APA Group

Compressor Strategy

AA3 (2008 to 2012)

AA4 (2013 to 2017)

Mar 2012

Contents

1.0 Introduction

This document sets out the compressor strategy to support the Regulatory Reset (Access Arrangement 4: 2013 to 2017). It details the current and proposed operations at the existing compressor station sites at Gooding, Wollert, Springhurst, Brooklyn, and Iona. Details of the facilities and proposed augmentation of the existing five Victorian compressor stations are also presented, along with the compression facilities proposed to be installed at Stonehaven or Winchelsea (South Western System) and Euroa (Northern System).

It should be noted that the industry is entering a period of uncertainty regarding the impact of carbon pricing, particularly as it relates to the growth of gas-fired power generation (GPG) in Victoria. These potentially major developments may require additional significant pipeline augmentation which generally has the effect of radically changing requirements for compression and are not considered in this document.

The capital program presented is therefore focused primarily on the compression requirements to meet the underlying *medium* gas demand and growth outlook as presented in the AEMO “VAPR for 2012” and “GSOO 2011” with the following security-of-supply gas pipeline investments:

AA3	Rockbank to Plumpton	DN500 (WORM Stage 1)
AA4	Wollert to Kalkallo	DN500 (WORM Stage 2)
AA4	Wollert to LV3	DN450 (Northern Expansion)
AA4	Plumpton to Kalkallo	DN500 (Worm Stage 3)

Further detail on the basis of system augmentation is presented in the System Planning Strategy.

2.0 Description of Existing Facilities

APA GasNet owns and maintains compressor stations as part of the Service Envelope Agreement (SEA) with AEMO at Gooding, Brooklyn, Iona, Wollert and Springhurst. AEMO remotely operate the compressor stations.

Sufficiently large parcels of land surround most of the stations to facilitate expansion, with the exception of Brooklyn facilities which have become badly congested. Brooklyn has a large number of compressors, regulators and pipelines on the site and has a public bicycle track immediately adjacent to the station vent facilities further exacerbating problems at the site.

Specific features of each compressor station are described below and in Appendix I and 2. Upgrade and overhaul of compressors is summarised in Appendix 3. The location of the facilities is shown in Appendix 4 (maps extracted from AEMO VAPR 2011 Appendix C). The facilities description includes projects in progress or expected to be completed by the end of the current Access Arrangement 3 (ie 2012).

2.1 Eastern system - Longford to Melbourne

2.1.1 Gooding

Gooding compressor station is located approximately halfway along the Longford to Dandenong pipeline and compresses gas from Longford into Melbourne. The compressor station was constructed in 1977 and comprised four Solar Centaur T4002-C307 gas turbine driven wet seal centrifugal compressors located in a common compressor hall, any three of which may be operated in parallel to lift the pipeline pressure to a Maximum Allowable Operating Pressure (MAOP) of 6,890 kPa. Each compressor has a nominal ISO output power of 2,850kW. As the station is only required to reach a maximum pressure ratio of 1.35, the outlet temperatures are such that gas cooling systems are not required. Station pipework is primarily buried.

Historically, the station has operated for approximately 80 days per year with a minimum of two and up to three compressors running in winter. Compression is increasingly being used for short periods to relieve high pressure constraints in the Latrobe zone. This trend towards short operation intervals during periods of high inlet pressure has been exacerbated by the introduction of the four-hourly gas market.

The four C307 compressors were re-staged in Feb-83 when the Longford pipeline was partially duplicated. Subsequent downstream augmentation of the Longford pipeline, (including the commissioning of the Pakenham to Wollert pipeline), and operation of the compressors at high inlet pressure as a result of the competitive gas market have meant that the staging was no longer optimal for operations.

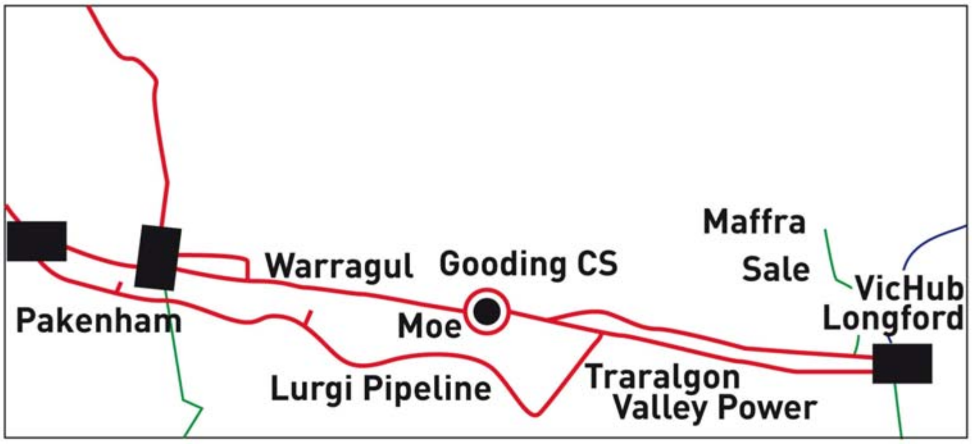


Figure 1 Diagram of the Longford and Lurgi Pipelines

Gooding compressor unit and station control systems were upgraded during 1998. The engines of compressors 1, 2 and 4 were overhauled in 1997 to 1998 and the engine of compressor 3 is budgeted for overhaul in calendar year 2013, subject to condition monitoring (boroscope inspection).

Dry seal C402 compressors and replacement power turbines have been installed to replace the existing C307 wet-seal compressors and provide improved compressor staging. Selected facilities have been upgraded including fail-safe station valves, instrument air system, standby generator and fuel gas heaters.

Gooding compressor unit controls are to be upgraded to the latest TT4000 control system in 2011-12 and will include upgrade to the aging fuel control valves and engine starter systems.

2.2 South-Western system - Melbourne to Portland

2.2.1 Brooklyn

Brooklyn compressor station (BCS) is located in western Melbourne and provides gas compression from the Dandenong to Brooklyn pipeline (with a MAOP of 2,760kPa) into the Brooklyn to Geelong and Brooklyn to Ballarat (Figure 2) transmission systems (each with an MAOP of 7,390kPa). As the station operates at pressure ratios of up to 2:1, the station generates high temperatures and the gas is cooled before being delivered into the pipelines. The station is designed to permit a variety of combinations of unit operation including parallel and series operation. The mode of operation is selected using local controls and with units off-line. Station pipework is primarily buried.

Prior to a reconfiguration brought about by the Longford supply incident in September 1998 the station had eight gas driven centrifugal compressor sets in two groups known as Stage II and Stage III. (Stage I, comprising three reciprocating gas engines, was constructed in 1972 and decommissioned in the early 1980's. Stage II was constructed in 1979 with four Solar Saturn T-1200 compressor sets each of ISO 850kW and decommissioned in 2011).

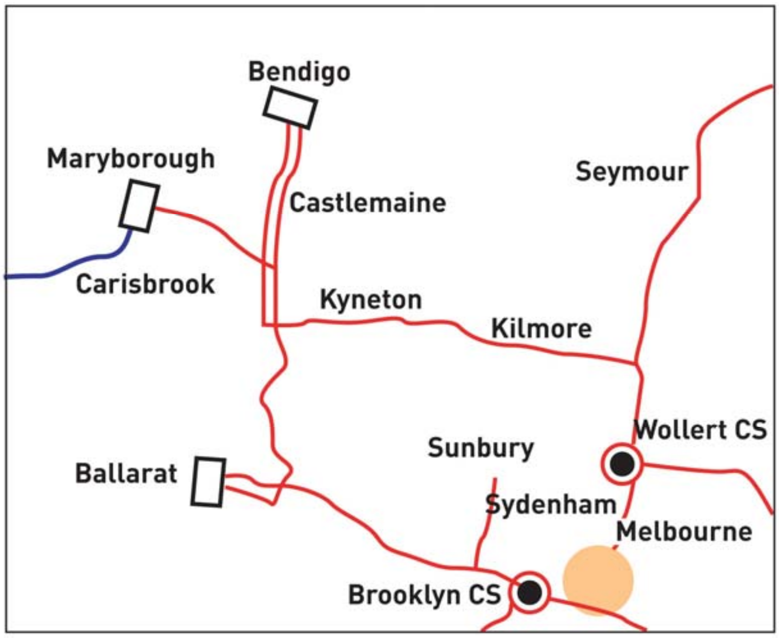


Figure 2 Diagram of the Ballarat Pipeline showing supply from Brooklyn Compressor

Stage III was constructed in 1982 with two Solar Saturn T1200 at ISO 850kW (BCS8 and BCS9) and two Solar Centaur T4000 at ISO 2,850kW (BCS10 and BCS11) gas turbine and wet-seal compressor units each housed within a package enclosure. The Saturn units in Stage III are mainly used to boost pressures into the Ballarat system from the Geelong pipeline and have relatively low running hours. Each Centaur unit has its own heat exchanger for gas and oil cooling, but shares water cooling facilities. The Saturn units will have their own air cooled heat exchangers for gas and oil cooling in 2012. The Stage III building was erected post-construction of the facility in order to provide noise control. The building structural supports and process equipment (inlet separator and water-cooled gas exchanger) are located immediately adjacent to the equipment and significantly interfere with maintenance of equipment (refer photos 10 to 15).

From January 2000, the mode of operation of Brooklyn changed with the connection of the Southwest pipeline (SWP), development of underground storage and "toll processing' of Santos Otway gas at Iona, and the requirement to refill during the summer months. The Centaur compressors were again restaged and controls upgraded in 1999, and unit 11 engine (Centaur T4000) was overhauled in November 2000. Increasing injections of Otway gas from the Iona UGS and SEAGas systems have resulted in a changed pattern of operation of Brooklyn compressors for much of the year. However, there are typically several weeks of the year where Longford gas is required to flow into the Geelong system and BLP/SWP (eg underground storage, gas fired power generation or refilling the SWP after intra-day linepack withdrawal) using up to two Centaurs, plus compression of Otway or Longford gas using up to two Saturns to Ballarat during periods of high gas demand. This pattern continued as the gas market moved from daily to four-hourly intervals with an increasing frequency of short-term operation of compressors into the BLP/SWP.

In 2006 GasNet commenced a dry-seal compressor retrofit program to mitigate problems being experienced with pipeline liquids affecting customers. The C307 wet-seal compressor of unit 11 was replaced in June 2006 and a new Centaur T4700-C337 dry-seal compressor package (BCS12) was commissioned in 2007 to functionally replace Centaur package BCS10. Staging in BCS12 has been selected to match the operational requirements for the system following commissioning of the BLP and is able to compress to Geelong or to Ballarat. The Centaur T4000 engine of unit 10 was overhauled in December 2006 and has been retained in the short term to provide backup to existing compressors.

Stage 2 Saturns (BCS6 and BCS7) were withdrawn from service in 2010 and associated controls and balance of plant were demolished in 2011. This reduced the equipment available for operation at the site to two Saturns (BCS8 and BCS9) and three Centaurs (BCS10, BCS11 and BCS12)

In 2011 APA GasNet re-fitted discharge valves to both BCS10 and BCS11 following failure of the water/gas exchanger of Saturn BCS8. This enables any of the Centaur compressor packages to compress either to Ballarat or to Geelong. Work is in progress to replace the water-cooled oil and gas coolers of BCS8 and BCS9 with their own air cooled heat exchangers for gas and oil cooling by mid-2012. The works include upgrade of controls to ensure valves fail safe and operate on available site instrument air.

The Saturns are expected to be the primary resource for peak winter supply to Ballarat following commissioning of the Sunbury loop (Western Outer Ring Main, WORM stage 1) in 2012. Saturns are no longer required for compression to Ballarat following completion of the WORM Stages 2 & 3 circa 2015 and are proposed to be retired by 2018.

Significant additional high pressure gas facilities were added to the site with the addition of pig trap assemblies for the Melbourne 750NB, Geelong 350NB and Ballarat 200NB pipelines and the addition of the five-run Brooklyn (BCP) City Gate and Brooklyn pressure Limiter and associated 500 kW heater installed in conjunction with the Southwest pipeline in 1998). The adjacent tip has been closed and a new public bicycle track has been opened on the site boundary adjacent to the station cold gas vent. The site has become further congested with four new heaters (625 and 2050 kW ea), a six-run regulator station and pig-trap for the 10.2 MPa 450NB Brooklyn Lara pipeline (BLP) which was commissioned in 2008. A new CTM and regulators to supply the [redacted]-have been committed for 2012.

The APA strategy based on the medium growth forecast in the AEMO GSOO 2011 provides for increased security of supply and more efficient operation with the completion of the Rockbank to Wollert Pipeline (WORM). This proposal reduces the compression requirements from Brooklyn in the medium term.

