Knarr Gas Pipeline Decommissioning Programme

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Revision Control

Revision No	Reference	Changes/Comments	Issue Date
A.1	Internal Draft		Nov 2019
A.2	Internal Draft	Incorporating split into 2 DPs	Dec 2019
0	Draft for Issue	Incorporating Rev 03 of Wood KGP Decommissioning Concept Study.	Jan 2020
0.1	Update to draft	Gassco AS internal review comments	Feb 2020
0.2	Update including JV review comments	JV review comments	Feb 2020
1	Update to reflect OPRED comments	OPRED review comments	Mar 2020
2	Update to reflect OPRED comments	Change to single phase Decom Programme	Sep 2020
3	Issued for construction	Updated for OPRED consolidation and approval	Dec 2022
3	Update to Rev 2	Reflects change in phase 1 sequencing, with one integrated cleaning and disconnection phase, replaced by two separate activities within phase 1.	Dec 2022
3	Update to Rev 3	Update to reflect comment from OPRED and prior to consolidation with others	Jan 2023
4	Update to Rev 4	Update to reflect comments from OPRED as per ODU Comments Rev.3 submitted 17.August 2023.	Dec 2023
5	Update to Rev 5	In agreement/advise from OPRED; removed all text related to phase 3, removal of PLEM	Dec 2023
6	Update to Rev 6	Update to reflect comments from OPRED 16 January 2024	Jan 2024

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Holds Table

Hold	Section	Description
01		Branding of a S29 holder(s) to be included prior to consultation
02	1.2 / 8.0	Partner Letters will be issued with final version of DP (post public consultation)
03	5	The first part of Table 5.1 'Statutory Consultations' will be populated following results from formal consultation
04	7.0	Web link for all stakeholder / interested parties to be included prior to consultation

Terms and Abbreviations

Abbreviation	Explanation
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
KGP	Knarr Gas Pipeline
EA	Environmental Appraisal
CA	Comparative Assessment
FLAGS	Far North Liquids and Associated Gas System
DESNZ	Department for Energy Security and Net Zero
UKCS	United Kingdom Continental Shelf
PLEM	Pipeline End Manifold
NCS	Norwegian Continental Shelf
NPD	Norwegian Petroleum Directorate
MPE	Norwegian Ministry of Petroleum and Energy
FPSO	Floating Production Storage Offloading
JV	Joint Venture
GRP	Glass Reinforced Plastic
NORM	Naturally Occurring Radioactive Material
LSA	Low Specific Activity
SAC	Special Area of Conservation
SCI	Sites of Community Importance

Abbreviation	Explanation
NCMPA	Nature Conservation Marine Protected Area
NNS	Northern North Sea
NSTA	North Sea Transition Authority
ICES	International Council for Exploration of the Sea
VMS	Vessel Monitoring System
JNCC	Joint Nature Conservation Committee
CO_2	Carbon Dioxide
SO_x	Oxides of Sulphur
NO_x	Oxides of Nitrogen
LCV	Light Construction Vessel
GBP	Pounds Sterling
CoP	Cessation of Production
SSIV	Sub-sea Isolation Valve
PLET	Pipeline End Termination
PWR	Preparatory Works Request
MEG	Mono-ethylene glycol
WI	Water Injection
E&E	Energy and Environmental (emissions)
FEED	Front-end Engineering Design

Figures and Tables

1 EXECUTIVE SUMMARY

1.1 Decommissioning Programme

This document contains a decommissioning programme for the Knarr Gas Pipeline (KGP) decommissioning as pertains to the 11.6km length of the pipeline that is within the United Kingdom Continental Shelf (UKCS) only, extending from the UK-Norway median line to the Knarr Tee structure tie-in spool flange.

The DP is submitted (to the Secretary of State) by the equity partners and s29 notice holders. Gassco AS, as operator of the KGP, has produced this Decommissioning Programme for and on behalf of the equity partners and s29 notice holders in the KGP. The s29 notice holders have adopted the DP as their own and they have agreed to be bound by it and to carry out its provisions, as may be approved or modified by the Secretary of State.

The decommissioning of the KGP in the UKCS has been planned in two phases.

1. Phase 1 followed the cessation of production (CoP) on the Knarr field on 1st of May 2022, and was carried out under the terms of the Preparatory Works Request (PWR) submitted by Gassco AS on 29/04/2021. This involved isolation of the KGP at the Knarr Tee and PLEM from downstream infrastructure, the installation of a pigging spread at the Knarr PLEM and cleaning and flushing of the KGP back to the Knarr FPSO. Phase 1 activities were completed on 18th of May 2022.

2. Phase 2 – a minor section of the spool #7 will physically be cut and disconnected from PLEM, retrieved and transported to shore (Norway). This is scheduled to be completed before December 2026 and most likely during Q3/Q4 2024.

The remaining spool sections and the KGP will be abandoned in place, cleaned and under rock cover.

Due to the proximity of the UKCS subsea infrastructure; the Knarr Tee and Knarr PLEM, to the operational FLAGS gas pipeline, the removal of these items will be concluded to a later date, when the FLAGS gas pipeline enters CoP, estimated to be within the next 25-30 years. This will eliminate risks attendant with removal works near live, hydrocarbon containing infrastructure. To understand the total decommissioning work some sections in this DP will include description related to removal of the subsea structures, but is not part of this programme. Removal and disposal of the subsea structures will be subject to a separate DP.

A separate submission for the sections of pipeline within the Norwegian Continental Shelf (NCS) have been developed, issued and approved by the Norwegian Ministry of Petroleum and Energy (MPE). There has been dialogue between UK and Norwegian authorities to ensure alignment in the decommissioning work.

1.2 Requirement for Decommissioning Programme

Pipeline: In accordance with the Petroleum Act 1998, the Section 29 notice holders of the Knarr gas pipeline system (see Table 1.4) are applying to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) to obtain approval for decommissioning the pipeline system detailed in Section 2.3 of this programme. (See also Section 8 – S29 Notice Holder(s) Letters of Support). [HOLD 02]

In conjunction with public, stakeholder and regulatory consultation, the decommissioning programme is submitted in compliance with national and international regulations and OPRED guidelines. The schedule for the activities outlined in this document is as noted below:

1. Phase 1 - following KGP CoP (performed from 1st (CoP) to 18th (FPSO sail away) of May 2022.). This phase was completed under PWR submitted by Gassco AS on 29/04/2021.

2. Phase 2 - The later removal of the spool #7 section will be for another 1 month planned before Q4 2026 as per abandonment project plan (ref. figure 9: Gantt Chart of Project Plan).

1.3 Introduction

The Knarr Field is located in Block 34/3 of the Norwegian Continental Shelf (NCS) in the northern North Sea, 50 kilometers northeast of the Snorre field. The Knarr Field is approximately 50-60 km from the UK-Norway median line (Figure 1) and is in water approximately 410 meters deep.

The Knarr Field comprised 2 subsea well templates connected to a floating production, storage and offloading vessel (FPSO), with shuttle tankers for oil export. Rich Gas were exported from the Knarr FPSO in the Norwegian sector to the UK via the Knarr Gas Pipeline (KGP) system, which passes through NCS to enter UKCS, and connects to the Far North Liquids and Associated Gas System (FLAGS) pipeline (Figure 2). The system was installed in 2013, and field production started in 2015. CoP took place 1st of May 2022.

Figures 3 and 4 illustrate the field and pipeline arrangement. The Knarr FPSO flexible riser connected to a Subsea Isolation Valve (SSIV) inside the Knarr FPSO safety zone on the NCS. A rigid spool mated the SSIV structure with the main Pipeline End Termination (PLET). The main length of KGP system route (approximately 105.7 km) consists of 12" rigid pipeline which connects (on UKCS) to the Knarr Pipeline End Manifold (PLEM) and Knarr Tee through a series of 12" rigid spools. 11.6 km of the KGP system extends into the UKCS (Block 211/29 and 211/30). The KGP enters the UK sector at KP 94.1 and between KP 94.1-105.7 the pipeline is surface lain and completely rock covered, has no free spans, and is at a water depth of approximately 140 m. The detail of the location of the UKCS pipeline system routing and subsea infrastructure is shown in Figure 4.

As illustrated in Figure 5, the Knarr Field is operated by AS Norske Shell; the 12" KGP (PL3039) is operated by Gassco AS on behalf of the pipeline Joint Venture (JV) owners (A/S Norske Shell, INPEX Idemitsu Norge AS, Wintershall DEA Norge AS). The KGP system enters the UKCS to join the Knarr Tee structure before entering the FLAGS system, which is operated by Shell U.K. Limited. The section of PL3039 extending from the Knarr Tee structure to and including the Gjoa GEFVS is operated by Shell U.K. Limited, has been renumbered PL6086, served on a separate s29 notice and does not form part of this DP.

The UKCS components of KGP, which are the subject of this decommissioning programme, comprise:

- 11.6 km of the KGP system pipeline extending into the UKCS
- Tie-in spools between the KGP system and Knarr PLEM (#1-7)
- Concrete mattresses at crossings

The initial phase (phase 1) of the KGP decommissioning included;

- the isolation of the KGP system from FLAGS by closure of valves on the Knarr Tee and Knarr PLEM.

  This ensures a double barrier isolation between the FLAGS pipeline and the KGP system infrastructure where cutting and removal activities will occur.

- the filling of the section between the Tee and PLEM with MEG.

  Filling the section displaced residual process fluid in the section and provides protection against degradation/corrosion of the spool section between decommissioning and final removal.

- the pigging of the KGP from the Knarr PLEM to the Knarr FPSO on the NCS.

  Pigging the line ensured that the pipeline contents were displaced back to the FPSO for disposal, the pipeline internal surface was cleaned, and the pipeline filled with inhibited seawater.

The intermediate phase (phase 2) of the decommissioning will include:

- cut and removal of a small section of spool #7 to isolate KGP from UK infrastructure.

  Cutting and removing the small spool section will physically isolate the KGP system from the PLEM and downstream infrastructure. An abandonment plug will be installed on the PLEM side.

- 'as-left' survey of the KGP subsea infrastructure and arrangements for ongoing monitoring.

  The 'as-left' survey will establish the initial post-decommissioning status of the KGP infrastructure that can then be used as a baseline for monitoring the local area around the infrastructure to determine changes at the site.

These works are necessary to ensure compliance with the requirements for decommissioning under the Petroleum Act 1998 and Energy Act 2016.

The as-left state of the pipeline allows for later decommissioning and removal of the PLEM, spool section #8 (between the Knarr Tee and PLEM) and GRP spool covers co-incident with the FLAGS pipeline system decommissioning.

