



# **Code of Practice**

## **Upstream Polyethylene Gathering Networks – CSG Industry**

**Version 4**

**Companion Paper CP-11-004**

**Safety in Operations**

**Rev 0**

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**Important note on use of the *APGA Code of Practice for Upstream Polyethylene Gathering Networks in the Coal Seam Gas Industry*.**

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## Preface

Companion Papers have been developed by the Working Group responsible for the *APGA Code of Practice for Upstream PE Gathering Networks – CSG Industry* (the Code) as a means to document technical information, procedures and guidelines for good industry practice in the coal seam gas (CSG) industry.

Since 2008, the development of the LNG export industry based in Gladstone, Queensland, with its related requirement for a large upstream CSG supply network of pipelines and related facilities presented the impetus for significant improvements in design and best practice approach.

The principal motivation for the initial development of the APGA Code of Practice was safety and standardisation in design and procedures and to provide guidance to ensure that as low as reasonably practicable (ALARP) risk-based requirements were available to the whole CSG industry. Accordingly, the Code is focused solely on this industry and the gathering networks using locally-manufactured PE100 pipeline. The Code is a statutory document within Queensland.

The incorporation of Companion Papers in Version 4 of the Code is intended to provide information and best practice guidelines to the Industry, allowing the Code to be limited to mandating essential safety, design, construction and operation philosophies and practices.

These documents form part of the suite of documents together with the Code and are intended to:

- a) be used in the design, construction and operation of upstream PE gathering networks
- b) provide an authoritative source of important principles and practical guidelines for use by responsible and competent persons or organisations.

These documents should be read in conjunction with the requirements of the Code to ensure sound principles and practices are followed. These documents do not supersede or take precedence over any of the requirements of the Code.

A key role of the Companion Papers is to provide the flexibility to incorporate endorsed industry practices and emerging technologies expeditiously, as/when necessary.

A related benefit is that the Companion Papers can be referenced by the wider resources industry which uses similar PE gathering networks for gas or water handling, including coal bed methane (CBM) in underground coal mines; mine de-watering; or the emerging biogas industries (agricultural, landfill, etc.).

# 1 Scope

The scope of this Companion Paper is detailed in Figures 1.2a and 1.2b in the Code of Practice which define the limitations of the gas and water gathering network systems in a CSG field. While the PE gathering systems provide the 'passive' connections between the key production components, their associated 'active' facilities (valves, vents, drains, flares, etc.) require constant monitoring and hands on response by field operations staff.

There are many, but three (3) principal, differences between operational safety issues for conventional gas (or water) transmission pipelines and CSG gathering networks:

- Gathering networks comprise numerous buried pipelines or cables for: transporting gas, produced formation water (which can contain air/gas/solids/water), and electrical power and data.
- Gathering networks normally operate under a Landholder Agreement, and can be subject to seasonal access constraints (e.g. for cultivated cropping land or significant rain events).
- Gathering networks are significantly influenced by the sometimes rapid decrease in produced volume of water and solids, (often after the initial 10-15% of a well's life, and during system re-activation if phased development of a sub-block occurs).

CSG operational activity shall comply with statutory obligations and normally conform to the resources industry's HSE standards based upon 'golden rules', 'lifesavers', or the equivalent, which recognise the major hazards implicit in this industry. Specifically, these include:

- driving, compliance with safe systems of work (permitting, barricading etc);
- lifting and handling;
- working in confined spaces;
- isolations from live systems;
- working in excavation;
- retained (static) energy;
- working at heights.

Increasingly, CSG industry design protocols are reinforcing the reliability and related safety advantages of including wellheads in field power and fibre optic (FO) cable reticulation.

Operational safety case studies have identified that driving is responsible for a dominant percentage of the hazards in CSG field operations, which should be minimised by industry best practice.

# 2 Introduction

CSG field operations and maintenance are integrated ongoing activities throughout the life of all CSG fields. Change management occurs for reasons which include:

- Additional wells are drilled and connected to the network, or existing wells modified, to maintain gas production levels or to optimise de-watering.
- Additional high point vents (HPVs) on water lines or low point drains (LPDs) on gas lines and isolation valves can be required to be retro-fitted to optimise network operations.
- Gathering network lines are required to be suspended or abandoned, normally at/near the end of life.

