subject to condition monitoring. Refer to section 3.4 for more details on condition monitoring.

3.3 Maintenance Regimes

As of October 2015, Dalby unit 2 will be maintained as per the maintenance regime for intermittent equipment, PL-M-20275. Minor services, normally conducted at 4000 hours for continuously operating compressors, will be conducted annually on Dalby unit 2 compressor. Medium services normally conducted every 8000 hours on continuously operating compressors will be conducted once every four to five years.

As of October 2015, Kogan and Oakey compressors will be maintained as per the maintenance regime for standby equipment, PL-M-20276. Minor services, normally conducted at 4000 hours for continuously operating compressors, will be conducted every two years on the Kogan and Oakey compressor units. Medium services normally conducted every 8000 hours on continuously operating compressors will be conducted once every four to five years.

Additionally all three compressors will be started up least once a month to rotate engine at a set speed and power and simple checks performed on the turbine performance, start and fuel gas systems, electrical control system, lube oil and seal systems.

The Work Instructions for overhaul and maintenance of the compressors can be found on the Hub, http://thehub.apa.com.au/workareap/transops/Transmission%20Documents/Regional/Forms/EAM%20Work%20Instruction%20by%20Asset.aspx?Paged=TRUE&p_GroupCol1=Mondara%20Facilities&PageFirstRow=31&&View=%7b6B404C99-C03A-4F07-A5C1-CA53FDD83C61%7d

3.4 Condition Monitoring

At present, APA performs condition monitoring of the compressor lube oil, and results are sent to the RBP's rotating specialist engineer. Annual compressor vibration surveys are conducted on Oakey and Kogan compressors. Vibration data from the Dalby Centaur compressor is downloaded for analysis on an annual basis. No regular diagnostic assessments of key performance parameters nor borescope inspections are performed on any of the compressors. Due to the infrequent operation of the RBP compressors, and relatively good reliability of the units whilst in service, a more sophisticated condition monitoring program is not required at this stage. However once the 32,000 hours of service has been exceeded, condition monitoring strategy has to be implemented.

3.5 Spare Philosophy

At present, a low hour T1602 Solar Turbine Saturn 20 engine, previously installed at Condamine compressor station, has been installed at Yuleba. Yuleba's original turbine was overhauled by Solar and is now stored at a Maintenance Base on RBP. However this turbine has not been preserved with nitrogen or desiccants as recommended by Solar but have been stored securely in their original packaging from Solar.

APA has commissioned the Transmission National Inventory project. As part of this project a nation-wide stocktake of inventories was conducted. These inventories have been transferred to Maximo, and are available in Queensland. It is recommended that APA's Queensland transmission and engineering groups devise a compressor spares strategy, to determine which Solar recommended spares to maintain locally on site, and which spares to obtain from the National inventory as and when required.

4 SERVICE AGREEMENTS

APA is currently in the process of arriving at an alliance partnership with Solar Turbines which gives APA access to enhanced technical support from Solar staff with respect to achieving better operational and fleet management strategy.

5 REFERENCES

Reference	Title / Description
	20150319 RBP Compressor Meeting Minutes
	Design Note- RBP Compressor Criticality
PL-M-20275	Solar Gas Turbine/Compressor Intermittent Equipment Maintenance Regime
PL-M-20276	Solar Gas Turbine/Compressor Standby Equipment Maintenance Regime
RB-PL-LOP-Q-001	RBP DN250 and DN400 Pipeline Schematic
RB-PL-LOP-Q-002	RBP Brisbane Metro Area Pipeline Schematic

6 ABBREVIATIONS / DEFINITIONS

The following abbreviations and definitions are used in this report.

Abbreviation	Description
BP	British Petroleum Refinery (Shipper)
C50	Solar Centaur 50
DN	Nominal Diameter
EAM	Enterprise Asset Management project
IOC	Integrated Operations Centre
MDQ	Maximum Daily Quantity
MOC	Management of Change (in Maximo)
MOP	Maximum Operating Pressure
OEM	Original Equipment Manufacturer
RBP	Roma Brisbane Pipeline
S20	Solar Saturn 20

7 REVISION HISTORY

Revision	Date	Amendment	Prepared by
0.1	7/12/2015	Issued for Approval	P Ranga
1.0	05/02/2016	Approved - Issued for Use	P Ranga