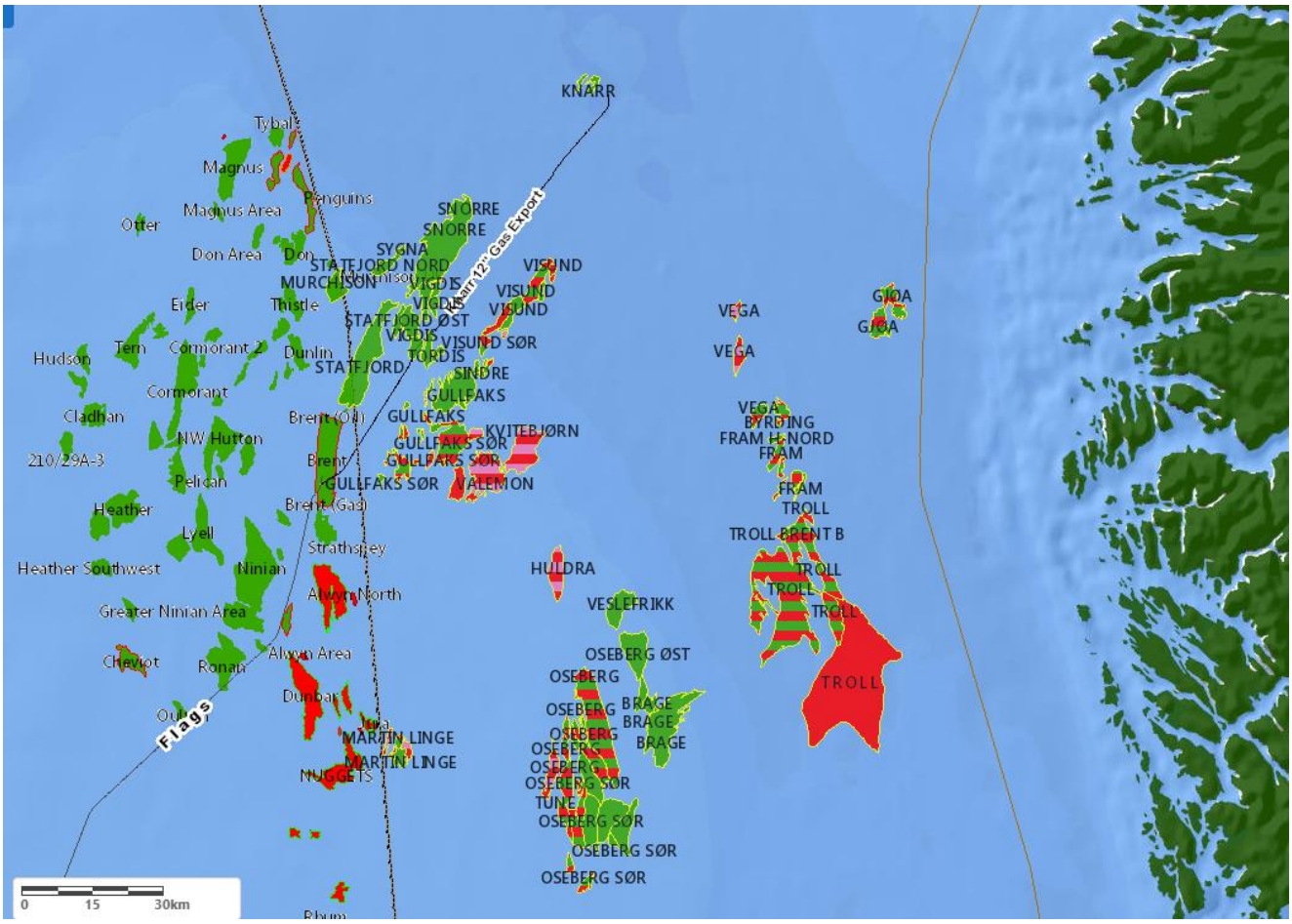

Figure 1: The Knarr Field and Knarr Gas Export Pipeline

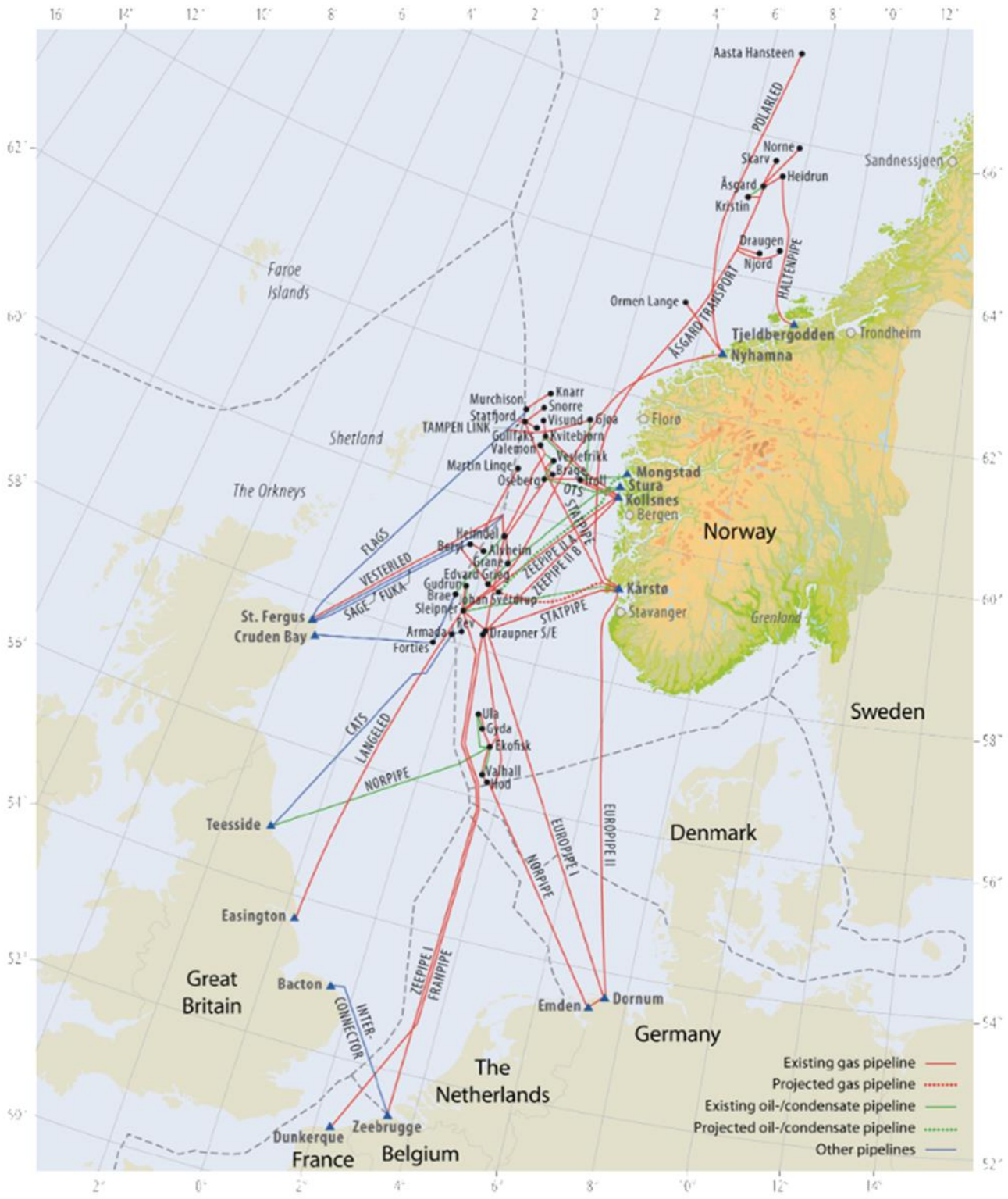

Figure 2: Knarr Gas Pipeline in relation to other oil and gas facilities, UK/Norway boundary & FLAGS

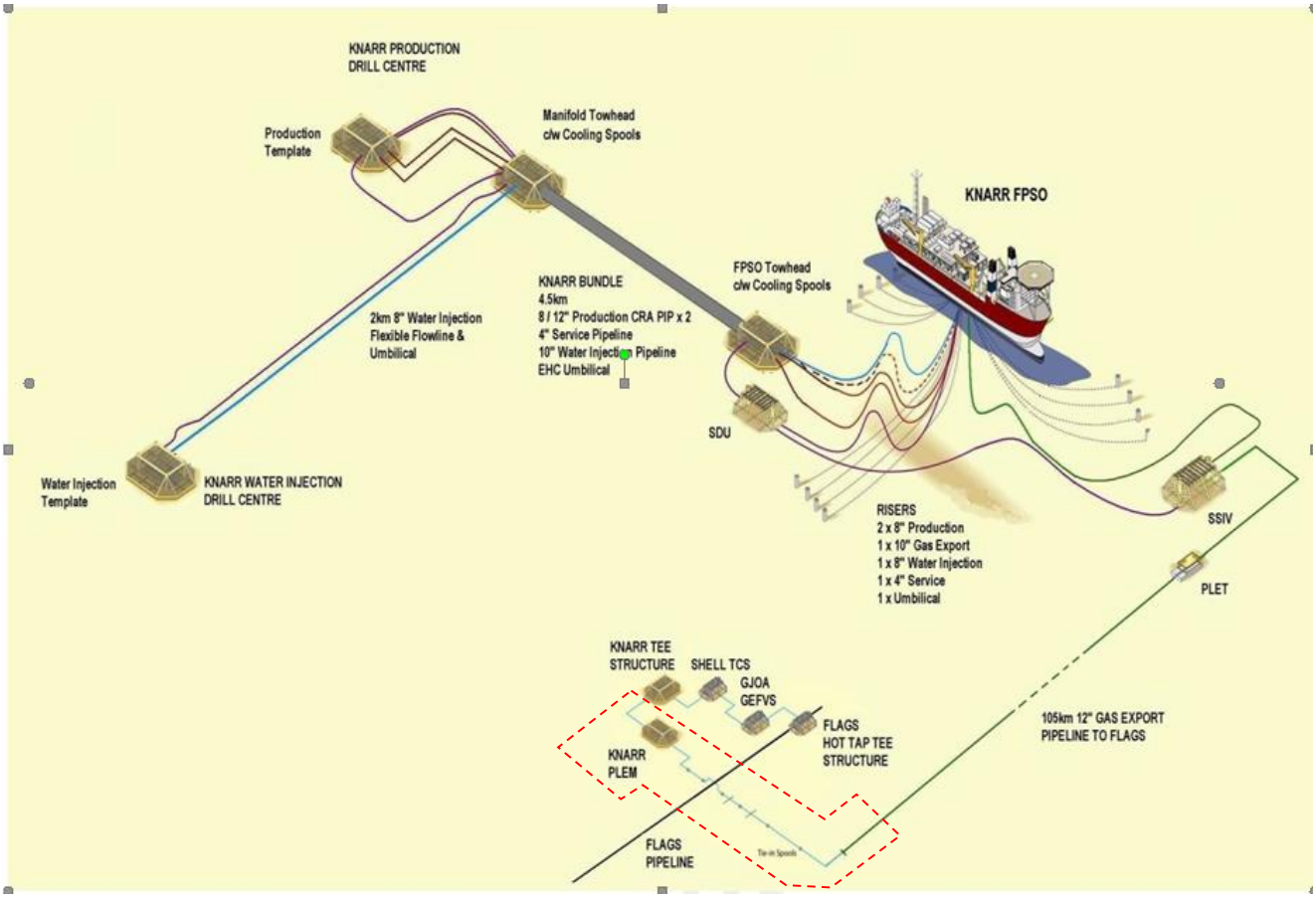

Figure 3: Knarr Field Layout. UK scope of KGP decommissioning indicated by red dashed area.