Note: Key safety equipment (such as over-pressure protection devices) for the buried gathering network is normally installed and maintained within the wellhead facilities (or for gas or water transmission/transfer lines), at the pump stations.

## 2.1 Background

The CSG industry in Queensland now has more than 5000 active wells, mainly supporting the three (3) major LNG export projects at Curtis Island, (near Gladstone), but also the domestic market. Most fields are at/or approaching the operational phase with a growing focus on safety, conformance and production optimisation, all in a very challenging period of low profitability and related cost-optimisation.

New technology is emerging, in particular the use of unmanned aerial vehicles (UAV) or remote piloted aerial systems (RPAS) and related innovative technologies to improve key operational and HSSE issues, for example in monitoring pipelines and gathering networks to reduce driving associated with conventional line patrolling. These major projects have facilities that can be remotely monitored, and in many instances activated/actuated from centralised control rooms.

These major projects co-exist with legacy projects, in many cases with wells and compression facilities which are non-automated yet have safely and effectively produced gas for the domestic markets for more than 20 years. These developments are field-managed and focused, and have generally enjoyed the support of local community stakeholders.

While the effective safety principles of each CSG field are constant, the safety management plans (SMPs) of each shall of necessity vary significantly. In the Code, section 11.3.3 mandates that such plans document the procedures by which any identified risks are mitigated to ensure the field activities and actions do not unduly expose its personnel, the public and contractors, including third parties, working on or near the gathering network.

Evidence from the past two decades indicates that safety in operations can be best supported by, as a minimum, ensuring that the following are expedited by the production operations team:

- Completions designs should be optimised for each individual well or well type to ensure simple and safe facilities: one size does not fit all.
- Ensure that any subsequent well rectification or optimisation program minimises disruption to field operations activities, e. g. by readily exchangeable spools to permit free flowing or pumping well operations.

## 3 Risk management

### 3.1 Driving

Driving has been identified in the various industry safety cases or similar reviews as the highest risk factor for all CSG activities.

However, driving is a necessary activity. Accordingly, ALARP requirements are achieved by various mechanisms (refer Controls section 4) the simplest and most effective control being task minimisation.

Within the operations areas of activity, detailed (but flexible) daily planning should be used to optimise the task load related to minimum travel.



### 3.1.1 Wet weather

While all-weather roads have normally been constructed within the gas fields to access essential facilities-compressor stations, water treatment plants, power and electrical sub-stations. However it should be noted that the majority of the gathering network is accessed by well site access tracks (WSATs) of minimal and variable quality-essentially designed and provided for drilling rig purposes in dry weather only. As such, these are normally not suited to operations/maintenance/drilling/construction activities in the event of wet weather, especially for heavy vehicles.

### 3.1.2 Flooding

During flooding events, community and industry protocols normally mandate cessation of all vehicle movement. Monitoring using aerial surveillance (helicopters, fixed wing UAVs/RPAS) should assist in both assessing the requirement internally within a gas field, and on condition of council and State roads and subsequent reinstatement of access.

## 3.2 Grass and bush fires

Many CSG fields are located within, or adjoin, State Forest areas or sections of undeveloped/regrowth containing significant fire fuel. However, due to right of way (ROW) clearing during construction, experience indicates that an appropriate risk assessment (RA) is predominantly for grass fires.

The designated site safety manager [field operations manager/superintendent or equivalent] should have the responsibility to manage the suspension of all activities in above circumstances using the Changed Circumstances provisions of the safe systems of work or equivalent permit/handover systems.

## 3.3 Operational activities

The PE pipe component of the gathering system is essentially passive, and retains its properties over its lifetime (compared to other pipeline materials), with only temperature possibly having a significant deleterious effect on its capabilities and remaining operational life.

Associated components require regular monitoring using integrity management plans (IMPs) to ensure their asset integrity over whole-of-life.