2.2.2 Stonehaven

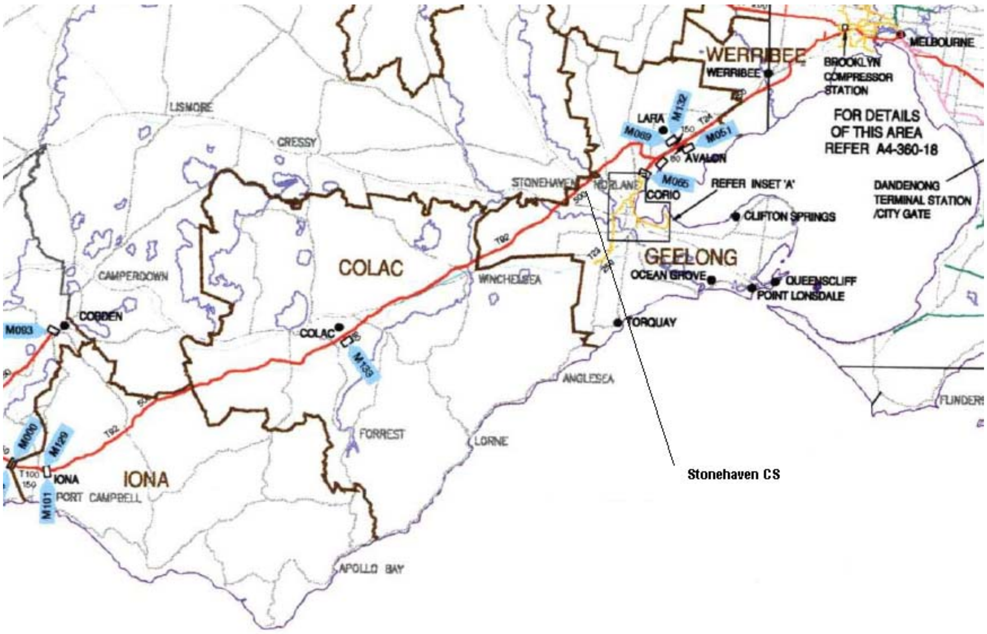


Figure 3 Diagram of the South West Pipeline showing possible location of Stonehaven Compressor

The site of the Winchelsea or Stonehaven compressor station is located west from Geelong. GasNet owns the Stonehaven property through which the 500mm South-West pipeline passes, whilst Winchelsea site is more optimally located for initial easterly expansion phases of the SWP/BLP. There is adequate land for initial and projected requirements for the proposed Taurus T7702S compressor at the Stonehaven site. The first compressor is projected to be required by 2014.

2.2.3 Iona

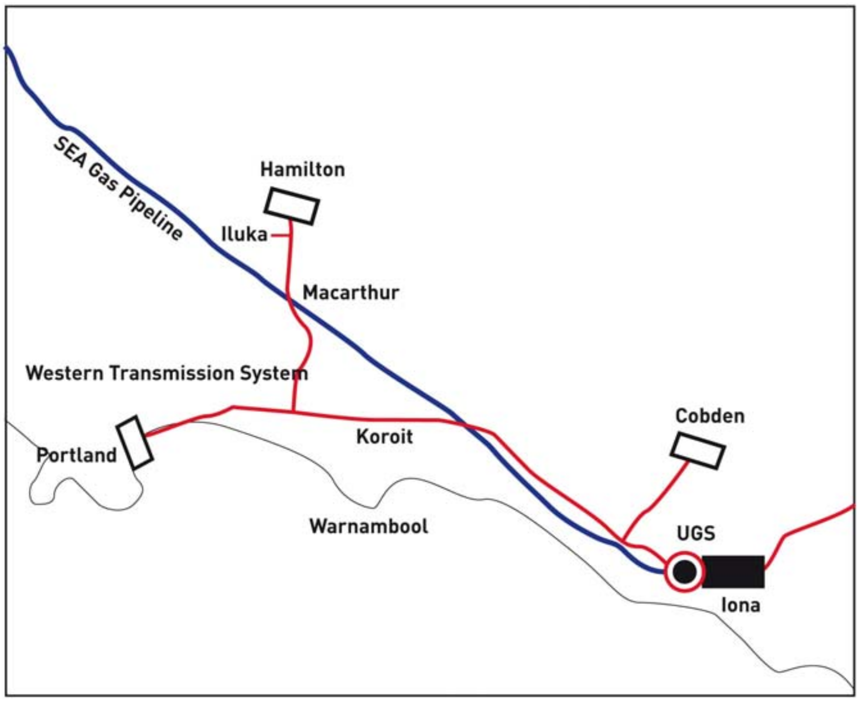
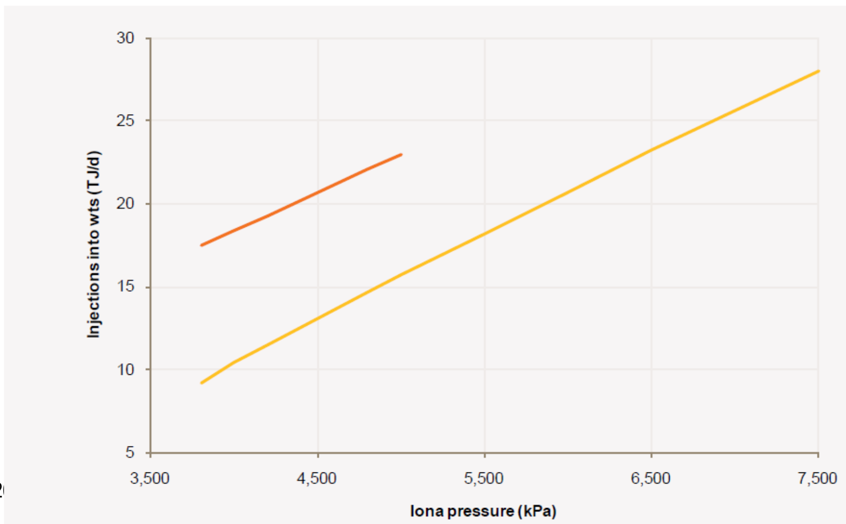


Figure 4 Map of the Western Transmission System

Iona compressor station is located within the Iona Underground Storage Facility (WUGS) and provides up to 18 TJ/d compression (at inlet pressure 3500 kPa) from the 500mm South-West pipeline into the 150mm Western Transmission System (WTS) to Portland (MAOP of 7,400 kPa). Constructed in 2001, the station comprises two gas Caterpillar engine-driven Gemini reciprocating compressor packages with unit cooling designed to meet spring/winter peak demands during underground refill operations, which is an unusual combination of events. Each package provides nominal 300 kW of compression power with one unit a designated backup.

The capacity of the 150mm western system to Portland is available inlet pressure at Iona. The free-flow capacity and capacity with one compressor is shown in the AEMO VAPR 2011 Fig C-12 below:

Figure C-12 — Western Transmission System injections and Iona pressures

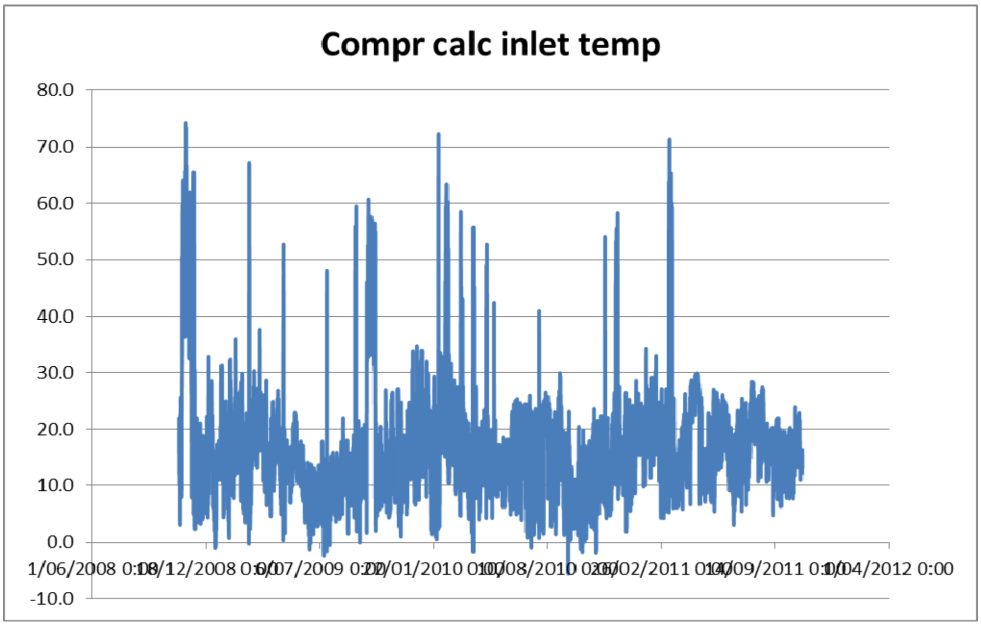


Currently, the Iona CS is capable of meeting the current peak winter demand of 20 TJ/d with minimum inlet pressure of 4500 kPag and discharge pressure of 6200 kPa (prior to the cooler). Maximum compressor differential pressure is 1700 kPa.

Normal operating pressures exceed the maximum permissible inlet pressure of the compressor of 6000 kPag which has prevented routine testing of compressor packages. Installation of inlet pressure reduction facilities to allow compressor testing is proposed for AA4. At 5200 kPag inlet, the compressor capacity is 25 TJ/d up to 6800 kPa discharge. A check of typical delivery pressures and temperatures indicate that, although marginal, a simple pressure regulator without pre-heat will be adequate to avoid formation of pipeline liquids. Control systems will need to be modified to protect the compressor from operation at unacceptable low inlet temperature.

Inlet temp

degC



The AEMO VAPR 2011 (Table 7-5) indicates the required pressure is achievable in event of loss of Brooklyn compression with a possible new interconnect from the SEAGas pipeline near MacArthur.

The APA GasNet strategy to install the WORM with compression at Wollert and Stonehaven provides an alternate and more flexible solution. It is assumed that withdrawals at Iona WUGS will be constrained by AEMO if required during potential 1:20 peak WTS demand (refer VAPR 2011, App C-14) in order to maintain minimum inlet pressure to the compressors. As there are currently no reverse flow capacity rights, this operational solution seems satisfactory.

2.3 Northern system - Melbourne to Wodonga/Culcairn

Figure 5 Map of the Northern Zone

2.3.1 Wollert

Wollert compressor station is located north of Melbourne and is the key supply point for the Wollert to Wodonga transmission systems (MAOP of 8,800 and 7,400 kPa) compressing Longford gas from the outer ring main from Pakenham. The original station (Station 'A') comprises three Solar Saturn centrifugal compressor sets. The units may only be operated in parallel in any combination from one to three, although one unit is a designated backup.

The station, constructed in 1981, was originally designed to operate with suction from the Metropolitan system. The need for compression from the metropolitan system ceased for a time in 1984 when the Pakenham to Wollert pipeline was constructed. The compressors were restaged before winter 1998 to operate with suction from the Pakenham to Wollert pipeline to meet the expected demand growth in the Wollert to Wodonga system as a result of the commissioning of the Murray Valley and Carisbrook to Horsham pipelines.

The station was not extensively used to support exports into NSW in the period to 2000, so one of its low operating hour engines was swapped for a high operating hour engine from Brooklyn. The

Saturn engine in WCS2 was subsequently overhauled and up-rated to T1300 (950 kW) in December 2003. Unit coolers and water towers were decommissioned and replaced with a station fin-fan cooler and station recycle valve in 2005. In recent years, compression has been required with between one and three compressors for 48% of the time (on an hourly basis), with two units operating about 28% of the time.

In 2008-2010 work was completed on the automation of the station and in replacing selected facilities including safety system, power supply and distribution systems, backup power generation and master control systems.

Stage 1: Automation. (2007)

At the conclusion of Stage 1 automation of Station 'A' in 2007, the reliability of station controls has improved and remote support improved. However, the compressor packages and associated balance of plant (valves etc) will continue to be exposed to moderately high failure rates due to their age and relay-based technology, and compressors will still inject moderate quantities of oil into the pipeline if operated due to the wet-seal technology.

Stage 2: Two Centaur T6102S's (2011).

The AEMO Planning Report for the Northern Zone identified the requirement for immediate augmentation of the Wollert compressor station with equivalent of four Saturn T1200 operating compressors (i.e. 3400kW plus one spare compressor). This could be achieved with any of the following options, all of which require additional station pipework and station and unit isolation valves:

- two Centaur 40 T4700 compressor packages at an approximate cost of $39.6M, or
- four new Saturn 20 T1600 compressor packages (to achieve 3400kW with three compressors operating) at an approximate cost of $48M.
- upgrade of three existing Saturn 10 T1200 compressor packages with C168 dry-seal compressors, plus two new Saturn 20 T1600 compressor packages at an approximate cost of $51M.

Even in the absence of the requirement by the ESV to replace the existing Saturn with dry seal machines the most efficient approach in present value terms is to remove the existing Saturns and replace them with Centaurs in 2009 ($39.6m) rather than install two Saturns in 2009 to provide the required additional capacity as identified by AEMO and then in 2011 replace the existing Saturns ($47.5m)

Additional options were investigated to manage the further loss of export capacity due to unfavourable northern system demand profile changes and increase in export demand. Options included the partial duplication of the Wollert to Wodonga pipeline and MAOP upgrade of Wollert to Euroa DN300 pipeline in conjunction with Wollert CS Upgrade and Springhurst CS flow reversal, facilitating delivery at higher pressure and flows to Culcairn.

The selection of the larger T6102S packages was not only more cost effective, but also is better suited to the role of compression transfers between the WORM (500mm) and Pakenham-Wollert pipeline (750mm) whilst still having the capability of delivering gas into the Wollert-Wodonga (300mm) pipeline as identified in the AEMO Vision 2030 document by 2015 for "east-west" compression of Longford gas. The identified requirement for 6 MW compression power would be achieved with the addition of one additional compressor package by 2015 (Stage 3).