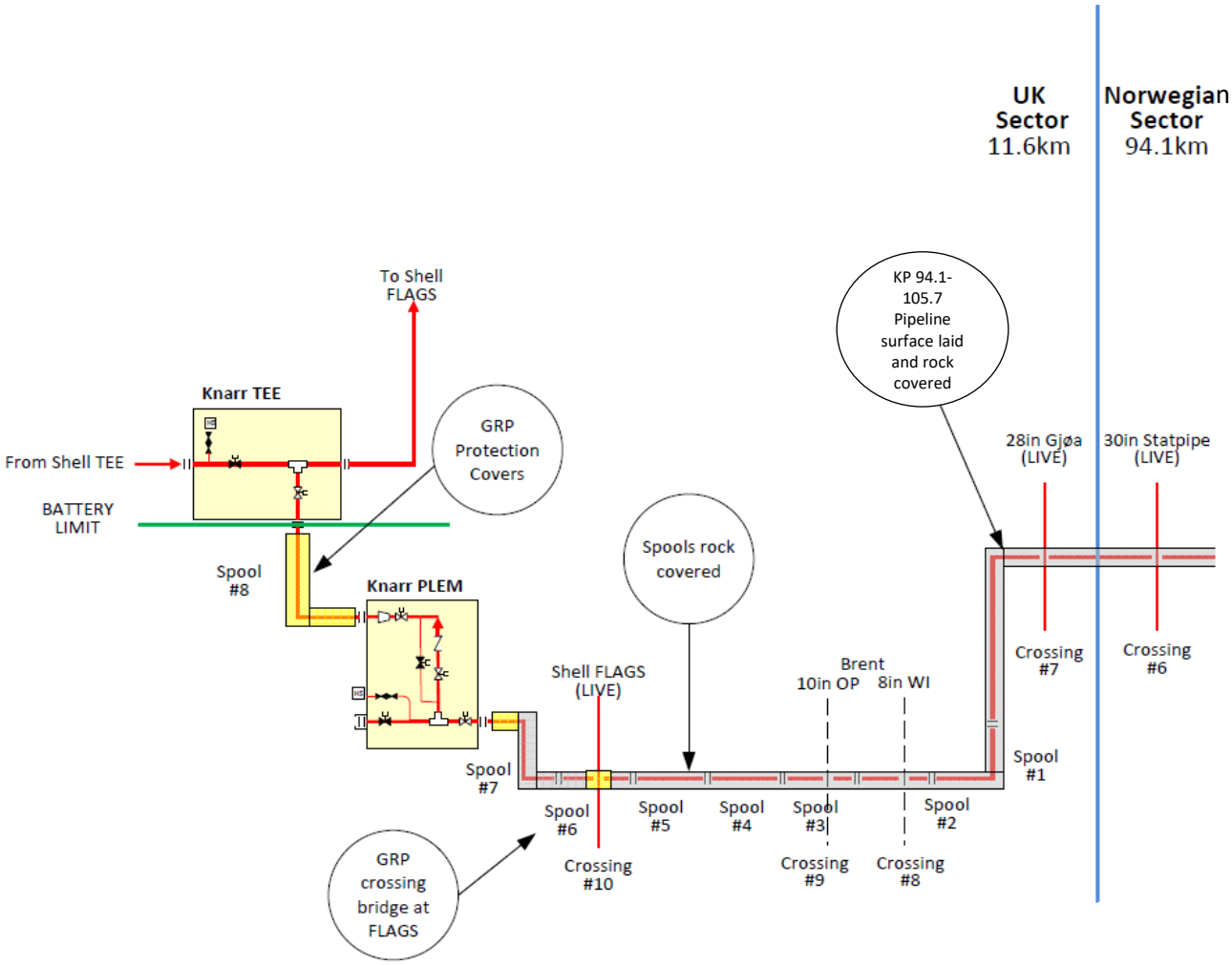

Figure 4: Knarr Gas Pipeline and Pipeline Crossings (Crossings 7 – 10 in UKCS).

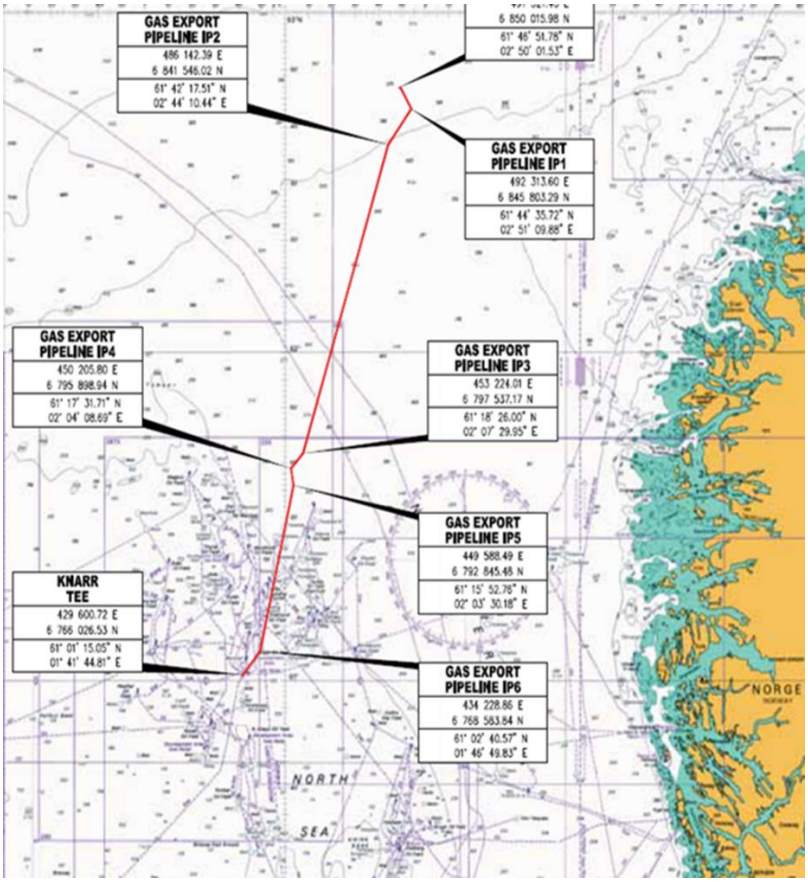

Figure 5: Coordinates of Knarr Gas Pipeline route from NCS to UKCS

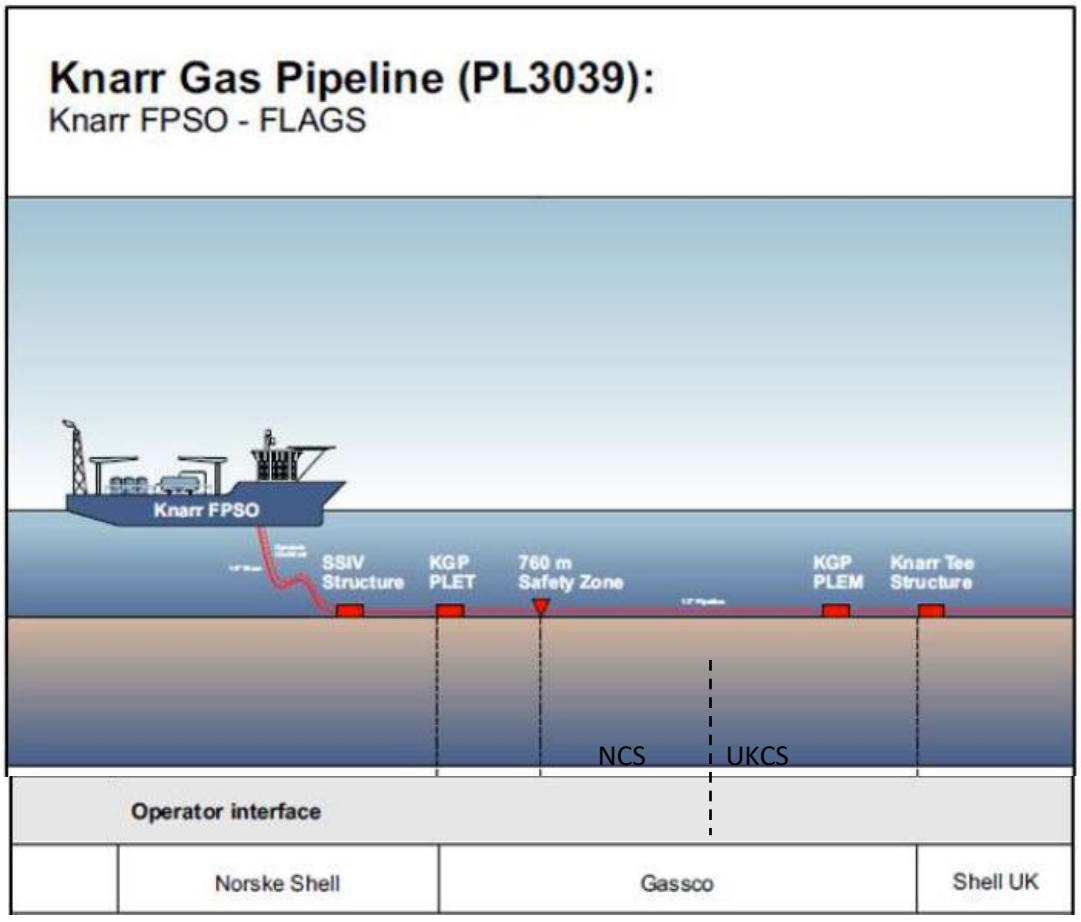

Figure 6: FPSO and Knarr Gas Pipeline

Following public, stakeholder and regulatory consultation, the decommissioning programme is submitted in full compliance with OPRED guidelines. A comparative assessment (CA) [1] has been carried out to identify and assess potential decommissioning options for the pipeline and subsea infrastructure on the UKCS. The decommissioning programme explains the principles of the removal activities and is supported by an environmental appraisal (EA) [2].

1.4 Overview of Installations/Pipelines Being Decommissioned

1.4.1 Installations

No installations form part of this decommissioning programme. This section is considered not applicable.

1.4.2 Pipeline

Table 1-1: Pipeline(s) Being Decommissioned	
Number of Pipeline(s) Details given in Table 2.1	1

Table 1-2: Pipeline(s) Section 29 Notice Holders Details		
Section 29 Notice Holder(s)	**Registration Number**	**Equity Interest (%)**
A/S Norske Shell	914 807 077	45%
INPEX Idemitsu Norge AS	953 133 210	25%
Wintershall DEA Norge AS	985 224 323	30%

1.5 Summary of Proposed Decommissioning Programme

Table 1-3: Summary of Decommissioning Programme		
Selected Option	**Reason for Selection**	**Proposed Decommissioning Solution**
1. Topsides		
N/A	N/A	Note: There are no topsides to be removed.
2. Substructures (fixed large steel jacket/fixed small steel jacket/concrete gravity base/floating facility etc.)		
N/A	N/A	Note: There are no jacket substructures to be removed.
3. Subsea Installation(s)		
N/A	N/A	Note: There are no subsea production installations associated with the decommissioning scope.
4. Pipelines, Flowlines & Umbilicals		
Knarr PLEM to Knarr Tee: Spool #8 Section (to boundary interface with Shell U.K Limited)	To isolate all upstream seabed structures from operational downstream infrastructure.	To be isolated by closure of valves at Knarr Tee and Knarr PLEM. Phase 1 activity. The Spool #8 section between the Tee and PLEM will be filled with MEG. Phase 1 activity
Pipeline Crossings and Spools sections #1-7 a. Gjøa 28" Gas Export Pipeline (P261) b. Brent South 10" Oil Pipeline (PL987A) c. Brent South 8" WI pipeline (PL988A) d. FLAGS 36" Gas Export Pipeline (PL2)	Mattresses and exposed pipelines shall normally be removed. However, as the mattresses are entirely rock-covered the left mattresses will pose no to negligible risk only. Re-location of the rock cover implies significant dredging work, and including support vessel it will have significant CO_2-emissions.	KGP crosses over all pipelines. Separation provided by 300mm thick flexible mattresses under rock cover ((a) to (c)) or GRP cover (d). Spools #1-7 from pipeline end to PLEM under rock cover. Spools #1-7 and pipe crossing mattresses will be left in situ under rock cover. Phase 2 activity. The GRP cover on spool #7, adjacent to the PLEM will be temporarily removed to achieve the KGP-PLEM disconnection and reinstated at the end of the disconnection operation. The GRP cover will be secured by using 12 gravel bags. All crossings will be left in-situ as they are buried under rock cover. This reduces the risk of construction and removal works close to live pipeline

Table 1-3: Summary of Decommissioning Programme		
Selected Option	**Reason for Selection**	**Proposed Decommissioning Solution**
		infrastructure.
12" Knarr Gas Export Pipeline (PL3039).	In the UKCS, the Knarr Gas Export Pipeline (PL3039) is surface laid and covered with rock cover to a sufficient depth to protect against overtrawl, posing minimal risk to marine users.	Leave in situ – this option will cause minimal seabed disturbance, have lower energy usage and reduce risk to personnel. KGP will be disconnected at spool #7 and a small part of the spool removed as part of Phase 2 to isolate it from UK infrastructure.
5. Wells		
N/A	N/A	N/A
6. Drill Cuttings		
N/A	N/A	N/A
7. Interdependencies		
Decommissioning of the Norwegian infrastructure (i.e., Knarr field facilities) and the pigging of the KGP system have been completed prior to any removal works at the UK pipeline end. The preferred option for the Knarr PLEM removal is to leave in situ until the decommissioning of the FLAGS pipeline. Isolation of the KGP from the FLAGS infrastructure was achieved through valve isolation at the Knarr Tee and PLEM, and the section between the Tee and PLEM was filled with MEG. KGP will be disconnected at spool #7, and a small part of the spool removed to isolate it permanently from UK infrastructure. The preferred option for the Knarr PLEM removal is to leave in situ until the decommissioning of the FLAGS pipeline, in approximately 25-30 years under a separate DP. The Knarr gas pipeline crosses over four other pipelines and the preferred option for crossing sections is to decommission in situ. Separation is provided by flexible mattresses under rock cover or GRP cover (GRP for FLAGS crossing only). The two non-operational Brent pipelines (PL987A and PL988A) are intended to be decommissioned in situ therefore there is no impact to these pipelines at their crossings. The pipeline also crosses the live Gjøa 28" (P261) and FLAGS 36" (PL2) Gas Export pipelines.		

