Final Plan Attachment 8.6 V01 Supporting Information 1

Business Cases

Geoff Cope & Associates Report

December 2016

CONFIDENTIAL

SEYMOUR CITY GATE REGULATOR PIT

REPORT ON

ELECTRICAL SURGE EVENT
NOVEMBER 2009

Rev O 5 May 2010

Geoff Cope & Associates Pty Ltd

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Reference Standards

AS/NZS 4853:2000 Electrical hazards on metallic pipelines
AS/NZS 1768:2007 Lightning protection

Revision History

Revision	Date	Description
1	29 March 2010	Initial issue for comment.
O	5 May 2010	Final issue following client discussions

Seymour City Gate Regulator Pit
Report on electrical surge event November 2009

1. Introduction

During November 2009, ignition of gas within the Seymour city gate regulator pit caused the lids to be opened and caused some damage to their concrete surround. The timing of this incident was coincident with a period of thunderstorm activity in the Seymour area. APA Thomastown group has engaged Geoff Cope & Associates to assist with reviewing the incident and providing guidance as to the possible cause and the remedial works which might be considered to reduce the probability of any recurrence at this or other similar locations. This report summarises the results of this review and provides recommendations in relation to measures that might be applied to mitigate against future occurrences.

2. Site layout and other relevant structures

Gas supply to the town of Seymour is taken from the 300 mm Keon Park to Wodonga transmission pipeline at a transfer station several kilometres east of the town at Telegraph Road. Details of structures within the station are shown in Appendix 1. The 300 mm pipeline passes through the station, with a 50 mm offtake supplying into the regulator pit where the pressure is reduced into the 200 mm Seymour supply. Inlet and outlet pipelines are fitted with insulated flanges where they enter inside the regulator pit, and other pipework inside the pit is fitted with insulated couplings such that the inlet and outlet pipes are electrically isolated from the centre pipework and other equipment within the pit. In the vicinity of the transfer station, the transmission pipeline runs parallel to Telegraph Road on the eastern side, whilst the distribution pipeline runs on the western side for a short distance to the Goulburn Valley Highway, which it then follows into Seymour. A general map of the locality is shown in Appendix 2.

A 22 kV powerline supplying local rural properties runs at an offset of (typically) 50 to 100 metres for a distance of approximately 1½ kilometres. A 66 kV powerline crosses the transmission pipeline at Telegraph Road, and runs on the southern side of the distribution pipeline for 3 kilometres, at an offset of typically 130 metres, to a terminal station at Hume and Hovell Road in Seymour.

Telecommunication structures within the transfer station site include a tall pole, estimated height 20 metres, which is positioned about 7 metres from the regulator pit. This pole is significantly higher than adjacent structures and would be the initial object most likely to be struck by lightning.

3. Methodology

The site was visited on 20th January 2010 and the internals of the pit were inspected for any evidence of electrical arcing or other damage caused by electrical activity. The locations of powerlines in the area, which might case voltage rise due to induction or earth potential rise, were established by visual inspection along the routes of the transmission and distribution pipelines that are associated with the pit. Possible causes of electrical arcing that might have resulted in gas ignition were considered taking into account electrical continuity of pipework and metalwork in the pit and assessed in view of practical experience and the principles and guidance as provided in AS/NZS 1768 and AS/NZS 4853. The outcomes of this assessment are provided in this report.

4. Results of inspections

Comprehensive preliminary inspections were carried out by APA personnel following the incident. These revealed no significant damage caused by the gas ignition apart from that associated with the lid of the regulator pit. Arcing was observed on a section of stainless steel tubing where it ran beneath the pit lid, with corresponding evidence of an arc on the steel frame of the lid. With the lid closed, the tubing would have been lightly in contact with the lid at the point where the arcing occurred. Relevant photographs are shown in Appendix 3.

Examination of pipework within the pit indicated no evidence of lack of electrical continuity except where broken by insulated flanges or couplings that separate centre pipework from inlet and outlet pipelines. Electrical continuity of reinforcing steel in the pit walls is undetermined, however it is unlikely that this pit was constructed with reinforcing sections intentionally bonded. The steel pit lid, which is set in a concrete surround, is not bonded to any of the pipework and is electrically separate.

Measurements taken at the insulated flanges within the pit revealed all to be electrically intact, and it is understood there is no indication of loss of cathodic protection due to failed insulation or contact to earthing or other structures. At this location, flanges are not fitted with electrical surge protection devices as has been done elsewhere where a higher level of risk of surges has been assessed. This is in accord with the observations as discussed below in relation to powerlines, in that the lengths of exposure and separation distances are such that levels of induced voltage sufficient to cause physical damage would not be expected.