This is also expected to be less disruptive to station operations than the alternative of separate projects to up-rate engines from T1200 to T1600, unit controls retrofit from relay logic to PLC controls, replacement of compressors to provide for dry seals and possible re-staging, and associated upgrade to balance of plant (fail-safe valves, surge control valves etc

The project would provide for future connection points to the station pipework for the SWP/BLP[1] extension via the WORM on the basis that the station will initially have a single point of suction and single point of delivery to the Wodonga pipeline during operation. The station incorporates two inlet filter/separators and unit gas coolers which will facilitate later augmentation to achieve the east-west gas transfers foreshadowed in the AEMO Vision 2030 report.

The works involved expansion of the station automation system and used packaged Solar Centaur dry seal compressor sets similar the latest Brooklyn C336 compressor BCS12 and fitted with SoLoNox combustion in accordance with EPA SEPP[2]. Solar packaging similar to the electric start Springhurst station and incorporating unit fire and gas detection and fire suppression will be employed, resulting in minimal station controls impact. The compressor station works includes new station air and fuel gas utilities and a station re-cycle valve for load control. The project also established new station fail-safe isolation valves and station gas headers, connecting to new unit isolation and control valves (again using fail-safe principles) and a new station vent. An instrument air system has been provided for these new facilities. The opportunity was taken to remove two of the three non-return valves which directly connect Class 600 pipelines to the Class 300 Keon Park (Melbourne) system[3].

At the conclusion of Stage 2, the two electric-start dry seal compressors (T6102S engines) are the primary compressors used for service, whilst the existing and associated station pipework and balance of plant would be ultimately retired and demolished.

In 2011 the Wollert CS ‘B’ comprising two Centaur T6102S-C334 (ISO 4500 kW) compressor packages was commissioned as part of the Northern Augmentation project utilizing the existing Wollert to Euroa DN300 pipeline which was uprated from 7400 to 8800 kPag MAOP. Both units may be operated concurrently to meet the northern Victoria and Culcairn export loads. Wollert CS ‘A’ wet-seal compressors (T1200/1300 engines) is available on a best endeavors basis as a backup to Station ‘B’. As low NOx technology has been employed, the site does not require an EPA licence for discharge to air.

2.3.2 Springhurst

Springhurst compressor station, located in the northern section of the Wollert to Wodonga/Culcairn transmission system (MAOP of 7,400 kPa), was constructed in 1999 to support up to 92 TJ/d import of gas from NSW in winter. The station comprises one packaged Centaur (C50) T-6102 centrifugal compressor set at ISO 4500 kW. Although the station was

[1] SWP = Southwest Pipeline (Iona to Lara); BLP = Brooklyn Lara Pipeline

[2] EPA Act 1970 State Environment Protection Policy (Air Quality Management) clauses 18 and 19.requires best practice in reducing class 1 emissions.

[3] The latest revision to AS2885.1 Clause 7.2.2 states “…a different MAOP, the minimum requirement for separation by isolation is two isolation components, two valves or one valve and a blind.” The single non-return valve does not meet this minimum requirement and represents a risk of overpressure of the lower pressure systems should the non-return valve fail to correctly close.

initially capable of compression south only, bi-directional compression was made possible in 2011 with station pipework and valving alterations. Instrument air systems and a diesel engine alternator were installed to improve availability for northern flows, and the control system was upgraded to TT4000 controls.

It has been identified that the oil/gas cooler is undersized for summer conditions which would constrain flows and head in summer.

3.0 System Growth Outlook

AEMO have published the following documents which provide information on system growth outlook and current operating practices:

- Vision 2030
- Vision 2030 Update
- Victorian Annual Planning Report 2011
- Gas Statement of Opportunities 2011
- 2011 Victorian Gas System Adequacy for 2012

System constraints identified in AEMO VAPR 2011 are:

  - Sunbury constraint
  - WTS constraint

The AEMO Gas Statement of Opportunities 2011 (Table A1-7) medium scenario forecasts annual system demand (no GPG) to be essentially flat (<1% pa) over the next 10 years in each zone. GPG growth (Table A1-8) averages 16.8% pa over the same period. Esso Australia Pty Ltd (Esso) is undertaking major development of Bass Strait reserves (Kipper Tuna Turrum Project) and is therefore assumed that GPG fuel gas is most likely sourced from the Gippsland Basin.

The AEMO Gas Statement of Opportunities 2011 medium scenario forecasts for 1:2 and 1:20 winter peak day system demand by System Withdrawal Zone (Tables A1-10 and A1-11) (no GPG) to be similarly flat (<1% pa) over the next 10 years. Peak hour forecasts (Table A1-12) exhibit similar low growth, the highest growth being in Melbourne and Gippsland.

The AEMO Gas Statement of Opportunities 2011 winter peak day supply forecast (Table A1-14) shows Gippsland (Eastern System) available supply over the next 5 years to be in modest decline and approximately matching pipeline capacity. Available supply into South-Western System is forecast to increase over the period and exceeds the current SWP/BLP pipeline capacity. Northern system available supplies decline slightly over the period.

The system augmentations outlined below are premised on increasing supply peak day and peak hour capacity (injections) from the Otway systems (WUGS, SEAGas Minerva, Geographe, Thylacine, Mortlake etc) with only modest changes to the supply from Northern and Eastern systems

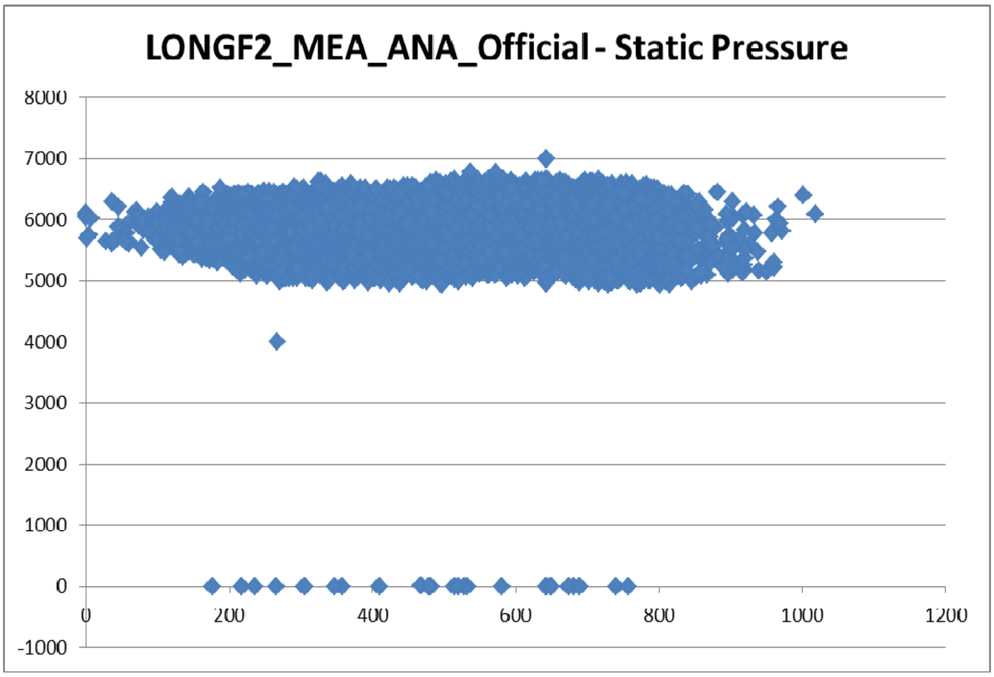
3.1 Eastern system - Longford to Melbourne

The capacity of the Longford to Dandenong/Wollert system is 990 TJ/d[4] with gas solely from Longford utilising three (3) compressors at Gooding and the Lurgi pipeline. -[redacted]. Maximum pipeline capacity is 1030 TJ/d[5] with Longford injecting 970 TJ/d and BassGas injecting 60 TJ/d (VAPR 2011 AppC.1.3)

AEMO have indicated that operational end-of-day (EoD) pressure at Longford is 6500 kPag, [redacted]

Pressure

kPag



No system capacity augmentation on the Eastern system is proposed for the Regulatory Reset period 2013-2017, although the system capacity is affected by the Lilydale TP pipeline offtake scheduled for commissioning in 2012 . The Eastern system supports westward flows to Melbourne only.

[4] AEMO VAPR 2011 App C

[5] AEMO VAPR 2011 App C.1.3

3.2 Northern system - Melbourne to Wodonga/Culcairn

The capacity of the northern system is 50 TJ/d south through Culcairn utilising the compressor at Springhurst only (note: 92 TJ/d utilising both Young and Springhurst, and approximately 117 TJ/d following commissioning of the Wagga Wagga (Young to Culcairn) Loop, and 38 TJ/d north through Culcairn using up to two Centaur compressors at Wollert. Target receipt pressure at Culcairn is 6000 kPa (above this the compressors cannot currently operate).

Figure C-10 — Imports from New South Wales through Culcairn

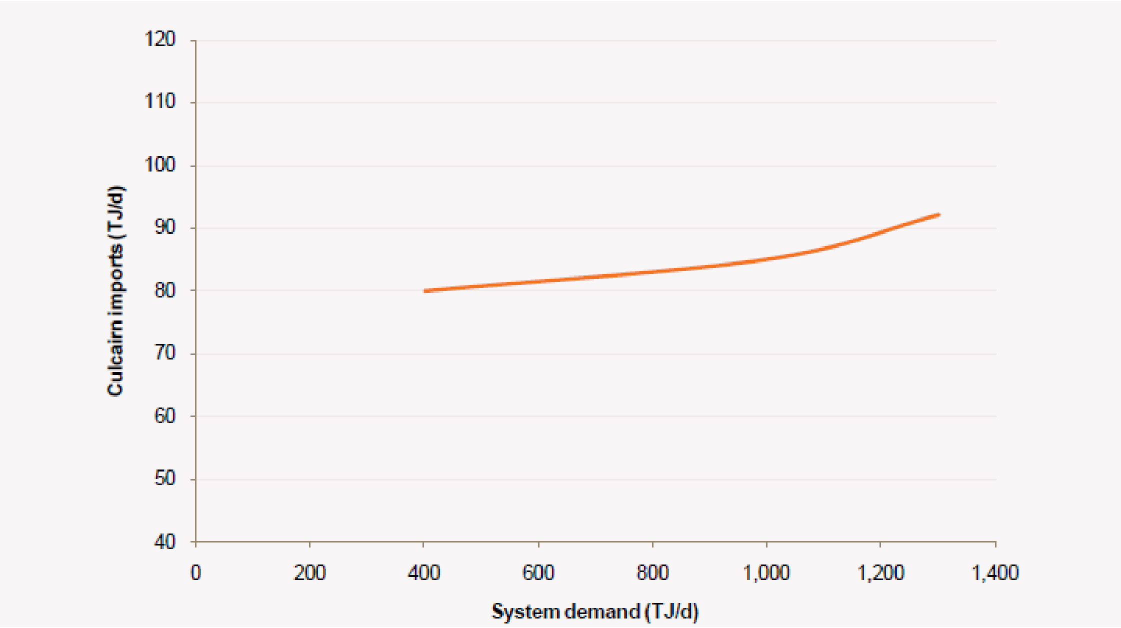
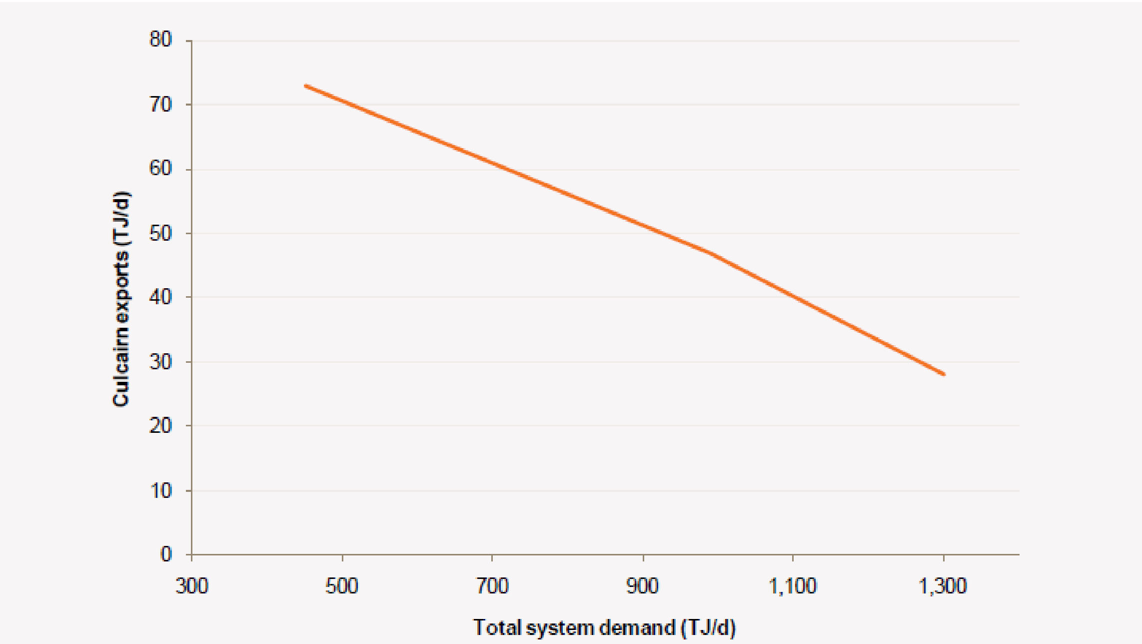


