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DEPT. OF RESOURCES, ENERGY AND TOURISM

DRET CCS Task Force Support

Impacts of Interruptions to Supply for Carbon Dioxide Pipeline Transport Flow

401001-00514-00-PL-REP-0002

21-Aug-09

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DRET CCS TASK FORCE SUPPORT
IMPACTS OF INTERRUPTIONS TO SUPPLY FOR CARBON DIOXIDE PIPELINE TRANSPORT FLOW

SYNOPSIS

The Australian Government Department of Resources, Energy and Tourism (DRET) has requested WorleyParsons to conduct a study to review the effects of non-continuous CO_2 flow on the proposed carbon capture and storage network.

This report describes both the technical and commercial impacts that result from non-continuous flow as well as providing preliminary conclusions.

Disclaimer

PROJECT 401001-00514 - DRET CCS TASK FORCE SUPPORT

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Issued for Use	A Cook	P Cox		21-Aug-09		

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1. INTRODUCTION

The Commonwealth Department of Resources, Energy and Tourism (DRET) has requested WorleyParsons to provide specialist support for carbon dioxide (CO_2) pipeline networks as part of their review into carbon capture and storage (CCS). This report reviews and describes the impacts of non-continuous CO_2 flow that would affect the CO_2 pipeline owner/operators.

This report describes both the technical and commercial impacts that result from non-continuous flow as well as providing preliminary conclusions that summarise the effects resulting from non-continuous CO_2 flow.

2. TECHNICAL IMPACTS

There may be occasions, due to an equipment failure, a requirement to carry out maintenance either at the capture station, injection facility or along the pipeline or for commercial reasons where the flow of CO_2 would need be stopped or curtailed for a period of time.

2.1 Single Source to Sink Systems

In the scenario where there is only one emission source of CO_2 into the pipeline and storage system and the capture equipment at the emission source is shut down, the total system would also need to be shut in. The pipeline would be isolated and the sequestration field shutdown. Although this study does not examine the storage basin impacts of temporarily shutting in, the capture facility, start of line compression, pipelines, pumping stations and the injection facility would all be designed for this scenario and would safely shut down isolating the CO_2 stored in the system. Venting of any significant quantities of CO_2 to atmosphere would not be required for short duration shut downs.

2.2 Multiple Source to Sink Systems

In the scenario where there are a number of connected emission sources and one of the capture facilities is required to be shut down then the network flow would be proportionally reduced. Because of the reduced flow and the requirement to maintain the CO_2 in the super-critical phase, the storage site would also need to reduce flow by the same amount by either closing or choking a number of wells. If the storage site continued to operate at normal flow, it would eventually draw down the pressure in the pipeline to below super-critical causing significant operational issues. Some midline pumping stations may also be temporarily shut down as there would be less pipeline frictional losses at the lower flow.

2.3 Impacts of shutting in a Carbon Dioxide Pipeline

If a pipeline is shut in, the pipeline pressure will equalise to a constant pressure slightly higher than half way between the normal start of line pressure and end of line pressure. If the start of line pressure is 15 MPa and end of line 8 MPa, the settle-out pressure would be in the order of 12 MPa. Normally the start of line compressor station would remain pressured with CO_2 for short duration shutdowns but if the compressor station is de-pressured as well as shutdown, there could be a circumstance where there is approximately 12 MPa on one side of an isolation valve and atmospheric pressure on the other side. Although valves would be designed for CO_2 with appropriate seals specified, it is realistic to assume that there would be some leakage across the valve. Calculations were carried out to review the estimated leakage rates across a valve and the rate of de-pressurisation of the pipeline analysed. It was found that leakage rates across valves are inconsequential and there is not a valid case whereby the pipeline could drop below super-critical pressure as a result of valve leakage.

In instances where a CO_2 pipeline is required to be depressurised for the purposes of a repair appropriate procedures will be required to be implemented during venting to manage:

- The phase change between supercritical and gaseous;
- Low temperatures due to the Joule-Thomson effect.

2.4 Pressure Surge

The rapid shutting in of a pipeline conveying super-critical CO_2 may result in pressure surges. The severity of the pressure surges is proportional to the rate of change in flow/velocity ie valve closing time. The effects from induced pressure surges will need to be considered and if required, alleviated in the initial design phase either by designing the system for any anticipated pressure surges and by limiting the valve closing time.

2.5 Impacts of Shutting in a Carbon Dioxide Compressor

With respect to shutting down a multistage compressor unit no significant issues were identified. All units would be designed to accommodate shut down for emergency situations or planned shut downs. It is expected that compressor units would remain pressurised with CO2 while shut down unless it is being shutdown for maintenance reasons or there is a technical fault that has caused it to trip which requires the unit to be de-pressured for repairs. However, when a compressor unit shuts down, it is expected that the power generation or other emitter will continue to operate and produce their CO_2 stream so the CO_2 must then be vented directly to atmosphere, while the compressor is shut down. While CO_2 venting must be minimised, it is considered likely that emitting industries will continue to operate and thus emit directly to atmosphere under the following scenarios:

- On a trip of a CO_2 compressor;
- On a CO_2 pipeline shutdown (compressor in recycle);
- On a trip of CO_2 field booster pump, depending on spare pump starting configuration.

3. COMMERCIAL CONSIDERATIONS

There may be situations where emitters purposefully shut down their CO_2 capture equipment for commercial reasons.

A potential scenario is where a power generation site may decide to bypass the carbon capture system and emit CO_2 directly to atmosphere because the revenue from selling the parasitical power that is normally used to power the carbon capture and compression to the grid, outweighs the financial penalties of emitting CO_2 to atmosphere. This could happen at periods of high demand and high prices on the electricity spot market. The parasitical load of post combustion capture may be up to 30% of the rated power station output. The decision to bypass the carbon capture system will need to consider the CCS tariff structure which is likely to be based on a take or pay basis. The take or pay arrangements are common within the energy industry and commits the customer to pay for the pipeline and storage whether CO_2 is being sent for storage or not.

Conversely, where the pipeline operator stops or curtails the CO_2 flow for repairs or maintenance outside the permitted durations in the transportation agreement, the pipeline operator could be penalised. An emergency pipeline repair may take up to one week to complete or longer if people are injured or killed in the incident. All capture equipment and storage would need to shut down if the main transportation pipeline had such an incident. It is likely that power generation and other industry CO2 emitters connected to the system would continue to operate and simply emit their CO2 to atmosphere. Contracts or legislation would need to be in place to deal with this situation to determine who is responsible for the cost of emitting the CO2 to atmosphere, the cost of shutting in the storage facility for the duration that the pipeline is out of service and the cost of pipeline repairs.

In the event of a temporary shutdown of the CCS network, it is anticipated the CO_2 compressors and pumping stations would be left pressurised. Starting a compressor or pump unit from a pressurised mode would not involve significant power usage before the compressor commences to inject CO_2 into the pipeline.

Starting a compressor or pump unit from a de-pressurised mode would involve additional power to compress the CO_2 to pipeline pressure in recycle mode before it can injected into the pipeline.

4. CONCLUSIONS

The conclusions from this study are that:

- The technical impacts of temporarily stopping the CO_2 flow at either the emission source, along the pipeline or the injection facility are manageable;
- Appropriate engineering design measures will be required to be implemented to ensure a safe and reliable CCS system;
- Stopping or curtailing CO_2 flow may result in carbon dioxide being emitted to atmosphere potentially creating cost penalties to the relevant stakeholders as well as undesirable environmental consequences; and
- Legislation or contracts governing the CCS system need to address the implications of bypassing carbon capture equipment for commercial and technical reasons.