1.6 Field Location Including Field Layout and Adjacent Facilities

Figures 1 to 3 illustrate the locations of the Knarr field and infrastructure, the layout of the field and the pipeline location in the UKCS.

Table 1-4: Adjacent Facilities					
Operator	**Name**	**Type**	**Distance/Direction**	**Information**	**Status**
Shell U.K. Limited / SEGAL	FLAGS (PL2)	Pipeline	Adjacent to UKCS end of Knarr Gas Pipeline	Knarr Gas Pipeline ties-in to FLAGS system. Decommissioning assumed in a timeframe of 25-30 years.	Operational
Shell U.K. Limited / SEGAL	Knarr Tee	Manifold	Downstream of Knarr PLEM.	Entry to Knarr Tee is the downstream battery limit of the GASSCO AS operated infrastructure.	Operational
Shell U.K. Limited /SEGAL	Gjøa Tee	Manifold	Downstream of Knarr Tee, before FLAGS Hot Tap Tee.	Between Knarr Tee and FLAGS	Operational
Gassco AS / Gassled	Gjøa PLEM	Manifold	Upstream of Gjøa Tee	Entry to Gjøa Tee is the downstream battery limit of the GASSCO AS operated infrastructure	Operational
Gassco AS / Gassled	Tampen Link PLEM	Manifold	Upstream of FLAGS Hot-Tap Tee	Between FLAGS Hot-tap Tee and Tampen Link pipeline	Operational
Impacts of Decommissioning Proposals					
FLAGS pipeline will continue operating beyond the Knarr Gas Export Pipeline decommissioning and abandonment. Given the close proximity between the subsea structures (Knarr Tee and PLEM), adjacent structures and the FLAGS pipeline, and the subsea construction activities required to remove the subsea infrastructure, the comparative assessment identified a risk of potential impact on the FLAGS infrastructure due to construction activities associated with the Knarr decommissioning. As per the outcome of the comparative assessment delaying the removal of the Knarr subsea infrastructure to coincide with the FLAGS cessation of production will reduce the risk of impact of Knarr decommissioning and abandonment activities on the FLAGS infrastructure.					

1.7 Industrial Implications

The contracting strategy for the subsea infrastructure isolation, cleaning, removal and disposal was to tender for contractor services. The contracting model envisaged the UK side of the project being split into 2 initial phases;

- Phase 1: KGP Decommissioning Project: Isolation and cleaning of KGP (after CoP in May 2022), followed by:
- Phase 2 KGP Abandonment Project: disconnection at spool #7, and removal of a small part of the spool, to isolate KGP from UK infrastructure.

If any waste is sent across a maritime boundary, then the contractor will prepare the appropriate documentation. Gassco AS will ensure the contractor follows both UK and Norwegian regulations for the complete scope of work including waste handling and disposal.

2 DESCRIPTION OF ITEMS TO BE DECOMMISSIONED

2.1 Installation(s): Surface Facilities (Topsides/Jacket(s)/FPSO etc.)

No installations form part of this decommissioning programme.

2.2 Installation(s): Subsea including Stabilization Features

No installations form part of this decommissioning programme.

2.3 Pipeline(s) Including Stabilization Features

Table 2-1: Pipeline/Flowline/Umbilical Information									
Description	Pipeline No. (as per PWA)	Diameter (inches)	Length (km)	Description of Component Parts	Product Conveyed	From – To End Points	Burial Status	Pipeline Status	Current Content
KGP	PL3039	12.748	11.6	3LPP coated steel	Gas	From, and including, the UKCS Median Line to and not including the Knarr Tee structure tie-in spool flange	Surface laid with rock cover to 0.6m	Non-Operational	None Flushed and cleaned

Table 2-2: Subsea Pipeline Stabilisation Features				
Stabilisation Feature	**Total Number**	**Weight (Te)**	**Location(s)**	**Exposed/Buried/Condition**
Gravel bags	12	96	GRP Cover	Exposed
Mattresses	22	230.4	At pipeline crossings where KGP crosses over other pipelines.	Buried under rock cover to average depth of 0.6m.
Rock cover	n/a	Ca. 151,000	Ca. 54,000 Te rock on crossings, spools, PLEM to Tee. Ca. 97,000 Te rock stabilising and covering the KGP on the UK sector.	

2.4 Wells

No wells form part of this decommissioning programme.

2.5 Drill Cuttings

No drill cuttings form part of this decommissioning programme.

2.6 Inventory Estimates

No installations form part of this decommissioning programme. The Knarr Pipeline Decommissioning Environmental Appraisal [2] provides an estimated breakdown of the materials in the overall KGP and associated subsea infrastructure. The inventory estimates for this Decommissioning programme are as follows:

Table 2-3: Inventory Estimates (Phase 1-2)		
Item	**Detail**	**Estimated Weight (tonnes)**
Pipeline (under rock cover)	Steel Pipe	1139
	Pipe Coating	32
	Aluminium (anode)	1
Subsea	Concrete mattresses (left under rock cover)	230.4
	Spools - left under rock cover	29.15
	Spools – to be removed to shore	0.35
	Gravel bags	96

Total Steel	**1168.5**
Total Plastics	**32**
Total Non-Ferrous	**1**
Total Concrete	**230.4**
Total Gravel	**96**
Total Inventory	**1527.9**

3 REMOVAL AND DISPOSAL METHODS

Gassco AS has a Waste Management Procedure that requires identification of potential wastes, their separation into discrete waste streams and instructions for treatment and disposal. The procedure is compatible with EU Waste Framework Directive and Norwegian waste policies and has the following hierarchy:

1. waste reduction, in the volume of waste generated by the decommissioning activities,
2. re-use/re-cycling of materials, in preference to disposal,
3. limiting of hazardous and environmentally harmful materials in any wastes.

3.1 Topsides

No topsides form part of this decommissioning programme.

3.2 Jacket(s)/Substructure(s)

No jackets form part of this decommissioning programme.

3.3 Subsea Installation(s) and Stabilisation Feature(s)

No subsea production installations form part of this decommissioning programme.

3.4 Pipelines and Stabilisation Feature(s)

3.4.1 Decommissioning Options:

*Key to Options:

1) Remove – reverse reeling
2) Remove – Reverse S lay
3) Trench and bury
4) Rock cover
5) Partial Removal
6) Leave in place
7) Remedial trenching
8) Remedial removal
9) Remedial rock-cover
10) Other

Table 3-1. Pipeline or Pipeline Groups Decommissioning Options

Pipeline or Group (as per PWA)	Condition of line/group (Surface laid/Trenched/ Buried/Spanning)	Whole or part of pipeline/group	Decommissioning Options* considered
Knarr Gas Pipe PL3039 (from UK / Norwegian median line: Lat: 61° 06' 07.23"N Lon: 01° 51' 09.21" E to Knarr PLEM.)	Surface laid, rock cover.	Whole of pipeline between the UK – Norway control boundary and the UK end of the pipeline.	Option 1, 2 (Remove) and 6 (Leave in place) have been evaluated. Preferred option 6 with 9 as necessary.

3.4.2 Comparative Assessment (CA) Method

Gassco AS chose Comparative Assessment evaluation method 'A' from the BEIS Guidance notes for the Decommissioning of Offshore Oil and Gas Installations and Pipelines. This method used a paired comparison system, which allows the relative importance of each differentiating criteria to be judged against each other in a qualitative assessment.

Qualitative assessment was considered an appropriate level of detail for the assessment given the lack of complexity of the decommissioning options. The criteria used in the Comparative Assessment were taken from the BEIS Guidance Notes for the Decommissioning of Offshore Oil and Gas Installations and Pipelines, as follows:

- **Safety** – the safety of personnel directly involved in the decommissioning programme activities offshore.
- **Environmental** – the environmental impact of the activities on the immediate environment of the pipeline and structures.
- **Technical** – the practicalities of cleaning the pipeline system and removing the PLEM and Tee structures and associated protection systems[1], in close proximity to operating oil and gas infrastructure.
- **Societal** – the benefit/disbenefit of the decommissioning activities to impacted stakeholders and onshore communities.
- **Economic Method**: - the cost of decommissioning activities and end-disposal.

Outcome of Comparative Assessment:

Table 3-2. Outcomes of Comparative Assessment

Pipeline or Group	Recommended Option*	Justification
Knarr Gas Pipe PL3039 (from UK / Norwegian median line:	Option 6 and 9 as necessary	Pipeline is rock covered to 0.6m minimum depth throughout the UK sector with little evidence of disturbance. In order to remove the pipeline the rock would need to be removed or dispersed in the local environment and the pipeline cut into sections for removal. This would require extensive ROV operational support for cutting and subsea heavy construction activity to remove. Both operations would result in local environmental impact. Remedial works will be completed during the final phase of KGP decommissioning.
Spool section from Knarr PLEM to Knarr tee	Option 6 Option 8 as necessary	Spool section would need to be disconnected to allow future removal of the subsea structures.

[1] Note that the CA was undertaken for the entire UK located KGP scope, hence includes PLEM and T-structures which are not part of the current DP.

3.5 Pipeline Stabilisation Feature(s)

Table 3-3. Pipeline Stabilisation Feature(s)			
Stabilisation feature(s)	**Number**	**Option**	**Disposal Route**
Concrete mattresses	22	It is intended that the mattresses will be left in situ as they are under rock cover.	Leave in situ
Gravel bags	12	To remain in place stabilizing the GRP cover	Leave in situ
Rock Cover for Pipeline	ca 151,000te	To remain in place	n/a

3.6 Wells

No wells form part of this decommissioning programme. This section is therefore considered not applicable.

3.7 Drill Cuttings

No wells form part of this decommissioning programme. This section is therefore considered not applicable.

3.8 Waste Streams

The pipeline from Knarr PLEM to the Knarr FPSO was cleaned from the temporary pigging spread at the Knarr PLEM back to the Knarr FPSO, where contents were contained in suitable available tanks for transport to a disposal facility and disposal onshore Norway.

Phase 2 activities will remove to shore a minor spool section only, remaining pipeline inventory being abandoned. No particular waste fractions are foreseen. Table 3-4 details the planned inventories from the Knarr Gas Pipeline Environmental Appraisal report.

Table 3-4. Inventory Disposition, Phase 1-2			
	Total Inventory Tonnage	**Planned tonnage to shore as part of the programme**	**Planned left *in situ* as part of this programme**
Pipeline	1139	0	1139
Pipeline coating	32	0	32
Spools (steel)	29.5	0.35	29.15
Anodes (aluminium)	1	0	1
Gravel bags	96	0	96

The small spool section removed in Phase 2 will weigh about 350 kg, of which the majority is steel and about 10 kg represents the coating layer. The steel item may be recycled without removing the coating.