Among such facilities, the following components and activities are of highest priority:

- over-pressure protection devices-PSVs/PRVs/PSEs
- isolation valves
- excavations: first and third party
- crossings-pipelines
- management of change
- legacy issues
- riser corrosion-asset integrity
- impurities in PFW line
- in-field flares
- valves-HPVs (high point vents)/ ARVs (air release valves)
- ROW subsidence and trench erosion monitoring.

### 3.4 Over-pressure protection devices

For gathering systems, these devices are normally located on the wellhead lease facilities, with set pressures often previously determined by a combination of piping and pipeline restrictions, plus sub-surface process safety in design (PSID) rather than operating safety considerations. As CSG fields are de-watered and de-gassed, these sub-surface parameters will change and could assume less significance. Operational priorities could then be based upon minimising the likelihood of losses of containment (LOCs) from pressure safety valve (PSV)/ pressure safety element (PSE) trips (and thus gas or water releases) by raising trip levels, while ensuring adequate protection of the PE pipelines. ALARP protocols can assist, together with a revision of PE pipe rated capacity using a FFP fit for purpose (FFP) review process, as described in the Code Version 4.

### 3.5 Isolation valves

Within CSG fields, many isolation valves are considered as ‘operational-sensitive devices’, as they directly interface with both planned and unscheduled operations and maintenance activities over the whole of life of the field, for example:

- Annual/bi-annual maintenance checks, PSV/PSE replacements;
- Workover rig activity, including pump changes, flush-bys, plug and abandon;
- Emergency Response within the gathering network;
- Provision for future changes viz. wellhead compression; wellhead plant change [e. g. artificial lift alternatives].

Isolation for PE pipelines can be achieved by various methodologies, including but not limited to valving, spade, squeeze-off, bagging or plugging. However, the latter three (3) options each require excavation to access the buried pipeline, which from an operational safety viewpoint is not preferred, as excavations at/near buried PE pipes should be minimised. The selective installation of suitably located and scoped isolation valves throughout the gas and water gathering network is considered an essential pre-requisite, based on individual operating company (OPCO) risk policies. Field evidence supports locating one of these as a ball valve on a flow or spur line, meeting ALARP definitional requirements.

Locations of these valves shall vary between OPCOs based on their individual risk matrices. Options include the following:

- base of riser at wellhead;
- edge of lease at wellhead;
- flowline connection to main lateral/trunk system.

The location of these valves may be influenced in part by flowline length and purging strategies. Individual OPCO policy, or site safety manager (SSM) or permitting officer requirements may mandate the use of an effective double block and bleed (DBB), with purging, in particular circumstances. The inclusion of a bleed point on both water and gas wellhead risers is strongly recommended to allow effective purging to occur, with the initial two location options requiring significantly less purge medium, most likely nitrogen.

Note: In this paper, DBB means two physical isolation points with bleed located between these isolation points. The bleed is used to verify the effectiveness of the isolation closest to the pressure source.

The activities listed above all require fully effective isolation prior to commencement. The Code Section 4.9 details the minimum requirements for isolation in a gathering network.

The Code mandates that “valve selection shall provide the appropriate level of isolation and leak tightness based on the fluid in the pipeline”. The PE valves have been long proven in practice over many decades in the distribution networks for sales quality gas and over two decades in the CSG area with the wet, dirtier gas, primarily due to their inert qualities.

Asset integrity staff should monitor all such new-to-industry valve performance and share the learnings in appropriate industry forums.

Operations staff should allow adequate lead time to validate leak tightness integrity when isolation and handover requirements are indicated. Annual stroking of these valves should be included in the relevant IMP. In practice, where buried PE valves are located at/near the well lease this occurs as an implicit or automatic activity as part of the annual maintenance scheduled activities.

A detailed locked open/lock closed (LO/LC) protocol should be endorsed for all valves.

### **3.6 Purging**

Each OPCO shall have individual purging policy and procedures, although this has been an activity identified for possible standardisation under the Safer Together initiatives.

Most procedures mandate the introduction of nitrogen at controlled velocities to maintain displacement of air prior to the introduction of gas.

Purging is a specialised activity area, requiring both competent staff and supervision.

Companion Paper CP-11-005 Isolation, Purging and Commissioning provides further details.

