PERENCO (UK) LTD

WELLAND DECOMMISSIONING OPTIONS

COMPARATIVE ASSESSMENT

Date: *SEPTEMBER 2010*

Revision: *03*

PERENCO (UK) LTD

WELLAND DECOMMISSIONING OPTIONS

COMPARATIVE ASSESSMENT

Prepared by:

M Creaser

September 2010

RPS Energy
HSE and Risk Management
13 Bon Accord Square
Aberdeen
AB11 6DJ

Tel +44 (0)1224 597350

Fax +44 (0)1224 586059

Email CreaserM@rpsgroup.com

DISCLAIMER

The opinions and interpretations presented in this report represent our best technical interpretation of the data made available to us. However, due to the uncertainty inherent in the estimation of all parameters, we cannot, and do not guarantee the accuracy or correctness of any interpretation and we shall not, except in the case of gross or wilful negligence on our part, be liable or responsible for any loss, cost damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees.

Except for the provision of professional services on a fee basis, RPS does not have a commercial arrangement with any other person or company involved in the interests that are the subject of this report.

RPS cannot accept any liability for the correctness, applicability or validity for the information they have provided, or indeed for any consequential costs or losses in this regard. Our efforts have been made on a "best endeavours" basis and no responsibility or liability is warranted or accepted by RPS.

NB The Comparative Assessment Criteria & Guidance Tables in Appendix A is based on original work by Project Development International Limited, Regus House, 139 Gallowgate, Aberdeen AB25 1BU

DATE	VERSION	DESCRIPTION	PREPARED	CHECKED	APPROVED
Apr 2010	00	Draft	MC	JC	-
Apr 2010	01	For Issue	MC	-	JC
Aug 2010	02	Re-issued to acknowledge source of comparative assessment criteria	JC		AA
Sep 2010	03	Final	RH	OB	OB
File Reference: Projects\Perenco\1767 Welland Decommissioning Env Support\Document\Comparative Assessment					

Table of Contents

Abbreviations

CEFAS	Centre for Environment, Fisheries and Aquaculture Science
FAC	First Aid Case
FAR	Fatal Accident Ratio
HLV	Heavy Lift Vessel
LTI	Long Term Injury
MEG	Monoethylene Glycol
MTC	Medical Treatment Case
NFFO	National Federation of Fishermen's Organisations
OSPAR	Oslo Paris Convention
PLL	Potential Loss of Life
PLONOR	Poses Little or No Risk
QRA	Quantitative Risk Assessment
RWC	Restricted Work Case
WPS	Wellhead Protection Structure

1 Introduction

The Perenco U.K. Limited (Perenco) operated Welland field is currently being considered for decommissioning. The Welland field is located in the southern North Sea in Blocks 53/4a, 49/28a and 49/29b, approximately 72 kilometres off the Norfolk coast. Production from the field started in 1990, although the field has been shut in since 2002.

The Welland infrastructure to be decommissioned consists of;

- The Welland installation topsides and jacket,
- Three subsea Wellhead Protection Structures (WPS),
- 17.5 kilometres of 16″ gas export pipeline (between Welland and Thames, PL674), associated 3″ MEG piggyback line (PL675) and three pipeline crossing points
- Three 8″ subsea flowlines (PL676, PL677 and PL678) approximately 18 kilometres in total
- Three 4″ subsea control umbilicals (PL679, PL680 and PL681) approximately 21.6 kilometres in total
- 128 concrete mattresses (43 flexible mattresses and 85 frond mattresses)

Well intervention and abandonment in the Welland field does not form part of the scope of work for the purposes of this comparative assessment of decommissioning options.

1.1 Scope

The scope of this Comparative Assessment is to provide an assessment of the decommissioning options available for the Welland field against a set of assessment criteria derived from DECC guidance documents (Ref. 1). It is understood that the output of this Comparative Assessment will guide Perenco UK's selection of decommissioning methods.

2 Comparative Assessment Process

The decommissioning options that were considered for analysis in the comparative assessment are listed in Table 1.1. These options are categorised by work package. Further information on these options is provided in the Welland Decommissioning Programme (Ref. 2).