Figure C-11 — Exports to New South Wales at 6,000 kPa minimum pressure at Culcairn



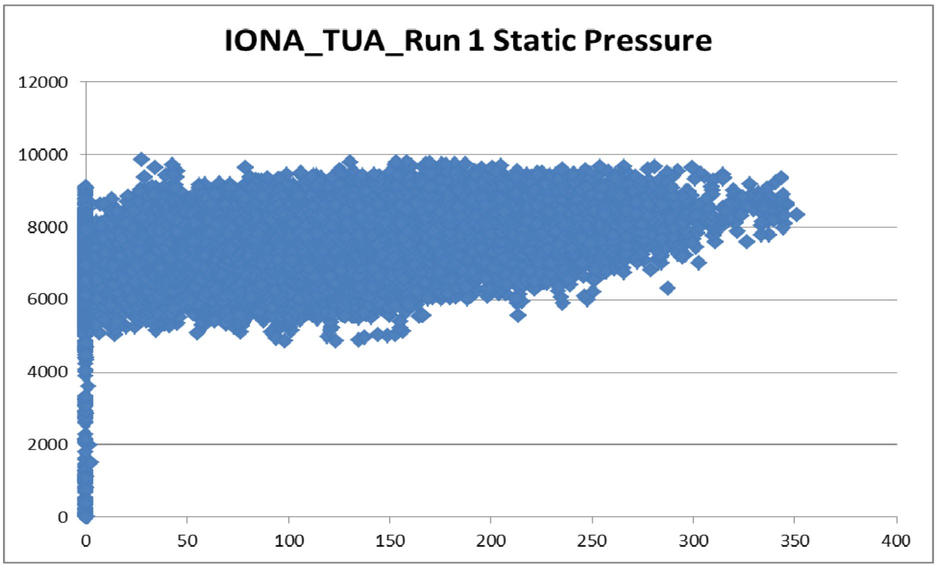
The Euroa compressor station comprising a Solar Centaur T6102S-C334 compressor package (ISO 4500 kW) is scheduled for commissioning in 2012. This restores export capacity to 38 TJ/d due to capacity erosion from northern Victorian demand (growth in demand and unfavourable gas use profiles).

3.3 South-Western system - Melbourne to Portland

The capacity of the South-western system is nominally 50 TJ/d into WUGS at Iona using two (2) Centaur T4002 compressors at Brooklyn at less than 7.4 MPa[6]. The capacity of the South-western system (SWP/BLP) in 2012 is nominally 353 TJ/d at 10 MPa from Iona to Melbourne.

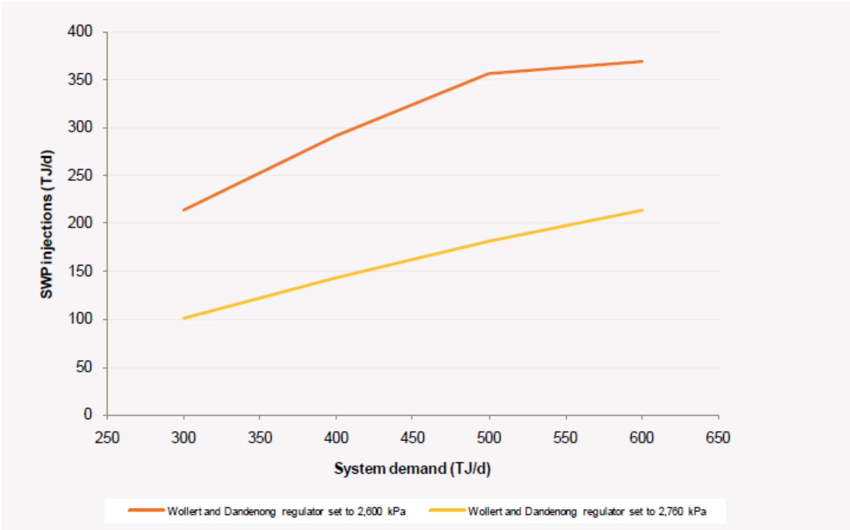
Pressure

kPag



However, prior to installation of the WORM, pipeline capacity into Melbourne is constrained on low supply days as Brooklyn represents only about 30% of Melbourne demand (see 2011 VAPR Fig C-7 below)

Figure C-7 — Iona injection capability on low system demand days



[6] Two Centaur T4002 compressors have insufficient power to achieve 7.4 MPa. Capacity to transport to WUGS is limited if Geelong system demand is above 40 TJ/d.

Following installation of the WORM during AA4, the capacity into WUGS using one compressor at Wollert only, is increased to over 100 TJ/d with 1030 TJ/d injections at Longford (and over 180 TJ/d with 750 TJ/d injections at Longford). This increased capacity is achieved with considerably less than half the compression required when using two compressors at Brooklyn.

Following installation of the WORM and Stonehaven (or Winchelsea CS) during AA4, the capacity of the South-western system (SWP/BLP) is nominally 415 TJ/d at 10 MPa from Iona to Melbourne. The principal benefit of the WORM is the removal of the capacity constraint which reduces the ability for the gas facilities at Iona to inject at pipeline capacity when system demand is low and the security-of-supply benefit of allowing gas from the Iona area to feed the main Melbourne supply points at Brooklyn, Wollert, Dandenong (and Lilydale).

A site for the Stonehaven compressor station has been chosen and agreement reached with the land owner subject to obtaining a planning permit from the local council. An alternative site at Winchelsea has been proposed.

The gas processing facilities supplying WTS at Nth Paaratte have been de-commissioned so that currently the two injection points at Iona (WUGS and SEAGas) and Longford gas via compression at Brooklyn are the only typical sources of gas supply into this system. (The Northern system normally exports to NSW). Augmentation of the western system could also be achieved with connection to the SEAGas pipeline south of Hamilton (see 2.2.3).

Over the coming AA4 period there will be significant changes to the compression requirements for Ballarat/Sunbury out of Brooklyn. The Sunbury loop (WORM Stage 1) is committed for 2012 (AA3) to meet the Sunbury constraint which could no longer be met with compression from Brooklyn. Sunbury system demands may be met from the SWP/BLP system thereafter with compression into the SWP/BLP as required to maintain minimum BLP pressures. The reduction in peak hourly gas demand of Ballarat load may be met in the short term using a Saturn compressor at Brooklyn CS for which gas cooling replacement has been committed. (The existing BCS 12, BCS11 and BCS10 Centaur compressors may now also perform this service). Following installation of the WORM (Stages 2 and 3) and the Rockbank PRS to service the Ballan-Ballarat pipeline, compression is no longer required for Ballarat.

3.4 Intra-day Balancing and Eastern System Constraint Management

AEMO operating practice on the SWP/BLP over winter 2011 has been to achieve about 8,500 kPag EoD (0900 hrs) pressure at Iona on most days, giving a system-wide active linepack total of 280 TJ (per MCE), and allowing up to 30 TJ of active linepack subject to adequate Otway gas injections overnight. This corresponds to daily typical pressures at Iona from 5,000 to 10,000 kPa depending on timing of operation of Brooklyn BCP CG, Lara CG and injection quantity at Iona. (1000 kPa in the SWP/BLP corresponds to about 10 TJ of linepack).[7] This EoD target is unsustainable when Otway gas injections are unavailable (eg during WUGS maintenance shutdown or during low demand periods when market schedules Otway gas off), and during periods of high demand on the Geelong system when Longford gas is required to be delivered using compression at Brooklyn. Intra-day balancing is discussed further in AEMO VAPR 2011 App C.3.

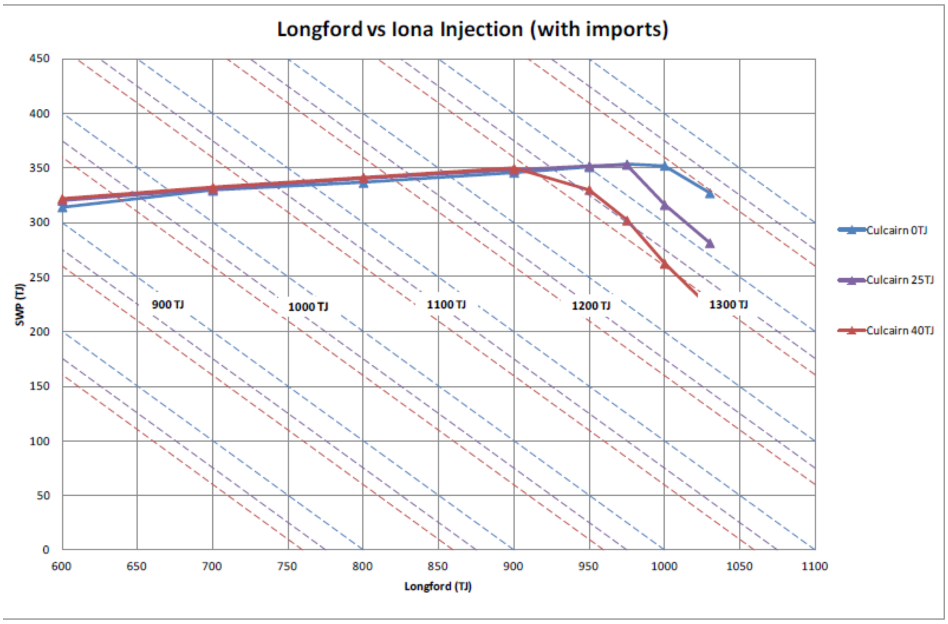
[7] Gas Scheduling and System Operations over Winter 2006 and System Augmentation Report 2005, Lara to Brooklyn

Re-bidding processes in the event of a reduction in demand (eg weather forecast error leading to a reduction in required injections) generally leads to reduction of injections from higher priced gas (typically Otway gas), which in turn creates the potential for a high pressure constraint in the Eastern System. This is managed by AEMO by moving Longford gas into the SWP using compression at Gooding and Brooklyn, and gas into the Northern System using compressors at Wollert and in active management of regulator station flowrates (over 5000 setpoint changes per annum). The small diameter pipelines at compressor outlets at Wollert and Brooklyn, compression staging and power limit the quantities that can be effectively moved overnight, although the quantity of active linepack available has increased with the installation of the SWP/BLP into Brooklyn[8] in 2008.

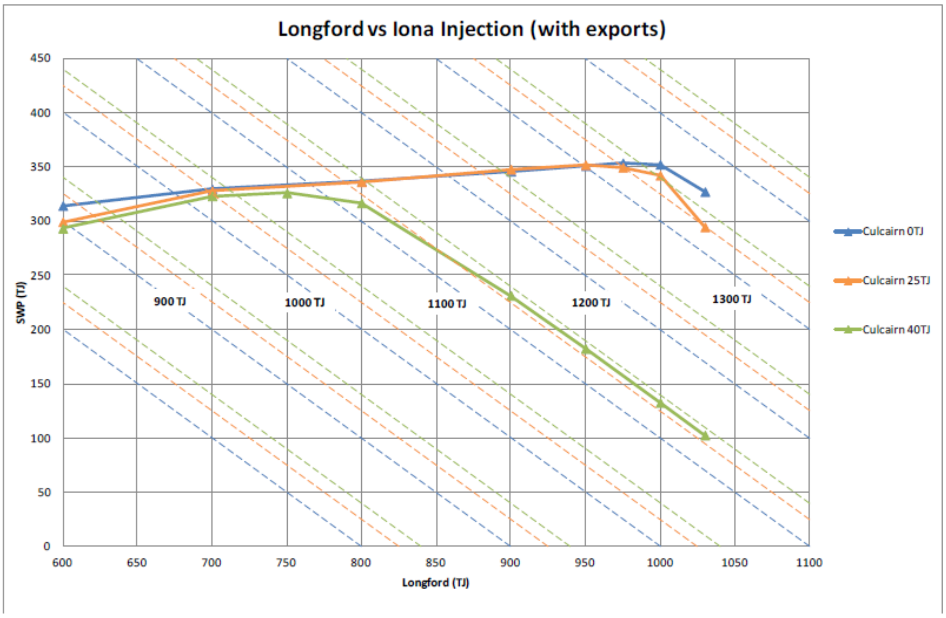
Current maximum discharge pressure from BCS10 and BCS11 operating together into the Corio pipeline is about 6200 kPa, and into the SWP at Lara is about 6000 kPag, a slight increase due to the replacement of BCS11 with a dry-seal compressor which removed the "P2 delta P" constraint.

Following commissioning of the T4700-C336 BCS12 compressor at Brooklyn in 2007, and again in 2008 when SWP/BLP was extended into Brooklyn, the flows and pressure marginally increased with operation of BCS11S with BCS12.

Prior to installation of the WORM in AA4, the imbalance between the supply sources at Longford, Iona and Culcairn and main Melbourne deliveries at Dandenong (50%), Brooklyn (30%) and Wollert (20%) are characterised by frequent intervention by the system operator (AEMO) on pressure/flow regulators and compression, and constraints in the SWP pipeline capacity. The following figures from AEMO 2011 VAPR AppC illustrate the effect of Culcairn imports and exports on SWP capacity.