### **3.7 Excavations: first and third party**

First party excavations on/over gathering networks by company contractors are fully covered by existing protocols and procedures, and occur only under permit conditions and normally on-site supervision by experienced competent staff.

Very significant lengths of the CSG gathering networks throughout Queensland exist on land owned by others, and in particular on government easements, both road and rail. While the risk exists of third party excavations at/near pipelines, the industry has developed significant control measures (refer Controls section 4) especially in relation to pipeline awareness. Several enhancements have been added to the Code Version 4.

Aerial surveillance, including UAVs should be able to provide significantly improved monitoring activity in relation to such possible unscheduled third party activity or events.

### **3.8 Crossings: pipe**

Due to the extent of the ~20,000 km of gathering networks, there are several hundred instances of crossings of high-pressure steel gas pipelines owned by others. In many such instances, such crossings also include other buried services such as electrical and fibre-optic communications cables. As a consequence, such crossings are likely to be significantly more trafficked and subject to possible third party activities, including by other pipeline operators.

### 3.8.1 Heavy vehicle crossing

Major easement crossings can involve many (5-6) different parallel services which may present many compaction challenges during construction and may require several years for adequate settlement and compaction to occur. Increased depth of cover, concrete blocks and or steel plates have proven to be effective methods of safeguarding pipeline crossings.

For major crossings, designated heavy plant working platform areas may need be provided, and indicated.

### 3.8.2 Permitting

Issues have arisen in implementation permitting. Conventional chronological priorities for crossings are now not always fully appropriate for the industry overall.

As an example, where PE pipelines are proposed to cross major easements, the option of such lines passing above the existing lines, with appropriate depth of cover adjustments / safeguarding, may be the preferred overall outcome, avoiding either the need for trenchless options or a very large and deep bell hole beneath the existing services. In the latter case, often additional low point drains with steel components are required, with corresponding added operational and maintenance activities. CP-05-001 Safety in Construction provides further guidance on this topic.

## 3.9 Management of change

The gathering networks and their components have generally been designed to accommodate the forecast gas and water production based on sub-surface predictions. Normally both gas and water flows, and pressures, decline over the field's life and the PE pipe operating conditions are relatively stable.

However, there are several instances when changed conditions apply as detailed:

- Gas transfer to adjoining alternate field compressor stations by inter-connecting lines, which can result in reverse flow in some headers or trunklines.
- Added wells within a field or block are connected, initiating localised increased flows and change in operating pressures.
- Later in life, introduction of wellhead or nodal compression.

Such situations may provide significant localised changes in operating conditions and shall require formal management of change in each instance, although OPCOs may elect to use generic procedures. This may require confirmation of capability using detailed calculations by experienced competent engineers. Furthermore, the PE pipe operating envelope may be revised using fit for purpose method as per the Section 4.6 of the Code.

## 3.10 Legacy issues

During the past two decades of CSG development, there have been many instance of the ownership of fields changing hands on several occasions, resulting in PE pipe still operating more than 15 years after it was designed to a different standard.

Often adequate records are not available to confirm the design integrity of the original network design.

While recognising that the Code is not retrospective, if additional gathering networks are to be added or extended, there is the opportunity to consider incorporating improved design practices, to provide overall fit-for-purpose ALARP outcomes in the design.

### **3.11 Riser corrosion: asset integrity**

Risers are a key component in the gathering system, occurring for:

- water/gas risers linking the wellhead facilities to the flowlines;
- HPV/ARV (air release valve) risers on the water lines;
- within low point drain assemblies on gas gathering lines.

However, there are increasing reports of various types of corrosion occurrences within the industry, both from external corrosion and internal corrosion (including microbial induced corrosion (MIC) from the presence of acid-producing and sulphate reducing bacteria).

Regular riser inspection including visual, tape wrap coating removal and non destructive testing (NDT) is an effective method of managing risk of external corrosion. For internal/MIC corrosion regular dosage of inhibitors in conjunction with NDT can be implemented. An option exists for using ALARP protocols to examine using sleeved PE risers by re-evaluating the likelihood of grass or bush fire damage at particular locations.