One spool cover (GRP) will be temporary moved to enable for cutting the spool. It will be wet-stored locally and moved back to protect the spool. Gravel bags will be used to stabilize the GRP.

4 ENVIRONMENTAL APPRAISAL OVERVIEW

4.1 Environmental Sensitivities (Summary)

Table 4-1: Environmental Sensitivities	
Environmental Receptor	**Main Features**
Conservation interests	No identified SAC in proximity to the UK section of the KGP, and the closest SCI (the Pobie Bank Reef) is more than 90 km away. The closest Marine protected area to the UK KGP project is the NE Faroe Shetland Channel NCMPA, but it is located approximately 110 km to the north-west.
Seabed	Benthic communities in the project area are similar to those found throughout the NNS. There do not appear to be any benthic species listed for their conservation value; the characteristic infaunal species is polychaetes (tube worms)
Fish	Decommissioning oil and gas infrastructure can potentially impact fish populations by, for example, underwater noise, hydrocarbon or chemical discharges, or sediment disturbance. Conversely, some fish species may congregate around offshore structures and pipelines, which may provide a habitat.
Fisheries	The KGP on the UKCS is located in rectangle 51F1/4 of the ICES database, and passes through the Brent Field, connecting with the FLAGS pipeline ~1.5 km south of the former Brent Alpha platform location. The KGP is located in spawning grounds for cod, haddock, Norway pout, saithe, sandeel and whiting, & in nursery grounds for anglerfish, blue whiting, European hake, haddock, herring, ling, mackerel, Norway pout, sandeel, spur dog & whiting. April and May are the busiest months for fishing vessel activity in ICES rectangle 51F1 and equates to about one fishing vessel every other day. Fishing intensity in the KGP UKCS area from 2007-2015 ranges between 5-20 vessel monitoring system (VMS) tracks.

Table 4-1: Environmental Sensitivities	
Environmental Receptor	**Main Features**
	Analysis of bottom trawling statistics over this 2-year period on the UK side shows the number of passes totals 118, i.e. 59 per year or 5 per pipeline km per year. Based on updated statistics from Marine Scotland on fishing effort in the ICES rectangle this magnitude of passes is considered representative also in 2024.
Marine Mammals	Marine mammals include whales, dolphins and porpoises (cetaceans) and seals (pinnipeds). They can be impacted by offshore oil and gas activities as they are vulnerable to underwater noise, injury from collisions with vessels, oil spills or chemical discharges, and effects on availability of prey. The KGP passes through the Brent Field, in the vicinity of which the following have been recorded: harbour porpoise, killer whale, minke whale, sperm whale, white beaked dolphin and white-sided dolphin. The majority of sightings of cetaceans occurred between May–August, although a few sightings of harbour porpoise, sperm whale and white-beaked dolphins have also occurred during autumn and winter. Seals are more likely to be seen in coastal areas than in areas around the KGP.
Birds	The KGP passes through the Brent Field. The overall vulnerability of seabirds to oil pollution is shown in the JNCC block-specific vulnerability data and overall it is “low”, although some specific months (e.g.) July and November are “high”.
Onshore Communities	There are no impacts on UK onshore communities from the initial phase of the KGP decommissioning. For later phase work, with removal of structures to shore, some employment effects will be generated including yard activities with associated ripple effects. Since the actual structures are small in an offshore decommissioning context, however, the effects will be limited and temporary. The actual yard is yet not decided.
Other Users of the Sea	There are 24 shipping routes trafficked by an estimated 686 ships per year passing within 10 nm of the Brent Field. This corresponds to an average of 1 to 2 vessels per day. There is limited international shipping traffic in the area and the majority of vessels are offshore and standby support vessels given the high concentration of oil and gas developments. Shipping density is considered ‘low’ in the KGP UKCS area.

Table 4-1: Environmental Sensitivities	
Environmental Receptor	**Main Features**
Atmosphere	The KGP decommissioning activities will be undertaken using conventional marine resource. There will be emissions to atmosphere of CO_2, SO_X and NO_X associated with the burning of marine diesel. The environmental impacts of energy and emissions from the decommissioning activities is negligible when compared to overall UKCS oil and gas emissions.

4.2 Potential Environmental Impacts and their Management

This sub-section considers the energy consumption and emissions to air related to decommissioning and end disposal of the KGP and associated structures. Estimations are made for the preferred decommissioning option, and are based on the following approach and assumptions:

- Material inventory breakdown of the KGP pipeline from as-built documentation
- Vessel spread and duration of decommissioning activities from a KGP Decommissioning study
- Daily fuel consumption, energy and emissions factors for vessels and material processing from Institute of Petroleum guidelines, and vessel specific / updated data as applicable.

Based on previous decommissioning projects, it is generally acknowledged that E&E estimates performed during the planning phase has an uncertainty range of 30-40%, related to uncertainty of actual vessels being applied, weather conditions, etc.

Table 4-2: Environmental Impact Management		
Activity	**Main Impacts**	**Management**
Materials Disposal	A spool piece from spool 7 will be disposed during phase 2 abandonment project. Future: The recommended disposal solution implies that the PLEM structure, all GRP covers and spool #8 eventually will be recovered to shore. Removal of these facilities will be undertaken under a separate DP, once FLAGS cessation of production has occurred. About 8.5% of the materials will be taken to shore for further material management (generally material recycling). These activities will be executed applying different maritime vessels for the offshore work and material deconstruction, transport and recycling activities onshore. Such activities require energy, normally fossil fuels (marine diesel) provide the energy source	Recovery activities will result in swirling and resuspension of sediment, and re-sedimentation, covering any immovable immobile organisms. However, in this part of the NNS on the UKCS: • there do not appear to be any benthic species listed for their conservation value; characteristic infaunal species include polychaetes (tube worms) • no environmentally sensitive habitats were identified in proximity to the KGP, with the closest protected area more than 90 km away. • Sediments consist of moderately well sorted, fine to very fine sands, which contain a relatively low proportion of organic matter and coarse material, with moderate amounts of fine and shelly material. This implies that generally the sediments at the project area are not characteristic of those prone to adsorbing hydrocarbons or heavy metals. Because the decommissioning activities are very minor in nature, the disturbed sediment is uncontaminated, and the receiving environment is not particularly sensitive, the resulting environmental impact is anticipated to be small, localised and temporary in nature.

Table 4-2: Environmental Impact Management		
Activity	**Main Impacts**	**Management**
Pipeline Cleaning	Cleaning of the pipeline was performed by pigging trains. A light construction vessel (LCV, *Edda Fauna*) was employed near the PLEM location performing the pigging operation. The total duration of the cleaning activity was 4 days with the LCV on location. Since this vessel was located in UK waters (the pigs driven towards Knarr FPSO located in Norway) the emissions are included. Fuel consumption related to cleaning is estimated to about 45 percent of the overall fuel consumed by maritime vessels for the overall KGP decommissioning.	The environmental impacts of energy and emissions from the decommissioning activities is insignificant (cf. assessment terminology described in the EA section 8). • CO_2 emissions contribute to the global warming potential, however the KGP decommissioning contribution will be insignificant owing to the small scale of the activities, the Phase 1-2 activities contributing approximately to 950 tonnes. For comparison annual CO_2 (equivalent) emissions from UK oil & gas activities in 2022 was about 14.28 million tonnes. • NO_X emissions can contribute to global warming potential (nitrous oxide), and nitrogen oxide may increase ozone which can potentially cause damage to crops/vegetation. The contribution from KGP decommissioning Phase 1-2 (6 tonnes) is insignificant (ca. 128,300 tonnes/year from UK energy sector in 2021), and the distance to shore further prevents potential effects on vegetation. • SO_X emissions contribute to acidification/acid rain, however contribution from KGP decommissioning Phase 1-2 (0.3 tonnes) and distance to shore reduce the impact potential significantly. For comparison ca. 30,500 tonnes/year from UK energy sector in 2021. Marine vessels operating in the North Sea are required to use low Sulphur fuel as per IMO requirements, hence the SO_X emission estimate provided is considered conservative.
Preparatory work	Approx. 10 days of preparatory and post-pigging work was necessary for the pigging operations and was executed by the light construction vessel *Edda Fauna*. Tasks included isolation of the KGP from FLAGS, MEG injection into Spool #8 section, installation and removal of the pigging spread at the Knarr PLEM, and transit to and from work location. About one week vessel activity planned for the phase 2 activities.	

5 INTERESTED PARTY CONSULTATIONS

Gassco AS recognizes that stakeholder involvement is important in the successful delivery of the Knarr Gas Pipeline System Decommissioning. Stakeholders will be sought based on their areas of specialist knowledge and interest in the outcomes of the Knarr Gas Pipeline system decommissioning and consultation with regulatory bodies has been sought to ensure a comprehensive set of consultees are included. The programme has been presented to the North Sea Transition Authority (NSTA), and OPRED

Stakeholders will be provided with information on the KGP decommissioning, principally the Comparative Assessment, Environmental Appraisal and this Decommissioning Programme, and given the opportunity for meaningful discussion on the Knarr Gas Pipeline System Decommissioning Programme with Gassco AS and to provide comment. This process will be used by Gassco AS to ensure that well founded and properly informed decisions on the decommissioning of the Knarr Gas Pipeline system are taken.

Table 5.1 will be completed with the findings of the consultation process.

Table 5-1: Summary of Stakeholder Comments

Who	Comment	Response
Informal Stakeholder Consultations		
Statutory Consultations [HOLD 03]		
National Federation of Fishermen's Organisations		
Scottish Fishermen's Federation		
Northern Ireland Fish Producers Organisation		
Global Marine Systems Limited		
Public		

6 PROGRAMME MANAGEMENT

6.1 Project Management and Verification

A Project Management team will be appointed to manage suitable sub-contractors for the pipeline decommissioning and abandonment operations. Standard procedures for operational control and hazard identification and management will be used.

For residual seabed items left in-situ for later decommissioning, e.g. the PLEM, spools and spool covers, they will be decommissioned after the FLAGS cessation of production to limit work adjacent to live hydrocarbon infrastructure.

The Management team will monitor and track the process of consents and the consultations required as part of this process. Any changes in detail to the offshore removal programme will be discussed and agreed with OPRED.

6.2 Pipeline Cleaning

Pipeline cleaning was undertaken in accordance with the Preparatory Works Request (PWR) submitted by Gassco AS on 29/04/2021. The cleaning operation was performed by pigging as recommended in the prior Wood decommissioning concept study for GASSCO AS [3, 4]. The spool between the Knarr tee and the Knarr PLEM is un-piggable and was filled with 100% MEG. The KGP was cleaned by means of displacement dilution – utilising 4 x pigs in a single train to remove hydrocarbons from the pipeline and attain an ALARP oil in water content. The pigs, separated with MEG slugs to prevent hydrate formation, was propelled and the pipeline filled with uninhibited seawater. Cleanliness was verified by sampling. This concluded phase 1 of the KGP pipeline decommissioning activity.

During Phase 2 KGP will be disconnected at spool #7, with a small part of the spool removed and recovered to surface, to isolate it permanently from UK infrastructure. An abandonment cap will be installed on the PLEM side. The disconnection operation will require the GRP cover on spool #7 to be removed and a small amount of rock overburden cleared to access the spool and perform the cut. The GRP cover and rock overburden will be re-instated after the disconnection operation is complete.

The Phase 1 and 2 activities are illustrated step-wise in Figures 7 and 8.