[8] System Augmentation Report 2005, Lara to Brooklyn



Following installation of the WORM, APA GasNet modelling has demonstrated that linepack management will be significantly simplified with the eastern and western systems essentially interconnected at Wollert, and fixed pressure setpoints are possible at all major regulator stations at Lara, Brooklyn, Wollert and Dandenong.

4.0 Compressor Major Upgrade Strategy

4.1 Gooding Compressor Station

2008-2012 (AA3): Upgrade projects were identified and either completed or in progress. The Solar (hazardous area) control system is now beyond its support life and is currently being upgraded to current generation safe area TT4000 controls. As part of this work, the engine starters will be upgraded to electric start (thus minimizing release of greenhouse gases), and subject to risk assessment, the anti-surge system upgraded, and unit valves and actuators upgraded to fail-safe.

- Unit TT4000 controls upgrade
- Unit fail-safe valve upgrade.
- Control room fire suppression system

Other capital projects proposed for AA3 are:

- GCS GEA Fuel Gas Upgrade
- GCS Emergency Lighting Upgrade

2013-2017 (AA4): Whilst undertaking a review of its compressors stations APA GasNet identified a deficiency in its' fire suppression capability at Gooding. Therefore as part of the next Access Arrangement (AA4) submission it is proposing to install fire suppression equipment at a number of compressors stations including Gooding. At Gooding, because all compressors are located in a common compressor hall, they are also exposed to possible loss from fire due to the potential of fire from failure of oil hoses etc. The lack of fire suppression systems means that a fire can knock on to adjacent units. Implementation of a Marioff Hi-Fog suppression system was proposed for 2008. The station control room houses the safety control PLCs which are a long lead replacement item in the event of fire. In accordance with APA policy and insurer's recommendations a fire suppression system is to be installed during the coming reset period AA4.

- Compressor package fire suppression system (Marioff HiFog)

The projected gas flow demands for the medium term are not projected to increase, so no planned increase in engine power is foreseen at this stage. However, it is expected that GCS3 (which is the only engine to have not been overhauled), is likely to need to be overhauled because of age related performance issues with an exchange T4000 engine within the next Access Arrangement (AA4) (2013-2017).

- GCS Unit 3 Turbine Overhaul

Existing valves and actuators on all compressor packages are fail-last (including gas-over-oil actuators) and in need of replacement due to old age and frequent operation (except for unit 4 inlet and outlet isolation valves). Fail-safe actuated valves are good practice design and are recommended for implementation with current controls upgrade. Similarly, ASV and FSV valves meeting the OEM performance specification are proposed to be installed. Similarly, station vent valves shall be replaced.

- GCS Units 1,2,3&4 Suction/Discharge Valves Upgrade
- GCS Station Valve Upgrade
- GCS Anti-surge and Fast-stop Valves Upgrade

Life Extension: The facility was constructed in 1977 and further assessment will be required with respect to life extension of station piping and pressure vessels (eg suction scrubbers). Note that this facility was constructed in 1977 to AS 1697-1975 and, although it comprises large-bore underground pipework, has been cathodically protected as part of the Longford-Dandenong pipeline.

4.2 Brooklyn Compressor Station

Prior to completion of the WORM, for WUGS refill, both BCS11 and BCS12 may be required to operate, and BCS10 will be available for back-up.

History and modelling indicates that when there are adequate injections at Iona, the need for compression out of Brooklyn is minimal. However, periodic shutdown of WUGS facilities and low injection from SEAGas have meant that compression from Brooklyn has been necessary to meet demand in the Geelong and SWP/WTS systems for several weeks each year. Two Centaurs have been used extensively in recent years to meet the combined Geelong/SWP demand [redacted]

BCS11 (in parallel mode) will meet the standard mode operation with BCS12 (or BCS10) providing back-up. [redacted] BCS12 will normally be available to operate as the preferred compressor to Ballarat with the Saturn wet-seal compressors as back-up until completion of the BCS8 and BCS9 gas coolers upgrade in 2012. This project will extend the useful life of the two Saturn packages by about 5 yrs and upgrade the safety of the station by incorporating fail-safe valves functionality. Oil ingress into the Ballarat pipeline will be mitigated by prioritising the dry seal compressor packages BCS11 and BCS12 and changes to the BBP PRS.

Upon completion of the Rockbank to Plumpton pipeline (DN500) which will provide supply to the Sunbury pipeline, the peak demand on the Ballarat line will significantly reduce, allowing a single Saturn compressor to meet peak demand.

Following installation of the WORM and the proposed Rockbank PRS, compression to Ballarat will no longer be required. As westward demand will be more efficient serviced using compressors at Wollert and Stonehaven as required, the compression requirements at Brooklyn dramatically decline by 2017, and it is proposed to mothball stage 3 compressors (BCS8, 9, 10 and 11).

- Mothball Stage 2&3

Life Extension: The facility was constructed in 1972 (Stage 1), 1977 (Stage 2) and 1980 (Stage 3). Further assessment will be required with respect to life extension of station piping and pressure vessels (eg suction scrubbers). Note that this facility was probably constructed to ANSI

B31.8-1968, AS 1697-1975 and AS 1697-1979. Although it comprises some large-bore underground pipework, it has been cathodically protected as part of the adjacent transmission pipelines. Severe corrosion has been found on some above-ground flanges within stages 2 and 3 but will be decommissioned circa 2017.

4.2.1 Brooklyn Compressor Package Upgrades

Whilst maintenance support from Solar Turbines Australia is still available, the relay-based unit control systems on the Saturn compressor sets (BCS 8 and 9), the Saturn 10 (T1200) turbine engines and wet seal C168 compressors are all superceded technology[9]. Renovation or upgrade of gas compressor packages is costly and in practice on-site upgrades are limited to up-rate of engines from T1200 to T1300 (nominal 1300hp = 950kW). It is proposed to extend the life of BCS 8 and 9 until 2017 subject to the completion of the WORM and Rockbank PRS at which time the packages may be retired. Water-cooled exchangers are being replaced in 2012:

- BCS 8&9 Coolers Upgrade (2012)

Stage 2 Saturn packages (BCS6 and BCS7) were decommissioned in 2011.

BCS10 Centaur engine was overhauled in 2006. However, the wet seal C306 compressor cannot be upgraded on the integral skid. Balance of plant (valves, control valves, inlet separator, gas and oil coolers, water cooler, and piping) remains as originally installed in 1982 and can pump from Melbourne into the Geelong or Ballarat pipelines. The reasons for the replacement of BCS10 are detailed at 4.2.3.

- BCS 10 Ballarat valve (complete 2011)

BCS11 Centaur engine was replaced with an overhaul exchange engine in 1996 (a T4500 de-rated to T4000) and the C307 series/parallel compressor was replaced with a dry-seal C337 series-parallel compressor. Balance of plant (valves, control valves, inlet separator, gas and oil coolers, water cooler, and piping) remains as originally installed in 1982 and can also pump from Melbourne into the Geelong or Ballarat pipelines.

- BCS 11 Ballarat Valve (complete 2012)

The new Centaur compressor package (BCS12) using a T4700 Centaur engine and C336 dry-seal compressor was installed in 2007. The new compressor package, housed in the Stage I building, was installed with new balance of plant and to current engineering design practices (fail-safe valves, safe area controls etc). BCS12 is capable of pumping from Melbourne to either Geelong or Ballarat, thus allowing the Saturn wet-seal compressors to assume back-up function until completion of the upgrade programs outlined below.

- BCS 12 (complete 2007)

[9] The relay-based control logic used in the Solar Saturn compressors used at Brooklyn and Wollert (Photo 25) limits opportunities for safety improvements and rapid maintenance diagnostics and repair. For example, recent corroded ‘fail-last’ actuators at Brooklyn are more cost effective to replace than repair. However, suppliers have been required to remove the spring from stock items in order to permit them to function in the existing Saturn control system. The “spring-to-close” characteristic for isolation valves is preferred from a safety perspective and therefore Good Practice – see later discussion.

4.2.2 Station Redevelopment

The following revised strategy for re-development of the Brooklyn Compressor Station is set in the context of current requirements for upgrade of existing assets due to design and support deficiencies (including management of wet-seal compressors in order to cease injections of oil into the pipeline in accordance with the reinforcement of statutory obligations from Energy Safe Victoria[10]), and the projected augmentation program to meet short and medium term growth in demand.

A reflection on the Brooklyn station developments to date (from Stage 1 to current configuration) clearly demonstrates the radical impact of regional pipeline developments, operating pressures and gas supply sources on the station design, power and staging.

The DN500 Brooklyn-Lara Pipeline (BLP) is connected to the DN350 Geelong pipeline via the BLP City Gate facility to allow gas to be compressed westwards into the SWP utilizing both the Geelong and SWP pipelines at pressures up to 7390 kPa. Although gas supply from the Otway system is projected to increase in coming years, leading to decreased utilization of compression plant into Geelong, the need for capability to move Longford gas into both Geelong and Ballarat systems and for refill of the WUGS at Iona is expected to continue. There is no direct connection from the compressor station into the BLP at the present time.

The BBP PRS facility located at Brooklyn is currently being configured for operation between BLP and Ballarat pipelines which will reduce the number of compression days to Ballarat. The DN500 Rockbank to Plumpton pipeline currently under construction is the first stage of the proposed Rockbank to Wollert pipeline (WORM), also designed to operate at 4500 kPag minimum. This pipeline will significantly reduce demand on the Ballarat pipeline such that, following completion of the WORM, a new connection from the WORM to the Ballarat pipeline near Rockbank will remove the need for compression to Ballarat.

The following strategy sets out the steps necessary to move from the current station set-up to a two-Centaur and two-Saturn compressor station at Brooklyn capable of compression into Corio, Ballarat or SWP pipelines, and ultimately to a station comprising only the BCS12 Centaur package. Based on current modelling this is the most efficient means to meet the requirements of the gas network in the medium term.

As the primary mode of peak compression to Ballarat will be from the Geelong pipeline to Ballarat, it is recommended that the Geelong pipeline system be operated at about 5000 kPag (fixed setpoints) allowing the use of existing staging in the Saturn compressors to meet the projected demand. This topic is the subject of separate discussion as it involves issues bearing on controls of Lara SWP CG, BLP CG, BCP CG, BBP CG and many other network regulator stations outside the scope of this Compressor Strategy.

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[10] Energy Safe Victoria letter to CEO, GasNet Australia P/L dated 27th March 2006

2008-2012 (AA3):

Fuel gas heating and filtration has been installed as Otway gas is typically close to the hydrocarbon dewpoint specification limit and is required to maintain Solar Turbines warrantee for new packages[11].

- Fuel gas treatment skid (complete 2010)

2013-2017 (AA4):

As has been identified that all three station isolation valves are damaged due to lack of loading facilities and have inadequate reliability, it is proposed to modify the station ESD system such that station valves are manually operated. This is possible on the basis that the station supplies only BCS12.

- Mothball Stage 2&3 compressors
- BCS safety and control system and RTU upgrade
- BCS emergency lighting

The existing site backup generator is required to be replaced due to age and location. It provides essential support for compression and gas heater facilities associated with the adjacent regulator stations.

- BCS DEA/GEA Upgrade
- BCS Administration Building Distribution Board Upgrade

4.2.3 Stage 1: BCS12. (complete 2006/07)

The BCS12 project involved the installation of a Centaur T4700-C336 gas compressor package into Stage I building. BCS12 is available as the lead machine for compression to Ballarat, thus allowing the Saturns to be relegated to standby status. Similarly, BCS12 is available for compression to Geelong in parallel with BCS11 with BCS10 relegated to standby status. (If concurrent compression to Geelong and Ballarat is required, the Saturns would be used to Ballarat)[12]. With the low hours of expected use of the standby units, the risk of loss through fire or gas release is significantly reduced.

BCS12 is available to operate in parallel with BCS11 (series mode) compressing into Geelong or alternatively compressing gas into the Ballarat line. The loss of oil into the Geelong and Ballarat gas pipeline systems will be significantly reduced as a result of using the dry-seal compressors as lead compressors.

One remedial project has been identified –the need to install a fast-stop valve complying with the Solar performance specification.

- BCS12 fast stop valve upgrade (2012)

[11] Solar Turbines Specification ES9-98 Fuel, Air and Water (or Steam) for Solar Gas Turbine Engines

[12] As customers in the Geelong area have complained of liquids from the pipeline, GasNet have prioritised converting Gooding and Brooklyn (Geelong) to dry-seal operation.

4.2.4 Stage 2: BCS8 and BCS9 Upgrade (2011/12).

Following installation of the Rockbank to Plumpton pipeline (WORM Stg 1) in 2012, the smaller Saturn compressors are better suited for compression to Ballarat. In order to reach the required pipeline pressure, the gas must be sourced from the Geelong pipeline operating at about 4500 to 5000 kPag.[13] One duty and one standby compressor will be required in the near term to meet peak winter demand on the Ballarat pipeline.

Like BCS10, the Saturn systems have a number of design deficiencies that bear on the safety and reliability of the plant, including “fail-last” valves, swing-check valves, and water-cooling equipment with associated Legionella risks. Whilst some of this equipment is packaged, there is no fire suppression system and the potential for oil fires remains.