Data from the powerline authorities has not been obtained, nor have any soil resistivity measurements been taken. However a conservative analysis based on typical fault currents, estimated soil resistivity and the physical observations as taken during the site visit has been performed. This determined the induced voltage on the pipeline due to a phase to earth fault on the 66 kV powerline adjacent to Goulburn Valley Highway to be of the order of 1 kV, as shown in Appendix 4. Whilst this might have some possible ramifications in terms of personnel safety, voltages of this order would not be expected to cause any damage or failure of insulated flanges or couplings. The lengths of exposure to the 22 kV powerlines in the vicinity of Telegraph Road are considerably less than that to the 66 kV line as discussed above, and fault currents on these local supplies would also be lower, hence they would produce correspondingly lower induced voltages that pose less risk of causing damage.

5. Discussion and recommendations

The available evidence strongly points towards the source of ignition of gas inside the Seymour regulator pit being a spark between stainless steel tubing and the metal frame of the pit lid. Evaluation of voltages generated by phase to earth faults on powerlines in the area indicates that powerline faults are not a likely source of sufficient voltage to cause a spark. Furthermore the insulated flanges and other insulating fittings in the pit were found to be electrically intact, indicating that high voltages had not entered via the inlet or outlet pipelines.

The ignition had occurred at the time of substantial lightning activity in the area, and the telecommunications pole at the site is of sufficient height to attract lightning. A lightning strike to the telecommunications tower would result in a number of effects:

1. The potential of the earth in the vicinity of the tower would be raised substantially above that of remote earth, due to the current being discharged by the stroke.
2. The current associated with the stroke would cause a substantial electromagnetic pulse, which could induce substantial currents into nearby conductors such as metallic pipelines, pipes and cables.
3. Pipelines that intercept the voltage gradient created around a lightning stroke are effectively at remote earth potential due to their extensive contact with ground over their length. They would therefore be subject to substantial voltage across their insulating coating, although current flow along these pipes would be somewhat limited by their high impedance at the frequencies associated with a lightning impulse.

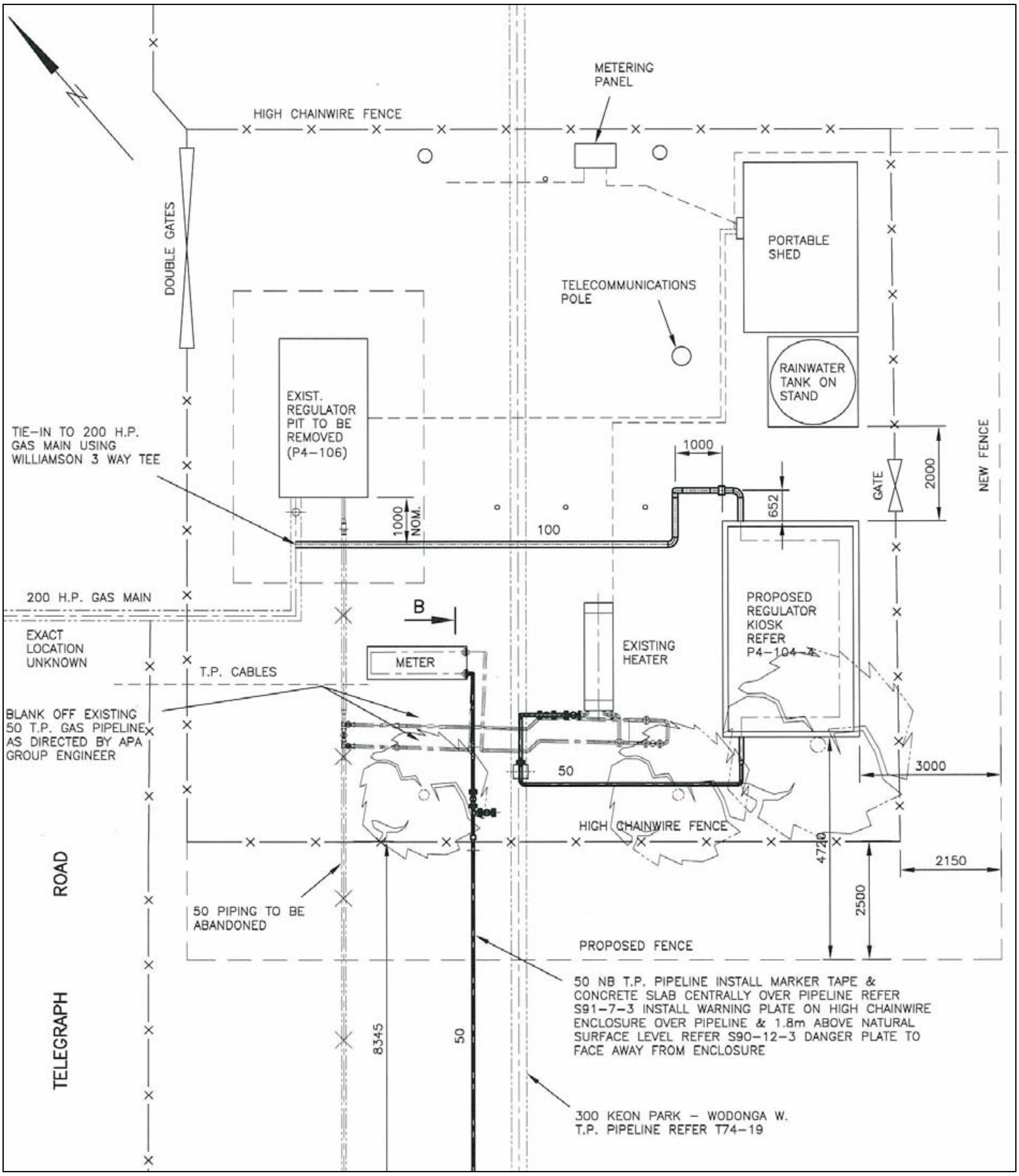
The exact mechanism that caused the voltage differential and arcing between the regulator pit lid and the tubing directly beneath it is uncertain, although it was almost certainly caused by a lightning stroke. Substantial voltage gradients would have arisen in the ground in the vicinity of the telecommunication pole, and significant currents could have been generated in nearby conductors by the electromagnetic pulse accompanying the stroke. It is possible there may have been a side flash from the telecommunications pole to the metallic pit lid, as this would have presented an attractive nearby ground, augmented by the metallic pipelines beneath. Any of these mechanisms would have been capable of producing sufficient voltage differential to cause arcing between adjacent metallic conductors that were not bonded together. The recommended solution, as discussed in AS/NZS 1768, is to employ equipotential bonding, either by direct connection or via appropriate surge protection devices (SPDs) where direct connection may cause unwanted effects such as loss of cathodic protection.