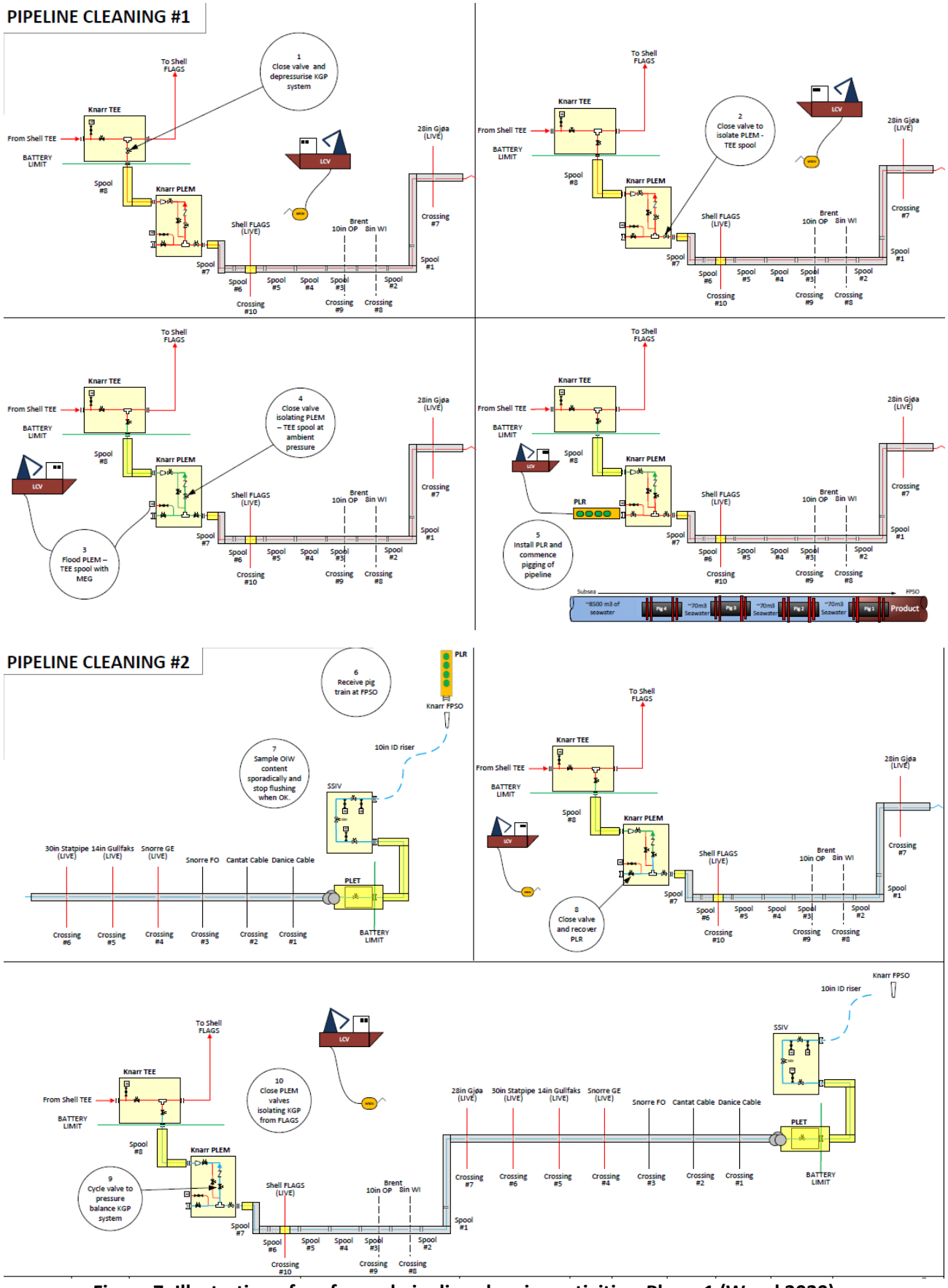

Figure 7: Illustration of performed pipeline cleaning activities, Phase 1 (Wood 2020)

Removal and disposal – Pipeline disconnection (UK end)

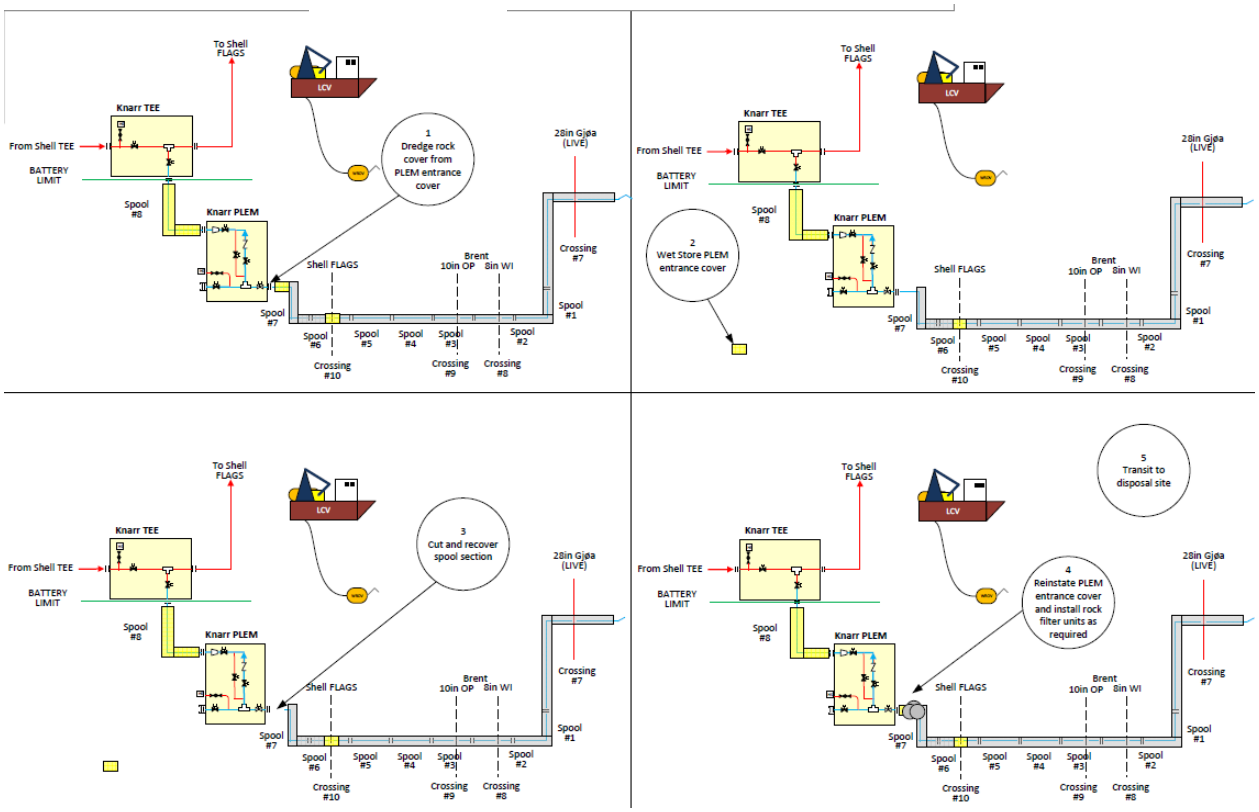

Figure 8: Illustration of planned disconnection at PLEM, Phase 2 activity (Wood 2020)

6.3 Debris Clearance and Verification

The status of the seabed following the decommissioning activities (phase 1 and 2) will be confirmed by an as-left survey completed at the end of these activities. Any oil and gas related debris will be removed from the seabed.

6.4 Schedule for Decommissioning

CoP of the Knarr field occurred on 1st May 2022. A general project plan is indicated in Figure 9.

The cleaning and flushing operations took place shortly after CoP 01.05.2022 and while the Knarr FPSO was still on station to receive and process the cleaning fluids and wastes.

The KGP is to be disconnected at spool #7 close to PLEM, and a small spool section removed. Offshore execution will be performed between early Q2 2024 - late Q4 2025, as per below project plan in Figure 9.

The base case is to complete the project in 2024, however, the below project plan reflects an opportunity to postpone and no later than 2026.

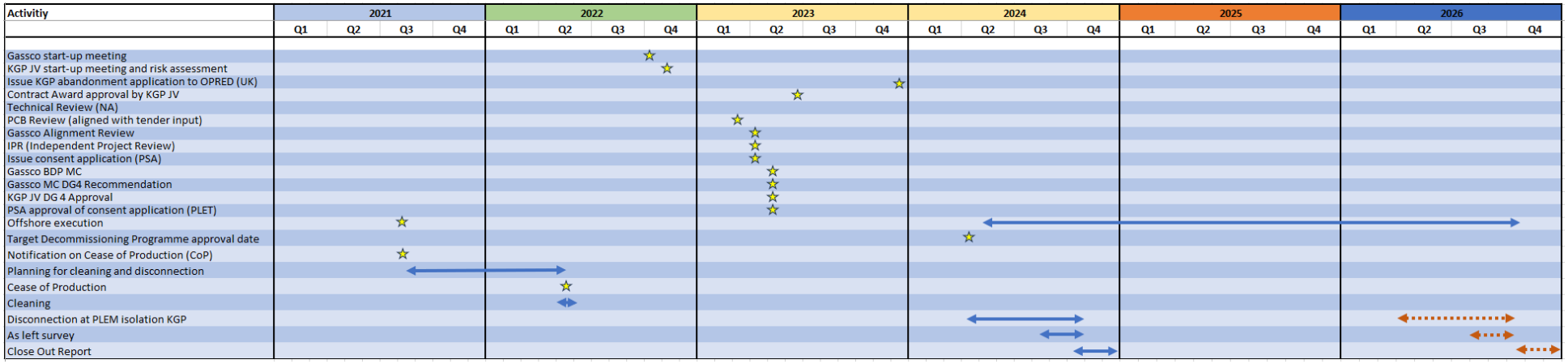

Figure 9: Gantt Chart of Project Plan

6.5 Close out report

Gassco AS will prepare a close out report to be submitted within 12 months of the works covered in this DP have been completed.

6.6 Post decommissioning future monitoring

Regular inspections will be performed on KGP and associated stabilization with a frequency of 12 years.

The timing for the 12 years interval for inspection of the abandoned pipeline is based on the fact that the pipeline is cleaned, disconnected and covered by a large gravel berm throughout the UK section. The risk for third party hooking of trawl gear is consequently considered to be very low.

Inspections will be performed on the PLEM and spool #8 every 4 years. The interval for the inspection of the PLEM and spool #8 is based on the low inherent risk for the components as they are isolated from hydrocarbons with closed valves. The third-party risks for the components are also evaluated to be very low. They are both protected with gravel berms.

7 SUPPORTING DOCUMENTS

Table 7-1 Supporting Documents	
Document Number	Title
1	Gassco AS, Comparative Assessment, Report No. **Error! Unknown document property name.**, Rev 7, January 2024.
2	Gassco AS, Environmental Appraisal, Rev 3, January 2024.
3	Wood 2019. J003034-01-PL-REP-001, KGP Decommissioning Study, September 2019
4	Wood, 2020. J003034-01-PL-REP-002, KGP Decommissioning Concept Study, Rev. 02, January 2020
5	Institute of Petroleum (London), 2000. Guidelines for the calculation of estimates of energy use and gaseous emissions in removal & disposal of offshore structures. Institute of Petroleum, London. ISBN 0 85293 255 3.
6	Offshore Norge, 2020. Handbook. Impact Assessment for Offshore Decommissioning. Decommissioning and final disposal of redundant offshore oil and gas facilities. Revision 1, June 2020.
7	Nesse, S. & U.E. Moltu, 2012. Frigg Cessation Project. Environmental footprint and EIA comparison. SPE 157361 (Rev 1).

8 Section 29 Notice Holder(s) Letter(s) of Support

Copies of letter(s) of support from current equity holders in the field will be provided here. Notice Holders Letters will be added post public consultation to the final version of the Knarr Gas Pipeline DP.