In 2010, the Stage 3 Saturn gas coolers both failed due to corrosion, having been in operation for only a few years, resulting in ingress of water into the Ballarat pipeline. One gas cooler has been repaired. Three projects were expedited to secure supply to Ballarat in AA3:

- BCS 10 Ballarat Valve (complete 2011)
- BCS 11 Ballarat Valve (complete 2011)
- BCS 8&9 Gas Cooler Upgrade (in progress 2012)
- BCS 8&9 Anti-Surge and Fast-Stop Valves Upgrade (in progress 2012)

Furthermore, the Stage II construction (BCS 6 and 7) was constructed with unit suction equipment and piping rated only to Class 300 (about 5000 kPag maximum). This equipment was therefore limited in capability and usefulness when compressing from the 7390 kPa Geelong pipeline into the Ballarat pipeline due to the compressor staging and safety limitations. Unit piping and balance of plant has therefore bebeening decommissioned whilst retaining the compressor packages in ‘storage’ within the existing compressor house.

- BCS 6&7 Balance of Plant Decommissioning (complete 2012)

[13] The effectiveness of the by staging and power of Saturn compressors is compromised by operation at low inlet pressures. APA GasNet recommend operation of the Geelong pipeline at a fixed inlet pressure of about 5000 kPag in order to optimize compression and provide agreed priority for security of supply.

4.3 Stonehaven or Winchelsea Compressor Station

Compression to service underground storage refill is more efficient and provides greater capacity using the existing BCS12 compressor at Brooklyn and recompression at Stonehaven than the alternative of two Centaur compressors at Brooklyn CS (refer approved AA3 projects: installation of additional Centaur compressors at Brooklyn). Following installation of the WORM this facility will provide greater flexibility for maintenance of compressors at Stonehaven, Brooklyn and Wollert as WUGS refill capacity is greater (and preferred) with compression from Wollert CS only refer Section 3.3). Installation of bi-directional capability similar to Springhurst CS and Euroa CS will also deliver at small incremental cost an increase in the SWP/BLP capacity to 415 TJ/d. This station will also provide capacity increase on the WTS by virtue of increased pressures to the Iona compressors[14] and is intended to be capable of bi-directional compression.

A site for the compressor station at Stonehaven has been chosen and agreement reached with the landowner subject to obtaining a planning permit from the local council. An alternative site in Winchelsea may be preferred which provides a higher initial capacity increase for supply to Melbourne. Modelling conducted by APA GasNet indicates that additional 60 TJ/d easterly is possible with either one Centaur 50 (T6100) compressor at Winchelsea, or a Taurus 60 (T7700) compressor at Stonehaven.

- Stonehaven CS

The expected scope of works will include a station control room with TMR PLC controls similar to Springhurst compressor station, utilising a local and remote station HMI and connected to safe-area Solar TT4000 controls also similar to the Springhurst compressor (a standard APA design).

4.4 Iona Compressor Station

GasNet installed two 300 KW (400 HP) compressors at the Iona Underground Storage site in early 2000, to assist in the transmission of gas from the Southwest pipeline to the Western System. The capability of the existing station is discussed in Section 2.2.3.

The following projects are proposed for AA4:

Although the compressor aftercoolers are known to be incorrectly sized for high inlet pressure operation, it is recommended that the packages be reconfigured for an operating inlet pressure of 5200 kPag. Analysis of typical operating pressures and temperatures at Iona suggests this simple solution, whilst constraining withdrawals at Iona in Winter, is both practical and achievable with minimal investment in inlet pressure regulators and low inlet temperature protection, avoiding the need for gas cooler upgrade (which can be bypassed for optimum operation). Routine testing can then be performed in accordance with good practice.

- Iona CS – Inlet Pressure Reduction

The packages have no fire suppression. Packaged Marioff Hi-fog suppression is proposed as currently used in standard Centaur packages.

- Iona CS – Unit Fire Suppression System

[14] VENCorp Planning Report for WTS constraint

The station control system at Iona (Bristol 3320 RTU) has reached the end of its life and has for some years exhibited frequent I/O faults. Current generation controls are proposed.

- Iona CS Automation and RTU Replacement

4.5 Wollert Compressor Station

The following proposed strategy for re-development of the Wollert Compressor Station is set in the context of the proposed completion of the WORM and augmentation of the Northern system.

Station 'A' may provide a backup service on a best endeavours basis over the next few years but is expected to run only for a few hours per annum, mostly under test operation. The future requirements for continued operation of Station 'A' will become clearer as the picture for Northern Augmentation (exports to NSW) develops. The Saturn compressor packages and balance of plant should be retired by 2017.

Station 'B' has been designed to facilitate expansion using Centaur 50S enclosed packages to provide compression services to additional WORM (DN500) and Wollert-Barnawartha (DN450) pipelines

4.5.1 Stage 2: Station Piping issues

The AEMO Planning report also identified the need for duplication of the Wollert to Wandong section of the Wollert to Wodonga pipeline in order to address the constraints at Echuca and Culcairn. This is of relevance to the pipeline route selection for the Wollert to Rockbank pipeline (WORM) as this pipeline may also need to parallel the existing pipeline north due to the 'green wedge' north-east of Wollert. The proposal to construct the Wollert to Rockbank pipeline (WORM Stages 2&3) will avoid costly duplication of pipelines in this easement.

The same analysis is relevant to the two looping stages of the Sunbury pipeline identified in the Sunbury Planning Report due to Sunbury constraint, the first loop identified as being required by 2009. The installation of the Rockbank to Plumpton DN500 pipeline is committed for completion by 2012 and is Stage 1 of the proposed Rockbank to Wollert pipeline. Stage 2 Wollert to Kalkallo is proposed to be installed by 2014 to enable delivery to a new estate, with the final stage to be delivered in 2014 together with associated facilities.

It is therefore recommended that system planning and front end engineering design (FEED) commence in the coming AA4 (2013 to 2017) to determine preliminary pipeline route selection, obtain necessary permits and approvals, and to establish the feasibility, benefits and facility requirements for a single additional pipeline rated to 10.2 MPag.

4.5.2 Stage 3: One Centaur 50 T6102S (2014).

In the AER GasNet Final Decision April 2008, AER approved $49.57M for Brooklyn CS capital works approved against the System Integrity Test. This primarily comprised relocation and upgrade of one Centaur compressor (BCS11) and installation of two new compressors (BCS13 and BCS14) to support the compression functions including peaking gas compression services to Geelong and Ballarat, and refill operation of the WUGS facilities at Iona. (see also Section 3.3). APA GasNet proposes to install the WORM by 2013/2014 and APA modeling indicates the most prudent location for compression services is at Wollert which will also satisfy peak demand requirements for Ballarat and Geelong. Additional compressors at Brooklyn will not be required.

The AEMO VAPR 2011[15] has identified that the SWP/BLP is currently constrained to between 100 to 214 TJ/d on low demand days (ie below 600 TJ/d). The AEMO planning solution is to lower the operating pressure at both Wollert and Dandenong to 2600 kPag, below the minimum contract pressure for delivery points in the Dandenong area. AEMO practice has been to shut down Wollert CG in summer in order that gas delivered at Brooklyn can reach customers in northern metropolitan Melbourne via distributors' interconnecting transmission systems.

APA GasNet modeling has demonstrated that completion of the Rockbank to Wollert pipeline (WORM) will significantly reduce this constraint allowing contract pressures to be met without active operation of the three main regulator stations feeding Melbourne.

The requirements for 6 MW power as identified in the AEMO Vision 2030 may be met with one additional Centaur 50S T6102S package. However, scope of station works may include connections from and/or to the new 10.2 MPa WORM. For example, there may be a requirement for Wollert compressors to inject Otway gas into the Wollert to Wodonga pipeline, or to inject Longford gas into either the WORM (BLP/SWP) or the Wodonga pipeline.

Construction of Stage 3 should be possible with minimal impact on station availability due to segregation of Stage 2 compressor facilities. Additional valve skids may be required for WCS4 and WCS5.

- WCS6 Compressor Upgrade - one Centaur T6102S compressor package

4.6 *Euroa Compressor Station (2012)*

The AEMO Northern Planning Report has identified the installation of a Solar Saturn compressor upstream from the branch to Echuca at Euroa as part of the most cost effective solution to the Northern Zone Constraint. APA GasNet modeling has determined that a more cost effective alternative delivering improved capacity is the installation of a larger compressor suitable for service in the future DN450 Wollert to Barnawartha pipeline, capable of delivering up to 220 TJ/d to Culcairn in conjunction with full looping (refer Vision 2030 Update).

2008-2012 (AA3)

APA GasNet has committed to construction of a compressor station comprising a single Solar Centaur 50S (T6102S) –C334 compressor skid which is planned for completion in the current access period (AA3). The station pipework is above-ground and uses a standard APA design. This station increases the current Culcairn import and export potential (following installation of Wollert CS 'B' and MAOP upgrade of Wollert to Euroa from 7400 to 8800 kPag).

The scope of works includes a station control room with TMR PLC controls similar to Springhurst compressor station, utilising a local and remote station HMI and connected to safe-area Solar T4000 controls also similar to the Springhurst compressor (a standard APA design).

- ECS1 Compressor - one Centaur T6102S compressor package

[15] AEMO VAPR 2011 App C, fig C-7 & Table C-1

4.7 Springhurst Compressor Station

2008-2012 (AA3): APA GasNet installed reverse flow capability (ie flow north) as part of the Northern Augmentation project. This included upgrade to the unit control (TT4000) system, station RTU and ASV/FSV valves.

- SCS Reverse Flow (complete 2010)

2013-2017 (AA4): In the course of assessing design of the facility (which was constructed without the usual design review processes due to the winter 1999 gas emergency), it was determined that the oil/gas cooler is undersized for summer operation. Capacity rights for export though Culcairn include summer operation. Cooler augmentation is therefore required.

- SCS Cooler Upgrade

Life extension: The station was constructed in 1999 to ANSI B31.3 and comprises above-ground piping systems.

4.8 Future Compressor Stations

The current outlook on gas supply growth in Victoria suggests that gas from the Otway basin will continue to provide an increasing share of peak day capacity into the Melbourne market. Peak hour and peak day gas sourced from the Bass Strait is gradually declining (GSOO 2011). This is expected to lead to the requirement to augment the SWP/BLP particularly for peaking services, therefore compression is likely to emerge as a preferred solution in conjunction with establishment of the Rockbank to Wollert pipeline (WORM). It is anticipated that there will be up to three compressor stations on the SWP/BLP. These are anticipated to be single compressor packages.

5.0 Station Automation

Whilst compressor stations have a typical design life of about 25 to 30 years, control equipment at compressor stations has a relatively limited life (about 15 years) due to the greater demands on the control capability and reliability of the stations and lack of support from suppliers. The first cycle of automation upgrades commenced with Gooding (1998) and Brooklyn (1999).

The APA national standard SCADA package is ClearSCADA and will be progressively implemented at all compressor sites in lieu of the previous APA GasNet iFix station HMI.

5.1 Gooding Compressor Station

The existing Fix station HMI is connected to the GasNet corporate SCADA LAN and is expected to be supportable through to 2012. The Dandenong control room iFix workstation accesses the station HMI via the SCADA LAN.

2008-2012 (AA3):

Gooding utilises Tricon TMR station PLC which provides critical safety and control functions. The CPU cards are no longer supported and will be replaced.

- GCS Tricon CPU Upgrade (in progress 2011)

Gooding compressors are currently fitted with hazardous area unit HMI (TT2) and PLC5 controls which will still be supportable through to 2012. However, there is no remote IP access to this generation of unit HMI and it is proposed to provide a composite windows-based Solar Turbotronics TT4000 HMI which will also facilitate unit fault diagnostics and commissioning of the new dry-seal compressors (see section 4.1).

- GCS Unit Controls Upgrade (in progress 2012)

5.2 Brooklyn Compressor Station

Brooklyn also utilises Tricon TMR station PLCs which provide critical safety and control functions. These PLCs are configured as a station ESD PLC and a station Integrated Unit Control System (IUCS). The original CPU cards are no longer supported and will be replaced. Similarly, the station RTU is a Bristol 3300 series RTU (no longer supported) and will be replaced with current generation RTU.

- BCS Safety and Process Control System and RTU Upgrade (2013)
- BCS RTU and Control System Upgrade (2013)

The station Tricon systems were expanded as part of the BCS12 and Brooklyn Lara Pipeline projects over 2007 and 2008. These systems include the site pressure regulating stations (Brooklyn BCP City Gate, BLP City Gate and Brooklyn PRS) to provide integrated control of the site. The upgrade of BBP PL to BBP CG and BCP CG controls is due for completion in 2012.

The existing Fix station HMI is expected to be supportable through to 2012. The Dandenong control room Fix workstation accesses the station HMI via the SCADA LAN. It is proposed to progressively upgrade the system to current generation iFix HMI.

- BCS Station HMI (2012)

The Centaur BCS10 and BCS11 compressors are currently each fitted with hazardous area unit Allen Bradley PLC5 controls which will still be supportable over the next few years. However, support for the DOS-based HMI (TT2) is limited and there is no remote IP access to this generation of remote HMI. A composite windows-based Solar Turbotronics TT4000 HMI was provided as part of the BCS12 project to install the new dry-seal T4700-C336 compressor. The Saturn compressors BCS 8 and 9 utilise relay-based logic and as such diagnostic support is very limited for this generation of controls. As these units are planned to be mothballed by 2017, controls upgrades are not planned for these units.