It is therefore recommended for regulator pits where telecommunications (or other) facilities are likely to increase the likelihood of lightning strikes, that all metalwork and pipework be electrically bonded. This applies only to pipework and metalwork that is not already in direct electrical contact, such as would be provided by welded or bolted connections or connection via metallic support frames, busbars etc. Pipework and metalwork connected in such a manner should be considered as electrically continuous and not requiring additional bonding. Bonding may be via bonding cables or suitably rated SPDs. Bonding cables should be run as directly as practicable and should avoid unnecessary bends and loops which would add inductance to the path. Bonding conductors should be of size 6 mm^2 minimum (copper) for general bonding of pipes and metalwork, or 35 mm^2 minimum (copper) where they may be subject to a substantial proportion of the lightning stroke current. Where SPDs are required (such as across insulated flanges or couplings where cathodically protected pipe enters a pit) they should be rated to carry both the lightning pulse current and any AC surge current that may be induced from powerlines under fault conditions.

Geoff Cope
5 May 2010

Appendix 1

Schematic diagram of Seymour transfer station site



Note: This drawing shows the existing site arrangement plus proposed future alterations, which include removal of the existing regulator pit and replacement with a regulator kiosk. Only the existing structures are relevant to this report.

Appendix 2

General locality map of area

Notes:

1. Goulburn Valley Highway is marked as B340 in the map above.
2. The transfer station and associated regulator pit is located on the east side of Telegraph Road a short distance north of the Goulburn Valley Highway (B340).

Appendix 3

Photographs of pit interior

Figure 1:

Pit interior. Tubing where arcing had occurred is circled in red.

Figure 2:

Closer view of tubing showing arc mark (centre of picture).

Note: Photograph was taken with pit lid open. When lid is closed, the frame of the lid is in light contact with the tubing where the arcing had occurred.

Appendix 4

Voltage induced from 66 kV powerline along Goulburn Valley Highway

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Faulted Tower Data
Comments

Comments

200 mm gas supply pipeline into Seymour.
Calculation of induced voltage using nominal typical parameters.
Length of exposure = 3 km (approx. actual), along Goulburn Valley Highway.
Offset from powerline = 130 metres (typical actual along length).
Pipe coating resistance 1 Meg ohm cm (assumed, conservative high figure).
Fault current = 5 kA (assumed as a typical high fault current on a 66 kV rural supply).
Soil resistivity = 10,000 ohm cm. (Assumed from observation of soil type. Not a highly critical parameter.)
Assumed no mitigation or earthing - worst case evaluation.

File Sey66kV1.acd

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Fault Voltage
Graph and Data