9 Public Notice

10 Preparatory Work Request (PWR)

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29.04. 2021

Knarr Gas Pipeline (PL3039) Decommissioning – Preparatory Works Request

Dear Amy,

This Preparatory Works Request have been prepared by Gassco as the Knarr Gas Pipeline Operator and is submitted on behalf of the Knarr Gas Pipeline (KGP) Joint Venture (JV), as set out in Table 1 below, being the recipients of the Section 29 Notices. Throughout this document the terms “owners”, “we” and “our” refer to the KGP JV.

Section 29 Notice	Notice Holder	Equity Share
Knarr Gas Pipeline Your Ref: 12.04.06.05/465C UKOP Doc. Ref: 869369	A/S Shell Norge Registered Company Number 914 807 077 Idemitsu Petroleum Norge AS Registered Company Number 953 133 210 Wintershall DEA Norge AS Registered Company Number 985 224 323	45% 25% 30%

Table 1 - KGP Joint Venture

The Knarr Field is located in Block 34/3 of the Norwegian Continental Shelf (NCS) in the northern North Sea, 50 kilometres northeast of the Snorre field. The Knarr Field is approximately 50-60 km from the UK-Norway median line (Figure 1) and is in water approximately 410 metres deep.

The Knarr Field comprises 2 subsea well templates connected to a floating production, storage and offloading vessel (FPSO), with shuttle tankers for oil export. Gas and condensate are exported from the Knarr FPSO in the Norwegian sector to the UK via the Knarr Gas Pipeline (KGP) system, which passes through NCS to enter UKCS, and connects to the Far North Liquids and Associated Gas System (FLAGS) pipeline. The system (Figure 2) was installed in 2013, and field production started in 2015.

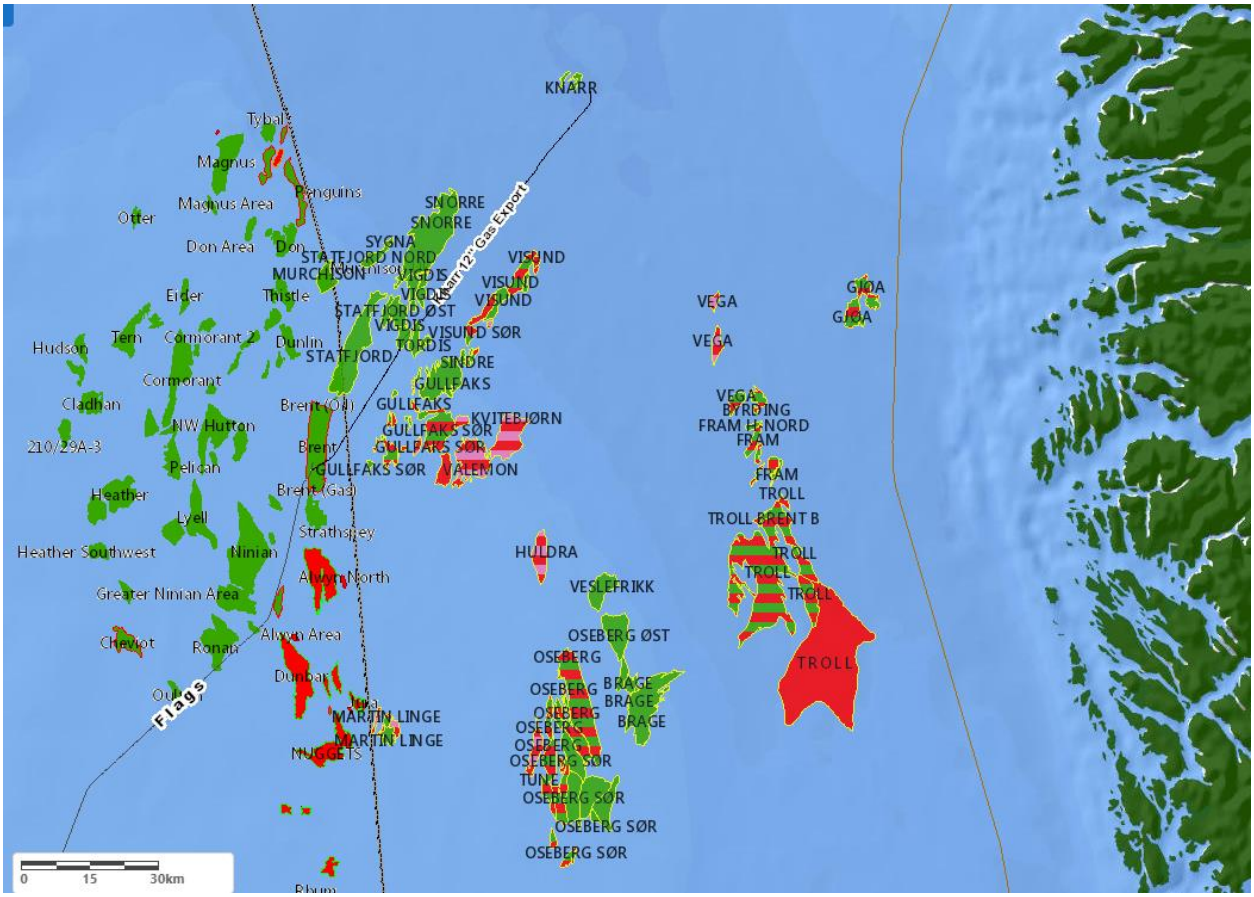

Figure 1: The Knarr Field and Knarr Gas Export Pipeline

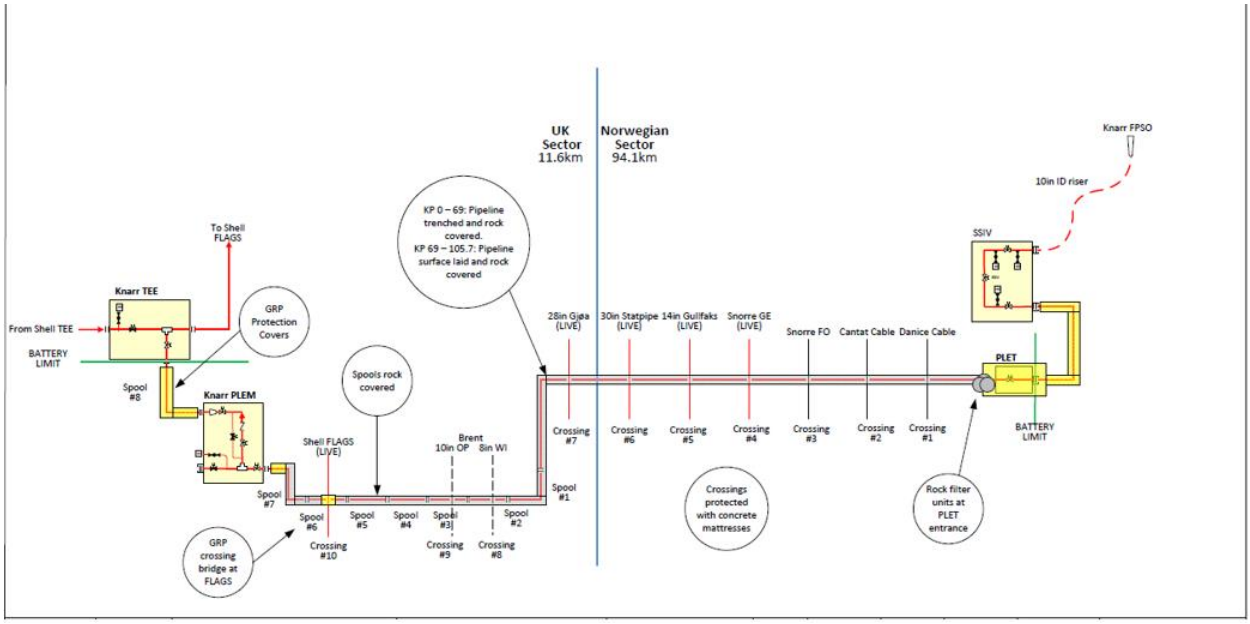

Figure 2 - Knarr Gas Pipeline

Production will cease from Knarr no earlier than March 2022 and the Knarr FPSO will leave the field shortly after. Pipeline cleaning will take place directly after CoP and while the Knarr FPSO is operative at the field, to receive and process the cleaning fluids and wastes. To mitigate the risk that the KGP Decommissioning Programme is not approved in time before the FPSO leaves the Knarr Field, we are submitting this Preparatory Works Request to seek OPRED´s approval to commence pipeline flushing and cleaning activities.

Description of the KGP Infrastructure

Knarr Gas Pipe

Gas and condensate are exported from the Knarr FPSO via the KGP, which passes through NCS to enter UKCS, and connects to the FLAGS pipeline

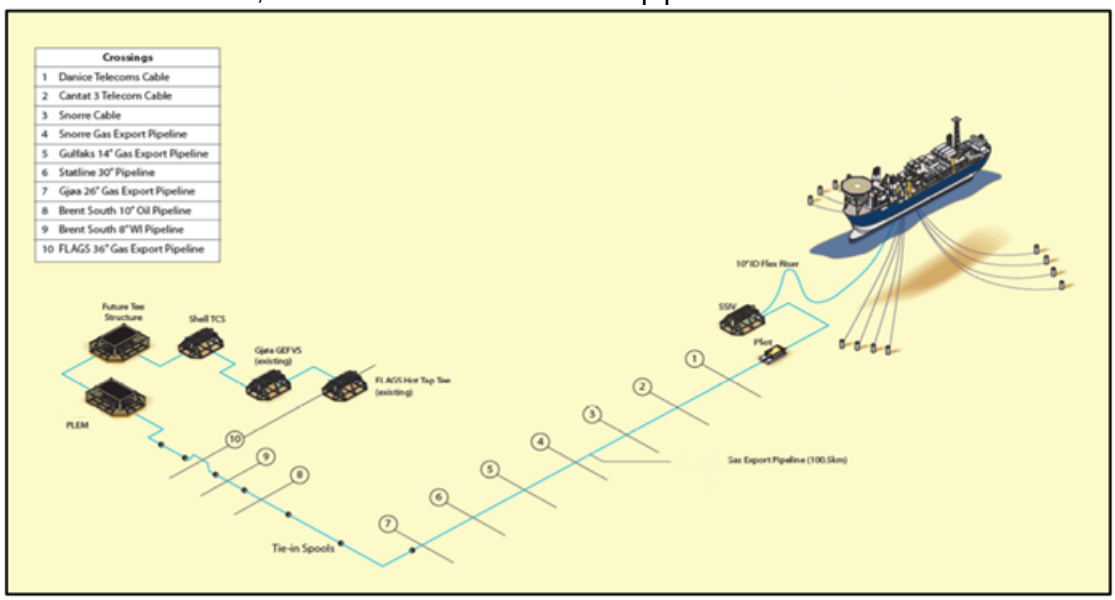

Figure 3 Knarr Gas Pipeline and Pipeline Crossings (Crossings 7 – 10 in UKCS)

The 105.7 km 12-inch KGP is a steel rigid pipeline which connects, on the UKCS side, to the Knarr PLEM and Knarr Tee through a series of 12-inch rigid spools before feeding into FLAGS. Figure 3 provides some details about the KGP.

Table 2 Features of the 12-inch KGP

Feature	Detail	Comments
Length (km)	105.7 including spools	11.6 km of the pipeline is in UKCS. In the UKCS, the pipeline is surface laid with rock cover. Pipeline has no concrete cap.
Inner Diameter (inch)	12	
Outer Diameter (inch)	13	Wall thickness generally 12.7mm, 13mm in certain areas.
Depth max (m)	411	Maximum depth at start of pipeline in NCS
Depth Min (m)	137	All of the KGP on UKCS is at water depth of approximately 140 m.
Material	DNV HFI 450 SFD	Steel
Coating (mm)	3LPP* 3 mm thick (min)	• Base coat: fusion bonded epoxy primer • Intermediate: polymeric adhesive • Top coat: polypropylene

		• Heat shrink sleeves were selected for the field joint coating • KGP has no concrete coating, as it is either trenched with natural backfill (NCS) or rock covered (UKCS)
Steel in UKCS (t)	1,139	Approximate weight for the 11.6 km KGP on UKCS only. The entire KGP is approximately 10,381 tonnes steel.
Plastic in UKCS (t)	32	This is the weight of the polypropylene coating.