5.3 Iona Compressor Station

Station controls are currently provided through the supervisory Bristol RTU for the compressor station as there are no instrumented safety critical functions on site. (i.e. there is no requirement to isolate and vent the small-bore station pipework). There is no SCADA LAN currently established on site and all data depends on SCADA transmissions on the Telstra DDN line.

Upgrade of the controls to an IP based Bristol ControlWave RTU or safety PLC is likely to be required prior to 2014 along with establishment of an alternate communications system.

Provision of a local station Fix HMI was installed for the Iona compressor station in 2007 which also provides local display of the adjacent Iona City Gate and Iona Fuel Gas Meter (CTM) facilities. The Dandenong control room Fix workstation provides a remote operator interface via the GasNet Open Enterprise SCADA system.

Each compressor has a small Allen Bradley local display console that is expected to be supportable through to 2012. Remote support for this equipment is currently not established, significantly affecting the ability of GasNet to respond to equipment problems.

- Iona CS Automation and RTU Replacement (AA4)

5.4 Wollert Compressor Station

Automation of Wollert CS ‘A’ was completed in 2007/08. The station safety (ESD) and control system comprises a Tricon TMR PLC to control the compressor station together with a Trident TMR PLC to control the regulator stations (Wollert City Gate and Wollert Pressure Limiter) and station isolation valves.

Provision of a local station iFix HMI was installed for the Wollert compressor station in 2007 which also provides local display of the adjacent Wollert City Gate and Wollert Pressure Limiter facilities. The Dandenong control room iFix workstation is configured to provide a remote operator interface via the corporate and SCADA LAN communications system.

The Saturn compressors WCS 1, 2, and 3 utilise obsolete relay-based logic and, as with the Brooklyn Saturns, diagnostic support is very limited for this generation of controls.

As part of the Northern Augmentation project, two new Centaur 50S (T6102S) compressors were installed in 2011 (WCS ‘B’) capable of delivering the required increased discharge pressure into the DN300 pipeline. The Centaur packages use current generation TT4000 unit controls (see section on Major Upgrades) and utilize the station Tricon PLC and HMI. The station layout provides for future expansion to extend the number of compressors, to connect to/from the SWP/BLP via the future Rockbank to Wollert pipeline (WORM) and to the future DN450 Wollert to Barnawartha pipeline. Station piping is above-ground.

Additional power is expected to be required in the coming AA4 to meet contracted demand on the Northern system. Options to be investigated include upgrade of the existing Saturn wet-seal compressors or additional Centaur 50S (T6102S) compressor package, the latter being more likely. The limitations in Station ‘A’ station piping pressure, age of the existing equipment, including wet-seals of the compressors, suggest there will be strong technical advantages to using a new package matched to the existing units.

5.4 Springhurst Compressor Station

Upgrade of the station controls to an IP based Bristol ControlWave RTU and safety PLC was implemented in 2011 as part of the Northern Augmentation, along with establishment of an alternate communications system. The facilities include the capacity to compress either north (NSW exports) or south (NSW imports) using two sets of station valves. The existing local Fix station HMI was upgraded to iFix and is expected to be supported for the remainder of the coming Reset AA4. The Dandenong control room iFix workstation accesses the station HMI via the real-time communications service.

The compressor unit controls were upgraded to current TT4000 technology and comprise a safe-area Allen Bradley Flex I/O control PLC that is expected to be supportable through to end of AA5

Appendix 1 Summary of Compressor Stations

Station	Compressors	Installation date
Eastern – Longford to Melbourne		
Gooding	GCS1 - Solar Centaur T4002, GCS2 - Solar Centaur T4002 GCS3 - Solar Centaur T4002 GCS4 - Solar Centaur T4002	Package installed 1977 Package installed 1977 Package installed 1977 Package installed 1977.
South-Western – Melbourne to Portland		
Brooklyn Stage 3 Brooklyn Stage 4	BCS8 - Solar Saturn T1202BCS9 - Solar Saturn T1302 BCS10 - Solar Centaur T4002 BCS11 - Solar Centaur 4002 BCS12 – Solar Centaur T4702	Package installed 1982 Package installed 1982 Package installed 1982 Package installed 1982 Package installed 2007
Brooklyn Stage 2	BCS4 - Solar Saturn T1302 BCS5 -Solar Saturn T1302 BCS6 - Solar Saturn T1202 BCS7 - Solar Saturn T1302	Package installed 1979 Package installed 1979 Package installed 1979 Package installed 1979 Decommissioned 2011
Stonehaven	StCS1 – Solar Taurus T7702S (TBC)	Package proposed for 2014.
Iona	ICS1 - Caterpillar engine with Gemini Recip compressor ICS2 - Caterpillar engine with Gemini Recip compressor	Package installed 2001 Package installed 2001
Northern – Melbourne to Culcairn/Young		
Wollert A Wollert B	WCS1 - Solar Saturn T1202 WCS2 - Solar Saturn T1302 WCS3 - Solar Saturn T1202 WCS4 – Solar Centaur T6102S WCS5 – Solar Centaur T6102S WCS6 – Solar Centaur T6102S	Package installed 1981 Package installed 1981 Package installed 1981 Package installed May 2011 Package installed May 2011 Package proposed for 2014
Euroa	ECS1 Solar Centaur T6102S	Committed for commissioning Jun 2012
Springhurst	SCS1- Solar Centaur T6102	Package installed 1999

Appendix 2 Summary of Major Works by Station

Station	Compressors	Status
Eastern – Longford to Melbourne		
Gooding	GCS1 - Solar Centaur T4002, GCS2 - Solar Centaur T4002 GCS3 - Solar Centaur T4002 GCS4 - Solar Centaur T4002	Compressor restaged Feb 1983 Overhaul engine Apr 1992 PT overhaul 1994 Control system upgraded to TT2 1998. C402 dry seal compressor install 2007/8 Replace PT with dampened PT 2007 Control system upgrade to TT4000 2012. Compressor restaged Feb 1983 Overhaul engine 10326hrs Apr 1997 Control system upgraded to TT2 1998 C402 dry seal compressor install 2007/8 Replace PT with dampened PT 2008 Control system upgrade to TT4000 2012. Compressor restaged Feb 1983 Control system upgraded to TT2 1998 C402 dry seal compressor install 2007/8 Replace PT with dampened PT 2008 Control system upgrade to TT4000 2012. Compressor restaged Feb 1983 Overhaul engine 11976hrs Mar 1998 Control system upgraded to TT2 1998 C402 dry seal Compressor installed 2007 Replace PT with dampened PT 2007 Control system upgrade to TT4000 2012.
South-Western – Melbourne to Portland		
Brooklyn	BCS8 - Solar Saturn T1202 BCS9 - Solar Saturn T1302 BCS10 - Solar Centaur T4002 BCS11 - Solar Centaur T4002 BCS12 – Solar Centaur T4702	Compressor damaged due to failed NRV Feb 1992 Engine replaced with BCS4 engine 2007 Compressor re-staged Aug 1993 Compressor re-staged Oct 1999 Control system upgraded to TT2 Dec 1999 PT overhaul at 28000hrs 2004 Engine reverse spin (NRV fail) 2006 Engine overhaul at 31049hrs Dec 2007 Compressor restaged Feb 1985 Control system upgradedto TT2 Dec 1999 Engine overhaul at 29277hrs Nov 2000 C337 dry seal compressor installed 2006 C336 dry seal compressor installed 2007
	BCS4 Solar Saturn T1302	Engine up-rated to T1302 Jan 1998

		Skid removed Jun 1998 (Euroa) Engine installed in BCS9 Mar 2007
	BCS5 Solar Saturn T1302	Engine up-rated to T1302 Jan 1998 Skid removed Jun 1998 (Young) Engine installed in BCS7 Jan 1999
	BCS6 - Solar Saturn T1202	Engine replaced with WCS2 engine 2000 Balance of plant demolition 2011
	BCS7 - Solar Saturn T1302	Engine replaced with BCS5 engine 1999 Balance of plant demolition 2011
Stonehaven	StCS1 – Solar Taurus T7702S (TBC)	Tie-in pipework on site. Land allocated. New bi-directional facility to be constructed by 2014
Iona	ICS1 - Caterpillar engine with Gemini Recip compressor ICS2 - Caterpillar engine with Gemini Recip compressor	Station is capable of compression west only. Unit coolers undersized Unit inlet pressure reduction to be installed 2013
Northern – Melbourne to Culcairn/Young		
Wollert	WCS1 - Solar Saturn T1202 WCS2 - Solar Saturn T1302 WCS3 - Solar Saturn T1202 WCS4 – Solar Centaur T6102S WCS5 – Solar Centaur T6102S	Compressor re-staged Aug 1997 Compressor re-staged Aug 1997 Engine FOD – repl. with BCS7 engine 2000 Engine up-rated to T1302 Dec 2003. Compressor re-staged Aug 1997 Engine & compressor damaged by reverse spin Apr 2002 (NRV failure) Station cooler and recycle valve inst'd 2004 Safety controls installed by Dec-2007 Package installed May 2011 Package installed May 2011
Euroa	ECS1 Solar Centaur T6102S	New bi-directional facility to be constructed near existing site at junction of Wodonga and Euroa pipelines Jun 2012.
Springhurst	SCS1- Solar Centaur T6102	Initially constructed to compress south only. No standby unit. TT2 HMI replaced 2006 Unit controls upgraded to TT4000 in 2011 Station pipework modified to permit compression either north or south

Appendix 3 Upgrade and Overhaul of Compressor Engines

The engine overhaul program has been based on scheduled turbine life programs under the Solar Turbines Alliance Agreement, with some early life overhauls conducted in response to annual condition reports or faults. The high start count at Gooding is considered to be a contributing factor to the short life of this equipment.

Overhauls of the installed engine base is summarized below:

Date	Tag	Engine Hours at time of overhaul/repair	Comments
	WCS1		T1302 from BCS7 installed 2008.
	WCS2		T1202 from BCS6, overhauled & uprated Dec 2003
	WCS3		T1202 from WCS1 repaired and installed 2008.
	WCS4		T6102S. Original engine
	WCS5		T6102S. Original engine
	BCS4	35,123	Uprated and removed from service; relocated to BCS9
	BCS5	36,062	Uprated and removed from service; relocated to BCS7
	BCS6	38,515	Removed from service & relocated to WCS2, then uprated
	BCS7	48,232	Removed from service; relocate to storage
	BCS8		Original engine.
	BCS9	16,532	Repaired 2007 following PT failure
	BCS10	31,049	Overhauled Dec 2007
	BCS11	29,277	Overhauled Nov 2000. PT replaced
	BCS12		Original engine
	GCS1	15,218	Overhauled Apr 1992. PT replaced 2007
	GCS2	10,339	Overhauled Apr 1997. PT replaced 2008
	GCS3	20,910	Due for overhaul, PT replaced 2008
	GCS4	11,976	Overhauled Mar 1998; PT replaced 2008

Under the Alliance Agreement engines are overhauled with agreement of the parties based on condition of the equipment or at designated life. Saturn 10 (T1202 and T1302) and Centaur 40 (T4002 and T4702) engines are overhauled at 40,000 hours, and Centaur 50 engines are overhauled at 30,000 hours unless condition assessment indicates otherwise.