The Comparative Assessment process involved a multi-disciplinary team participating in a Comparative Assessment workshop and a preliminary Quantitative Risk Assessment (QRA) of the available decommissioning options. At the Comparative Assessment workshop each decommissioning option was scored against a set of assessment criteria using categories derived from DECC guidance:

1. Safety
2. Environmental
3. Technical
4. Societal
5. Commercial
6. Legal Compliance

The criteria for evaluating the potential impact of the options are presented in Appendix A. The criteria are based on original work by Project Development International Limited, 139 Gallowgate, Aberdeen AB25 1BU

2.1 Comparative Assessment Workshop

A Comparative Assessment workshop was conducted on the 30th March 2010. Present were Keith Tucker (Decommissioning Engineer, Perenco), Gary Cooper (Decommissioning Engineer, Perenco) and Max Creaser (Senior Consultant, RPS Energy). The workshop involved working through the available options and assigning considered impact values (see Appendix A, Table A.1) and likelihood values (see Appendix A, Table A.2) to generate the overall semi-quantitative assessment of the option (see Appendix A, Table A.3).

2.2 Quantitative Risk Assessment

A preliminary Quantitative Risk Assessment (QRA) was conducted for the available decommissioning options by RPS Energy (Ref. 3).

The QRA involved a calculation of the Potential Loss of Life (PLL) using Perenco-provided data for operational exposure hours associated with each option, and a nominal Fatal Accident Ratio (FAR). The FAR used is derived from a joint industry project report on North Sea decommissioning operations (Ref. 4). The QRA methodology is covered in more detail in the QRA report.

Table 1.1 Overview of Decommissioning Options available for the Welland Field

	Options									
	1	**1a**	**1b**	**2**	**2a**	**2b**	**3**	**3a**	**3b**	**4**
Jacket & Topsides	One-piece removal (Heavy Lift Vessel)			Piece-small removal (Jack-up Barge)			Minimum Disposal Option (Leave superstructure in place after equipment removal)			
Subsea Wellhead Protection Structures	One-piece removal (Heavy Lift Vessel)			One-piece removal (Drilling Rig)			One-piece removal (Crane Vessel)			Minimum Disposal Option (Leave superstructure in place after wellhead removal)
16" Export Pipeline	Clean, Flush, De-pressure & Cut on Seabed	Clean, Flush, De-pressure & Cut on Surface	Clean, Flush, De-pressure & Leave *in situ*	Flush, De-pressure & Cut on Seabed	Flush, De-pressure & Cut on Surface	Flush, De-pressure & Leave *in situ*	De-pressure & Cut on Seabed	De-pressure & Cut on Surface	De-pressure & Leave *in situ*	
3" MEG Piggyback Pipeline	Flush, De-pressure & Cut on Seabed	Flush, De-pressure & Cut on Surface	Flush, De-pressure & Leave *in situ*	De-pressure & Cut on Seabed	De-pressure & Cut on Surface	De-pressure & Leave *in situ*				
Pipeline Crossings	Remove			Leave *in situ*						
8" Subsea Flowlines	Clean, Flush, De-pressure & Cut on Seabed	Clean, Flush, De-pressure & Cut on Surface	Clean, Flush, De-pressure & Leave *in situ*	Flush, De-pressure & Cut on Seabed	Flush, De-pressure & Cut on Surface	Flush, De-pressure & Leave *in situ*	De-pressure & Cut on Seabed	De-pressure & Cut on Surface	De-pressure & Leave *in situ*	
Subsea Control Umbilicals	Flush, De-pressure & Cut on Seabed	Flush, De-pressure & Cut on Surface	Flush, De-pressure & Leave *in situ*	De-pressure & Cut on Seabed	De-pressure & Cut on Surface	De-pressure & Leave *in situ*				
Mattresses	Remove			Bury			Minimum Disposal Option (Leave *in situ*)			

3 Comparative Assessments

3.1 Topsides & Jacket Decommissioning Options

The inclusion of a Minimal Disposal Option (see Welland Decommissioning Programme (Ref. 2)) has been considered to provide a base-case scenario for comparison. However, Perenco is aware that, in-line with OSPAR Decision 98/3, their disposal at sea or leaving them wholly or partly in place is prohibited.

The Comparative Assessment outcome for the topsides and jacket options is provided in Table 3.1 below.

3.2 Subsea Wellhead Protection Structures Decommissioning Options

The Comparative Assessment outcome for the subsea Wellhead Protection Structures (WPS) options is provided in Table 3.2 below.