### **3.12 Impurities in PFW lines**

Numerous impurities have been reported in the water flowlines, not unexpectedly including drilling muds, solids, etc. primarily related to the completion methodology employed. The principal operational safety aspect is that such deposits in flowlines may have reduced the flow capacity, or even stopped the flow; furthermore they have potential to prevent effective leak-tight isolation using squeeze off processes.

Sections below address these issues.

Scale has also been reported in some PFW lines from specific geographic fields. Various chemical treatments can be implemented primarily for scale inhibition.

### **3.13 SIMOPS**

CSG production is a fully integrated 24/7 activity, and accordingly simultaneous activity during operations, maintenance and construction shall be a regular daily occurrence within CSG fields, managed with controls as detailed in Section 4 below.

Driving represents a major hazard, as most travel will be over narrow wellsite access tracks with many drivers unfamiliar with the fields. Specific attention should normally be directed towards relocation of drilling rigs and their associated support vehicles.

The site safety manager shall exercise full coordination over these activities, especially when changed circumstances such as weather, security, etc. may impact on issued permits and handovers.

### **3.14 Contractor management**

Field operations associated with a network of 2000+ wells and associated facilities requires a myriad of support services, in some cases (IT technicians, catering staff, etc.) staffed by personnel unfamiliar with driving in the CSG patch in remote locations, or often on gravelled roads.

The Contractor Management requirements within the individual contractor health, safety and environment management system (HSEMS) and safety management plans must address this subject and transparent, auditable procedures should be developed to ensure that the minimum requirements reflect this topic. Personnel travel in private cars at end of shift/roster has been

identified as a significant risk. The construction SSM shall ensure that all such plans and procedures are fully aligned with the overall network management system (NMS) requirements.

### 3.15 Excavation risks

As the gathering network is buried, excavation is a regular activity and specific approved procedures and methods shall be required. Controls as detailed in Section 4.2 shall be adopted.

Several key lessons have been learned in the CSG province in recent years:

- Awareness of buried services. This issue is paramount, and additional requirements have been included in the latest Version 4 of the Code to emphasise this aspect;
- Provision of isolation valves. Pre-investment of valves in relevant locations at initial design/construction can significantly reduce the number and size of subsequent excavations, whether for plant change or emergency response reasons and is considered best practice. It has a significant safety benefit.

Note: Design consideration for isolation valve placement shall be required for all fields to allow isolation of all flowlines and main network segments. The importance of this recommendation is increased for large sizes, which are considered as greater than DN 450.

- Use of non-toothed excavator buckets. Field experience has clearly demonstrated that less inadvertent damage can be caused by PE pipe strikes from buckets without teeth and even less if a 'poly bucket' manufactured from PE can be used. The experience has indicated that PE buckets may be insufficiently robust to work effectively on well-compacted backfill over the PE gathering system, however in such cases they could be used in combination with steel buckets and only for final excavation in the vicinity of the pipe.

#### 3.15.1 Buried electrical services

While procedures shall be used to minimise any impact on buried services, and to prevent any losses of containment of gas or water, it is recognised that cutting an electrical cable (especially high voltage) represents an even greater operational hazard. For newer assets, these associated risks have been mitigated by the 'self-earthing' cable capability.

A high number of wells installed in recent years have had buried electrical power cables and FO communication cables installed with the gathering system, with details captured on 'as constructed' drawings.

However, a significant number of legacy wells installed more than a decade ago have electrical power supply, (either overhead or buried), that may not be captured on 'as constructed' drawings.

#### 3.15.2 Buried gathering networks

For the majority of the gathering networks, the x and y coordinates can be ascertained by standard procedures, based on 'as constructed' records gathered and stored via accurate geographic information system (GIS) platforms. However, over the past decade there have been various depths of cover used on different projects and whenever excavations are necessary, conservative practices including poly bucket usage (where practicable) as detailed above, supplemented by hand digging, are recommended. Furthermore, the methods of pipeline marking (installation of marker signs with/without offset, multiple/single signs in pipeline corridors, tracer wire/marker tape with transponders etc) have evolved in years. Therefore it is possible that different methods of pipeline marking could be used for different pipelines located in the same area of network or even co-

existing in the same corridor. Major pipeline crossings, especially when several buried services are involved, shall warrant caution.