Appendix 4 Maps

Figure C-1 — Main gas DTS pipelines

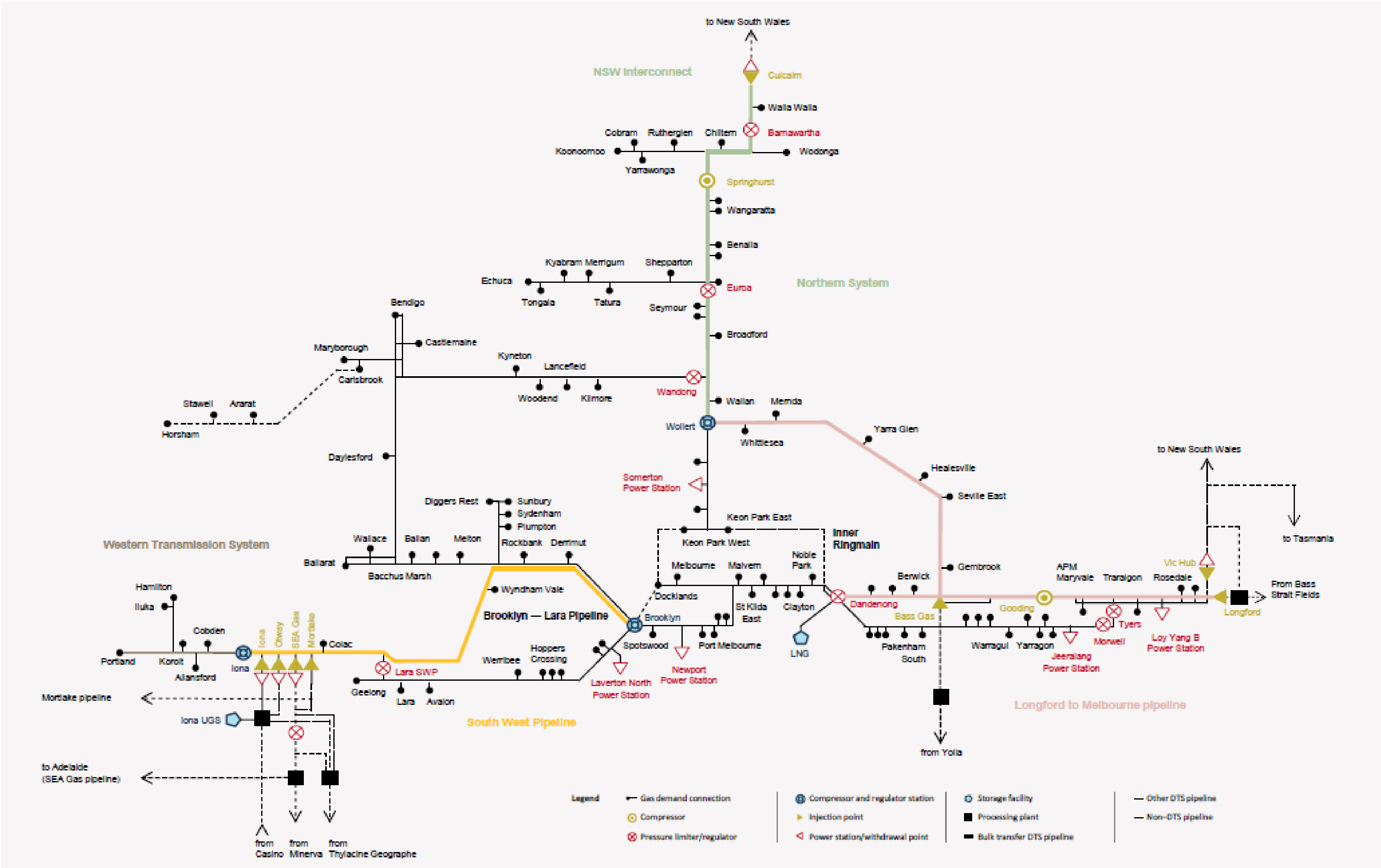


Figure C-2 — Gas DTS typical gas flows

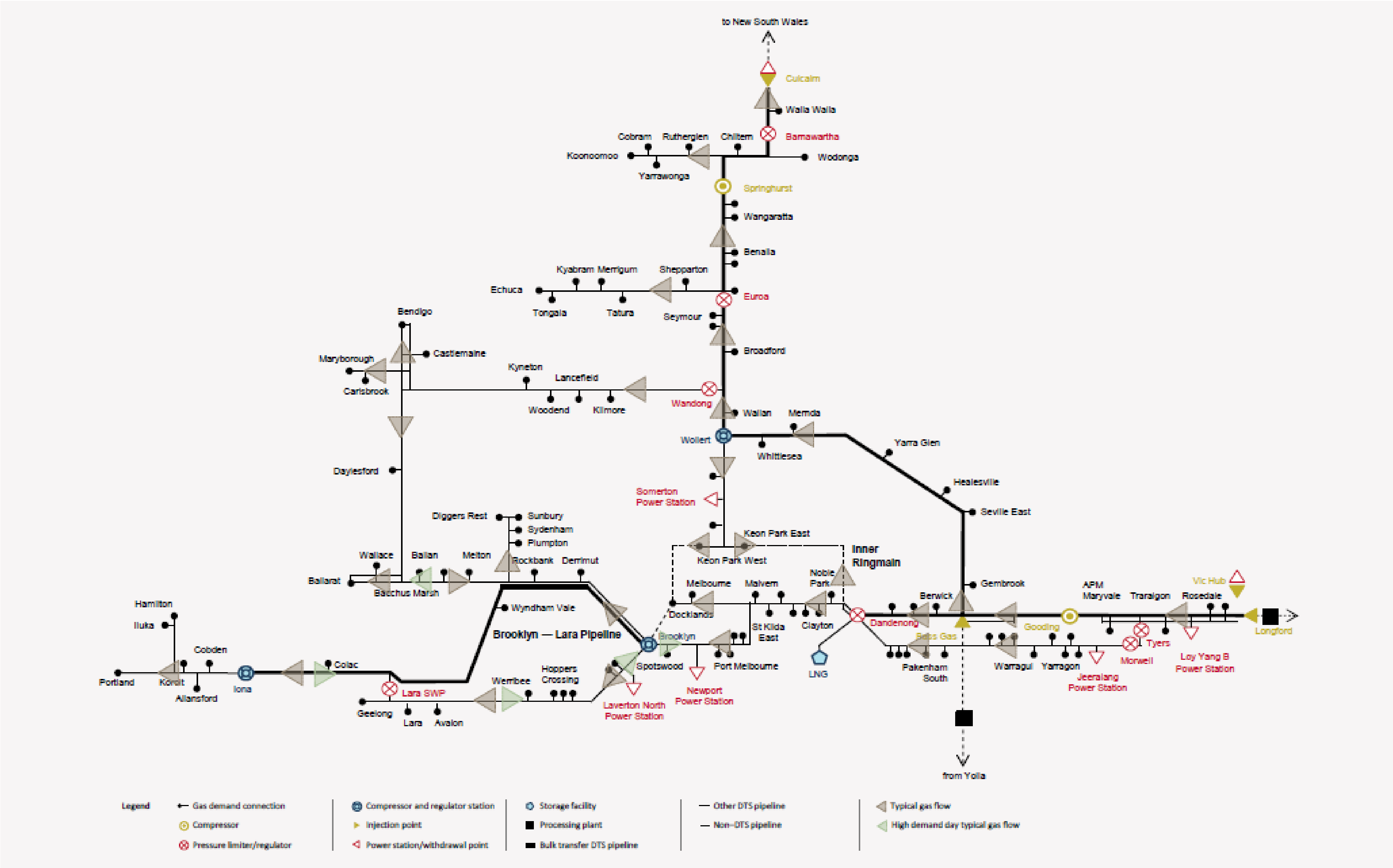
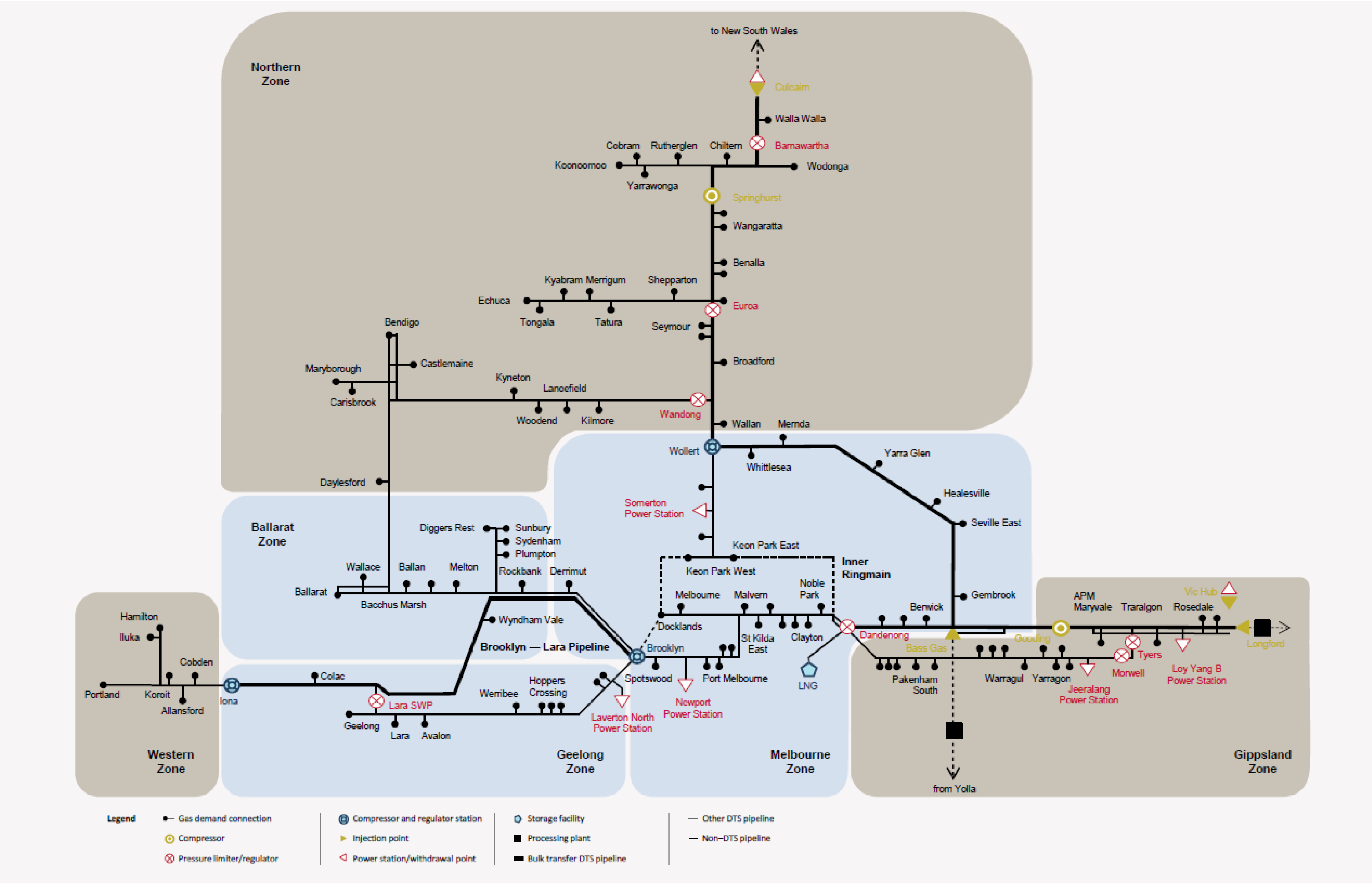
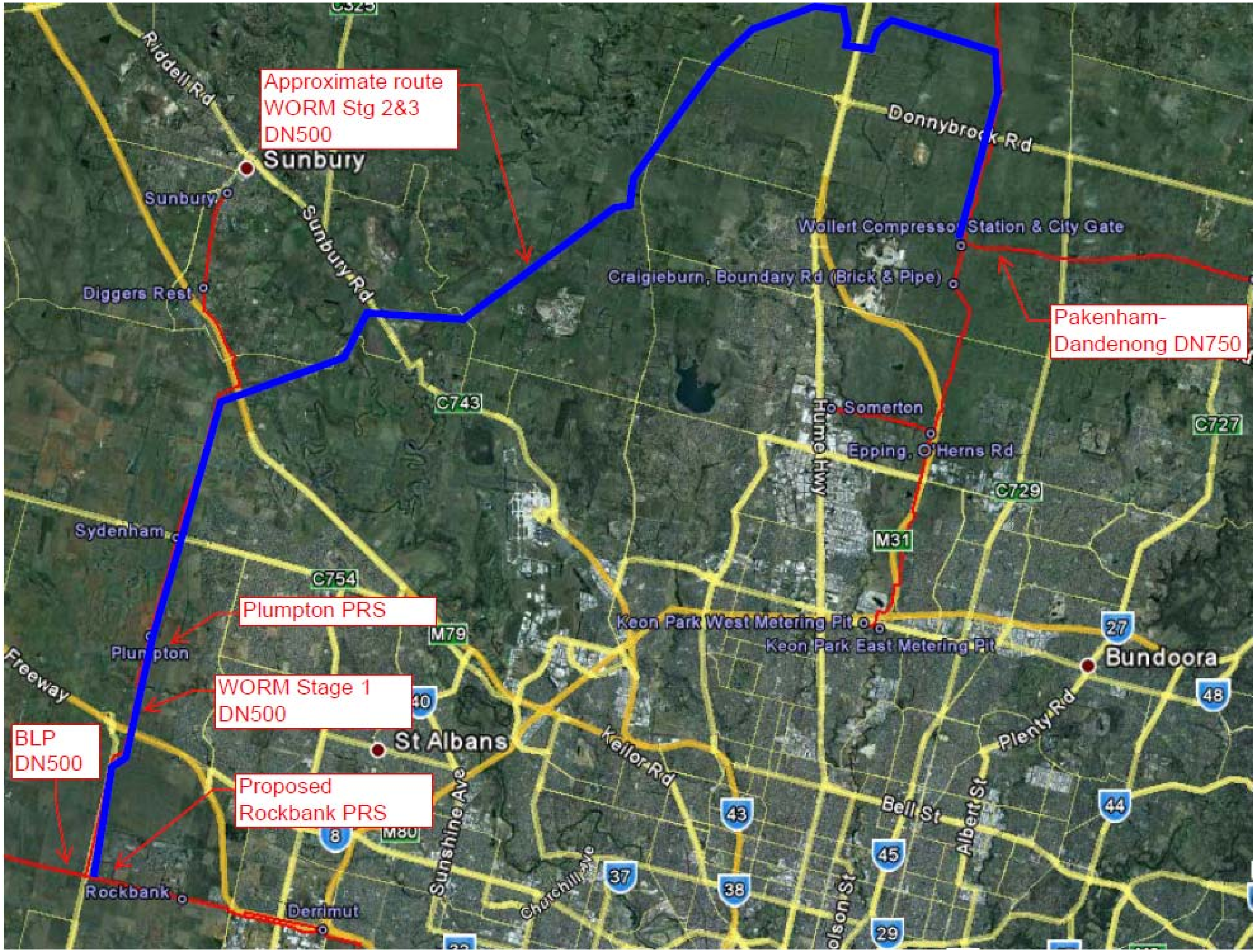


Figure C-3 — Gas regions





Approximate route of Wollert Outer Ring main