3.3 Pipelines, Flowlines, Pipeline Crossings & Control Umbilicals Decommissioning Options

Decommissioning options for the 16″ export pipeline, 3″ MEG piggyback line, pipeline crossings, 8″ flowlines and control umbilicals are compared in Tables 3.3, 3.4, 3.5, 3.6 & 3.7 below.

3.4 Mattresses Decommissioning Options

Decommissioning options for the 128 concrete mattresses (43 flexible mattresses and 85 frond mattresses) are compared in Table 3.8 below.

Table 3.1 Comparative Assessment of Jacket & Topsides Decommissioning Options

	OPTIONS		
	1	2	3
	Heavy Lift Vessel (HLV)	Piece Small	Minimal Disposal
1. Safety			
1.2 Risk to other users of the sea (post ops)	1	1	9
1.3 Risk to those on land (during ops)	12	9	1
1.4 Risk to 3rd party assets / vessels (during ops)	2	2	1
Average Safety Value	5.0	4.0	3.7
2. Environmental			
2.1 Chemical discharge	1	1	1
2.2 Hydrocarbon discharge	1	1	1
2.3 Seabed Disturbance	15	20	10
2.4 Energy Usage	20	20	5
2.5 Estimated Discard to Sea (% of total material)	10	10	25
2.6 Estimated Discard to Landfill (% of total material)	10	10	10
Average Environmental Value	9.5	10.3	8.7
3. Technical			
3.1 Technical Challenge	6	12	1
3.2 Level of Diving Intervention	3	10	1
3.3 Weather Sensitivity	6	15	2
3.4 Risk of Major Project failure	2	16	1
Average Technical Value	4.3	13.3	1.3
4. Societal			
4.1 Fisheries Access (post ops)	1	1	25
4.2 Communities	15	15	10
Average Societal Value	8.0	8.0	17.5
5. Legislative Compliance			
5.1 OSPAR 98/3	1	1	25
5.2 NFFO Guidance	1	1	25
Average Legislative Value	1.0	1.0	25.0
6. **Commercial**			
6.1 Economic	6	8	2
6.2 Ongoing Liability	1	1	8
Average Commercial Value	3.5	4.5	5.0
Overall Comparative Score	**6.00**	**8.11**	**8.58**

Table 3.2 Comparative Assessment of Subsea WPS Decommissioning Options

	OPTIONS			
	1	2	3	4
	Heavy Lift Vessel (HLV)	Drilling Rig	Vessel with Crane	Leave *in situ*
1. Safety				
1.2 Risk to other users of the sea (post ops)	1	1	1	6
1.3 Risk to those on land (during ops)	2	2	2	1
1.4 Risk to 3rd party assets / vessels (during ops)	3	6	3	1
Average Safety Value	2.0	3.0	2.0	2.7
2. Environmental				
2.1 Chemical discharge	1	1	1	1
2.2 Hydrocarbon discharge	1	1	1	1
2.3 Seabed Disturbance	20	20	20	10
2.4 Energy Usage	10	10	10	1
2.5 Estimated Discard to Sea (% of total material)	10	10	10	25
2.6 Estimated Discard to Landfill (% of total material)	1	1	1	1
Average Environmental Value	7.2	7.2	7.2	6.5
3. Technical				
3.1 Technical Challenge	6	12	6	1
3.2 Level of Diving Intervention	6	1	6	1
3.3 Weather Sensitivity	6	12	6	1
3.4 Risk of Major Project failure	2	4	2	1
Average Technical Value	5.0	7.3	5.0	1.0
4. Societal				
4.1 Fisheries Access (post ops)	1	1	1	20
4.2 Communities	15	15	15	1
Average Societal Value	8.0	8.0	8.0	10.5
5. Legislative Compliance				
5.1 OSPAR 98/3	1	1	1	25
5.2 NFFO Guidance	1	1	1	25
Average Legislative Value	1.0	1.0	1.0	25.0
6. Commercial				
6.1 Economic	4	4	4	1
6.2 Ongoing Liability	1	1	1	6
Average Commercial Value	2.5	2.5	2.5	3.5
Overall Comparative Score	**4.84**	**5.47**	**4.84**	**6.79**