### **3.16 Solids handling**

Most CSG fields produce 3-phase flow to some extent, with the produced water stream containing small quantities of air/gas mixtures and some solids (coal fines; silt; clay; shale; etc.). The principal determinants of the amount of solids involved are:

- completion methodology;
- composition of both targeted coal seams and intervening layers of silt/clay/shale etc.

Significant variability in solids quantities occurs between different fields, and each OPCO has developed separate procedures for solids collection and disposal. Examples are regular draining of wellsite separator to a solids trough for later collection and disposal by a waste disposal contractor; regular separator flushing at 3/6/9 month intervals, as required, normally with a larger DN 125 line, and variations in-between.

Operational safety aspects arising from solids build-up can be:

- Increased driving for the collection and delivery of the waste;
- Solids build-up in the gathering system (resulting from solids being flushed into it, either through flushing regime or even during normal operation);
- Obstruction or prevention of effective squeeze-off on the PFW lines for plant change or emergency response.

NOTE: As the solids are directly associated with water flow, and the presence often reduces significantly after 700-1000 days, it is possible for solids troughs to then be relocated, thus reducing the travel associated with both the operator driving to drain the trough (or flush the separator) and trucks driving to collect the waste.

## **4 Control measures**

### **4.1 Simultaneous operations during operations and construction**

The SSM for Operations has overall statutory authority and responsibilities to ensure that concurrent, or simultaneous, activities are fully coordinated and managed safely.

### **4.2 Safe systems of work**

Each Individual CSG OPCO has its own set of SSOW documentation, all philosophically near-identical.

Following the successful introduction of a standard SSOW system for drilling operations, with related competencies, the Safer Together team has been tasked to implement a similar standard SSOW system within the other activity areas in upstream operations. In the interim, some key comments related to existing procedures employed, with only slight variance in title and responsibilities.

#### **4.2.1 Permitting**

All systems have in common a hierarchy of procedures and protocols, all based on using competent staff fully trained in every aspect of the daily field operations and maintenance activities. Regular auditing is required to ensure compliance shall be included in the NMS and associated SMPs.

## 4.2.2 Approved task lists or equivalent

A key component developed to enable repetitive tasks to be generically risk assessed and executed by competent personnel, either company or contractor, on various facilities e.g. waste (water and solids) collection from well sites or low point drains.

## 4.2.3 Task approval notification or equivalent

Normally issued by the Operations representative responsible for a particular area on a daily basis, as a control mechanism to manage SIMOPS where appropriate. Issued only to approved contractors with staff fully familiar with the facilities involved, and when full isolation is not required. Examples include maintenance on: gensets, micro-turbines, HPUs etc. on well sites.

## 4.2.4 Work method statements

These are generally prepared by individual contractors to cover major repetitive key tasks, including:

- trenching;
- bell hole excavation;
- ploughing;
- confined space entry (CSE);
- pressure testing;
- welding.

These are used as subsidiary documents to support permit applications under the relevant permitting system within the relevant SSOW protocols.

## 4.2.5 Buried systems awareness

Section 5.11 of the Code details requirements for pipeline network location. Prevention is a key aspect of emergency response best practice (refer CP-11-002), so emphasis should be paid to ensure adequate awareness is provided, especially in those road/rail and other third party easements within the CSG province that are controlled by others.

# 4.3 Integrated facilities design and operation

Operational safety is significantly dependent on an optimised integrated design to provide the operational flexibility and efficiencies detailed above, an essential feature often not fully appreciated and a major lesson learned by the whole industry.

## 4.3.1 CSG facilities design

CSG gathering system differs very significantly from conventional field design and requires the following capabilities:

- agility and flexibility;
- understanding of the whole-of-life CSG field performance characteristics;
- knowledge of the PE 100 materials properties.



### 4.3.2 CSG design personnel

The importance of all personnel involved in CSG design process-from the basis of design to subsequent concept and detailed design-possessing specific CSG competency (expertise and experience) should be recognised.