PLEM

The KGP UKCS PLEM (*Figure 4*) is about 10 metres long, weighs approximately 114 tonnes (including entrance and exit GRP covers, which weigh 22.6 tonnes) and is located at KP 105.640 to KP 105.650.

Figure 4 PLEM

Spools and GRP cover

The KGP connects to the PLEM and Knarr Tee (in UKCS) through eight 12-inch rigid steel pipe spools as illustrated in. Seven of the spools are upstream of the PLEM, with one spool located between PLEM and Knarr Tee structure. The wall thickness of the spools is 12.7 mm, and they are coated with 3 mm of 3LPP. *Table 3* summarises the spool features.

Spool #	Weight (t)	Interface and cover
1	4	L-type spool, interface between Spool 2 & KGP. Swivel flange at each end. Rock cover
2	4,1	Connected by flanged connection and rock cover
3	4,1	Connected by flanged connection and rock cover
4	4	Connected by flanged connection and rock cover
5	3.6	Connected by flanged connection and rock cover
6	4	Connected by flanged connection and rock cover
7	5.7	Z-type spool, interface between Spool 6 & PLEM. Swivel flange at PLEM end & weld neck at other end. Rock cover

7 Cover	3.8	Spool 7 cover.
8	5.9	L-type spool, located between PLEM and Knarr Tee structure, fitted with swivel flange at each end. Protected by GRP cover (see below).
8 Cover #1	2.8	Spool 8 GRP straight cover #1
8 Cover #3	3.1	Spool 8 GRP Left elbow cover #3
8 Cover #15	2.4	Spool 8 GRP straight cover #15

Table 3 Spools 1 – 8 Details

Pipeline Crossings and Concrete Mattresses

Along the pipeline route to FLAGS, the KGP crosses the following 4 pipelines and cables in the UK sector (crossings 7–10 as shown in *Figure 5*)

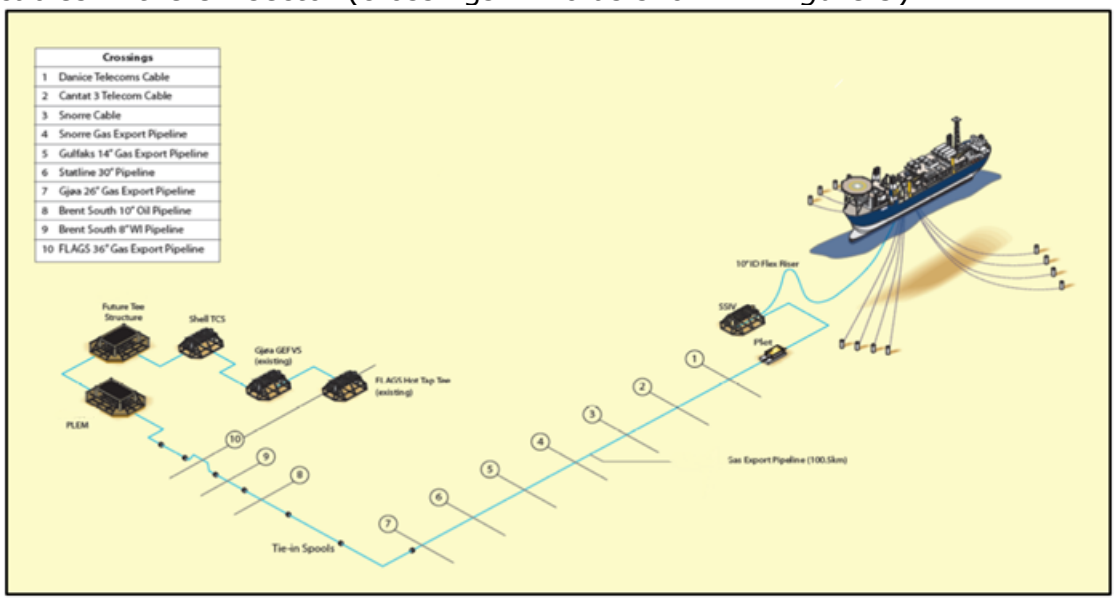

Figure 5 Pipeline crossings

The KGP crosses over at all 4 pipeline crossings. A physical, vertical separation of 300 mm minimum is ensured between the KGP and the other pipeline at the crossings (whether originally exposed or buried) and with consideration to both short-term and long-term settlement at the crossings. The separation is provided at crossings 7, 8 and 9 by 300 mm thick flexible concrete mattresses as detailed in *Table 4*. There are no mattresses over the FLAGS 36" gas export pipeline (crossing 10), as separation is provided by GRP cover

		Concrete Mattresses					
Pipe crossings		No.	Dimensions (m)	Weight (t in air)	Submerged Weight (t)	Density (kg/m³)	Additional Specs
7	Gjøa 26" gas export pipe	20	6x 3 x 0.3	9.6	5.9	2,400	20mm polyprop rope
8	Brent South 10" Oil Pipe	1	6x 3 x 0.3	9.6	5.9	2,400	20mm polyprop rope
9	Brent South 8" water inject	1	6 x 3 x 0.3	9.6	5.9	2,400	20 mm polyprop rope

Table 4 Concrete mattresses located in KGP UKCS

Scope of Work

In this section the proposed cleaning concept for decommissioning of KGP is described, including:

- Closed valves for Isolation towards FLAGS
- Depressurisation of KGP
- Barrier testing
- Spool and PLEM filling with MEG;
- Pigging
- Sampling to verify cleanliness
- Valve operation and barrier testing

Closed valves for isolation towards FLAGS

The control valve at Knarr Tee (KNA-GA-002) shall be shut to isolate the FLAGS line prior to depressurisation. The main isolation valves in Knarr PLEM shall be closed prior to the depressurization process and shall be monitored during depressurization process to ensure the valves hold the pressure well and there is no hydrocarbon leak.

Depressurisation of KGP

The depressurization process will be controlled from the Knarr FPSO. Detail engineering will define the optimal pressure for pigging operation and cleaning.

Barrier testing

When the differential pressure between FLAGS and KGP is at the agreed level the internal pressure in the Knarr PLEM will be monitored to verify no pressure build up from the FLAGS system.

Spool and PLEM filling with MEG

The spool between the Knarr tee and the Knarr PLEM is un-piggable and will be filled with 100% MEG. This operation will be performed prior to pigging operations to protect the Knarr tee and mitigate against the low probability of hydrate formation during or on completion of the decommissioning. The MEG will also protect the system from internal corrosion.

Pigging

Pigging shall be performed to remove hydrocarbons and other contaminants such as seal oil, condensate, and potential black powder from the pipeline. This method will positively displace pipeline contents with the pig and dilutes any residual contaminants which is in turn positively displaced by the next pig.

The Knarr Gas Export pipeline should be cleaned by means of displacement dilution – utilising 4 x pigs in a single train to remove hydrocarbons from the pipeline and attain an ALARP oil in water content.
The pigs, separated with MEG slugs to prevent hydrate formation, will be propelled and the pipeline will be filled with uninhibited seawater.

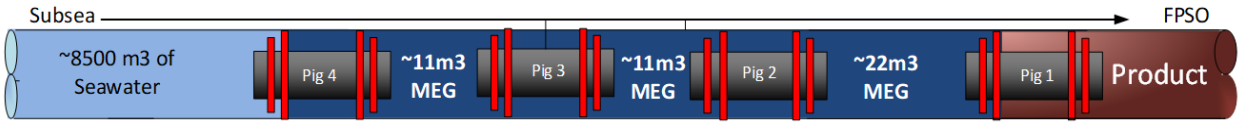

Figure 6 Decommissioning - pig train fluid medium and volume requirements

Sampling to verify cleanliness
The project will apply for an OPPC permit to cover the release of the residual OiW content as agreed with the regulator. The suggested pipeline cleanliness is an Oil in Water (OIW) level that is a safe level for diver intervention and from which further cleaning would provide no further environmental benefits. If the target level cannot be achieved in consecutive samples following 4 pigs then the OIW content is considered ALARP if the ppmv level in the final sample is reduced by <10% from previous sample. Samples will be collected on Knarr FPSO .

Valve operation and barrier testing
Following the pigging operation Knarr PLEM barriers will be confirmed prior to recovery of PLR. To ensure no leak into the Knarr Gas Pipeline, the valve between the Knarr PLEM and KGP will be closed. The valve downstream the PLR connection will be closed and tested to ensure no loss of containment from the Knarr PLEM.

Scope of Work - Preservation option

Gassco has received a 3rd party request to study the potential reuse of the Knarr Gas Pipeline which, if viable, will require the preservation of the pipeline for 3-5 years. A decision by the 3rd party on whether this opportunity is viable and will be investigated further is expected in November 2021. Therefore, an option to preserve the pipeline is included within this PWR as follows.

This section describes the changes in Scope of Work compared to the decommissioning concept described above if the pipeline is preserved:

- Closed valves for Isolation towards FLAGS (no changes)
- Depressurisation of KGP (no changes)
- Barrier testing (no changes)
- Spool and PLEM filling with MEG (no changes)
- Pigging
- Sampling to verify cleanliness (no changes)
- Valve operation and barrier testing (no changes)

Pigging
Pigging shall be performed to remove hydrocarbons and other contaminants such as seal oil, condensate, and potential black powder from the pipeline. This method will positively displace pipeline contents with the pig and dilutes any residual contaminants which is in turn positively displaced by the next pig.

The Knarr Gas Export pipeline should be cleaned by means of displacement dilution – utilising 4 x pigs in a single train to remove hydrocarbons from the pipeline and attain an ALARP oil in water content.
The pigs, separated with MEG slugs to prevent hydrate formation, will be propelled and the pipeline will be filled with chemically treated seawater with correct doses of biocide, corrosion inhibitor and oxygen scavenger to provide maximum protection possible during the pipeline preservation period.

A high-level assessment of potential pipeline preservation fill options is considered to evaluate the suitability of preservation and suitability for use in UK and Norwegian sector.

An optimised chemical composition based on Roemex RX-5255 components is recommended for use if the pipeline is to be preserved.

Permits and Consents

Knarr Decommissioning project maintains an Authority Plan which has identified the following permits to be submitted for this scope:

- Marine Licence, per Marine and Coastal Access Act 2009
- Notifications to the Hydrographics Office
- Pipeline Safety Regulation 22 notification, per SI 1996
- Pipeline Works Authorizations, per SI 1996
- Supply Chain Action Plan (SCAP), Oil and Gas Authority
- Deposit consents, per Petroleum Act 1998
- Chemical Permits, per Environmental Impact Assessment Regulations 1999 and Offshore Chemical Regulations 2002
- OPPC Permit, per Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005

Gassco will continue to engage regularly with the HSE UK, Oil and Gas Authority and BEIS OPRED to inform ongoing permit and consents requirements for the project.

Relevant Agreements

The activities described in this PWR will require that proximity agreements are entered into between Gassco and relevant proximity pipeline operators.

Target Approval Date

Gassco is developing Decommissioning Programme (DP) for the three s29 notice holders listed in Table 1. Gassco expects to submit DP for consultation by end 2021 and seek regulatory approval by Q2 2022.

A copy of this Preparatory Works Request will be an appendix to the decommissioning Programme and reference made to the work executed.

Impact on Future Decommissioning

Gassco confirms that the scope to be executed under this Preparatory Works Request will not compromise or prejudice feasible decommissioning options for the remaining infrastructure.