CP-02-001 details appropriate CSG competencies for various design, construction and operational roles, and is commended to act as a guide for future design activities. Each engineer/manager involved in csg design must be deemed competent, especially in the initial network design and safety management study (SMS) input.

Note: Within the various operating CSG basins and sub-basins, there is at least 15 years of accumulated local knowledge related to the overall behaviour of the various coal seams.

### 4.3.3 CSG design methodology

Simplicity, not complexity, has many advantages in CSG fields, especially after the initial years of de-watering accelerates the decline in the seam pressures, reflected in shut in wellhead pressure (SIWHP) calculations under PSID criteria.

Over the field's life, under ALARP the assessed likelihood of significant, or any, mid-term damage to the PE gathering pipelines due to a short-term OPP event is far less likely to occur than release events from PSVs/PSEs set at too low a practical level. This is based on theoretical calculations designed to safeguard the system based on prescribed design and not the FFP design flexibility endorsed by the Code Section 4.

The design paradigm is that PE 100 pipe can safely operate for short periods at pressures above MAOP as described in Code Section 4.18, and the visco-elastic nature of the material is such that it recovers. Management of change procedures should always be adopted. Steel pipe in contrast commences a permanent breakdown and change in its structure at pressures above MAOP when yield stress is exceeded.

In summary, for all related components of a gathering system, simplicity of design and operation should be a major objective.

## 4.4 Procurement

CSG produced in Queensland is of variable quality based on possible impurities, which include bacteria, coal fines, solids, water vapour and various gases in low concentrations. While the PE pipe and related valves, couplings, etc. are inert and thus resistant to such contaminants, various steel components of risers, HPVs, LPDs, etc, and assorted steel piping / valving on wellhead assemblies would require extra levels of inspection and integrity management activities in comparison to PE.

PE valves and fittings are now available for all sizes appropriate for local CSG field development, with reasonable lead times, and should be used to largest extent possible.

Composite pipes can provide an alternative design option for unique situations e.g. elevation differential water 'head' or higher temperatures.

Use of other materials to PE including composites for elevation control is addressed in Section 4.25 of the Code.

## 4.5 Monitoring

Monitoring of the gathering system is required to meet assurance requirements of the NMS, essentially to demonstrate that the gathering network has not operated outside the specific design parameters or deemed capability of the PE pipe.

### 4.5.1 Remote monitoring

The major CSG projects all have centralised control rooms where the key parameters, (gas and water flow, temperatures and pressures), can be monitored. Similarly, field operators can access this data in many instances from outside the wellsite hazardous area-a key safety initiative.

Additionally, many wellheads have the capability for their main valves to be actuated remotely, enabling remote start up and shutdown of these wells.

## 5 Summary

Widespread evidence exists across the oil and gas industry that an integrated basic approach is valid i.e. “simpler fit-for-purpose facilities are safer to operate than more complex facilities”. The CSG industry complies with this, based on the 25 years of safe and successful operation locally.

Note: Further details are available in the related Companion Paper CP-005-001 Safety in Construction.

All field operations activities, whether appraisal or production, active or inactive, new or 10-20 years in operation, operated by a major or smaller CSG operator, are required to meet the identical statutory obligations and thus must be covered by a network management system which prescribes the requirements of a HSEMS and safety management plan. The plan includes the nomination of proscribed safety roles held by competent personnel. These systems and procedures are specific to each individual Operator, and often to separate individual gas fields.

There is no ‘one size fits all’ design or operating plan- all are dependent on the unique sub-surface conditions in each block.

Operational safety is based on such plans being fit-for-purpose, with whole-of-life operational procedures and protocols, demonstrably assessed to meet ALARP principles, and executed by experienced staff with appropriate competencies.

For appraisal activities, different risk factors such as geographic location, which can include risks such as communications challenges, single-operator remote sole operation, travel distances etc. may apply which shall often require different protocols within this NMS framework.

## 6 References

CP-02-001	Competency
CP-04-005	Pressure Excursions and Surge
CP-04-006	System Design Considerations
CP-05-001	Safety in Construction
CP-05-002	Ploughing Specification and Procedures
CP-05-003	Trenchless Technologies