Table 3.3 Comparative Assessment of 16"Export Pipeline Decommissioning Options

	16" Export Line OPTIONS								
	1	1a	1b	2	2a	2b	3	3a	3b
	Clean, Flush & De-pressure			Flush & De-pressure			De-pressure only		
	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried
1. Safety									
1.1 Risk to other users of the sea (post ops)	1	1	4	1	1	4	1	1	4
1.2 Risk to those on land (during ops)	9	9	1	9	9	1	9	9	1
1.3 Risk to 3rd party assets / vessels (during ops)	4	4	2	4	4	2	4	4	2
Average Safety Value	4.7	4.7	2.3	4.7	4.7	2.3	4.7	4.7	2.3
2. Environmental									
2.1 Chemical discharge	1	1	1	1	1	1	10	10	10
2.2 Hydrocarbon discharge	15	15	12	20	20	16	25	25	20
2.3 Seabed Disturbance	25	25	10	25	25	10	25	25	10
2.4 Energy Usage	25	25	10	25	25	10	25	25	5
2.5 Estimated Discard to Sea (% of total material)	1	1	25	1	1	25	1	1	25
2.6 Estimated Discard to Landfill (% of total material)	20	20	10	20	20	10	20	20	10
Average Environmental Value	14.5	14.5	11.3	15.3	15.3	12.0	17.7	17.7	13.3
3. Technical									
3.1 Technical Challenge	20	12	4	20	12	4	20	12	4
3.2 Level of Diving Intervention	8	4	4	4	2	4	4	2	2
3.3 Weather Sensitivity	12	9	6	12	9	6	12	9	3
3.4 Risk of Major Project failure	20	8	6	20	8	4	20	8	2
Average Technical Value	15.0	8.3	5.0	14.0	7.8	4.5	14.0	7.8	2.8
4. Societal									
4.1 Fisheries Access (post ops)	1	1	3	1	1	3	1	1	3
4.2 Communities	20	20	1	20	20	1	20	20	1
Average Societal Value	10.5	10.5	2.0	10.5	10.5	2.0	10.5	10.5	2.0
5. Legislative Compliance									
5.1 OSPAR 98/3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5.2 NFFO Guidance	1	1	4	1	1	4	1	1	6
Average Legislative Value	1.0	1.0	4.0	1.0	1.0	4.0	1.0	1.0	6.0
6. Commercial									
6.1 Economic	15	12	4	15	12	4	15	12	4
6.2 Ongoing Liability	1	1	6	1	1	6	1	1	6
Average Commercial Value	8.0	6.5	5.0	8.0	6.5	5.0	8.0	6.5	5.0
Overall Comparative Score	**11.06**	**9.39**	**6.28**	**11.11**	**9.56**	**6.39**	**11.89**	**10.33**	**6.56**

Table 3.4 Comparative Assessment of 3"MEG Piggyback Line Decommissioning Options

	3" Piggyback MEG Line OPTIONS					
	1	1a	1b	2	2a	2b
	Flush & De-pressure			De-pressure only		
	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried	Cut on Seabed & Remove in sections	remove, cut into sections on surface	Leave *in situ*, ends buried
1. Safety						
1.1 Risk to other users of the sea (post ops)	1	1	4	1	1	4
1.2 Risk to those on land (during ops)	4	4	1	4	4	1
1.3 Risk to 3rd party assets / vessels (during ops)	4	4	2	4	4	2
Average Safety Value	3.0	3.0	2.3	3.0	3.0	2.3
2. Environmental						
2.1 Chemical discharge	1	1	1	10	10	10
2.2 Hydrocarbon discharge	1	1	1	1	1	1
2.3 Seabed Disturbance	25	25	10	25	25	10
2.4 Energy Usage	10	10	5	10	10	5
2.5 Estimated Discard to Sea (% of total material)	1	1	25	1	1	25
2.6 Estimated Discard to Landfill (% of total material)	1	1	1	1	1	1
Average Environmental Value	6.5	6.5	7.2	8.0	8.0	8.7
3. Technical						
3.1 Technical Challenge	16	12	4	20	12	4
3.2 Level of Diving Intervention	4	10	2	4	10	2
3.3 Weather Sensitivity	12	12	6	12	12	3
3.4 Risk of Major Project failure	20	12	4	20	12	2
Average Technical Value	13.0	11.5	4.0	14.0	11.5	2.8
4. Societal						
4.1 Fisheries Access (post ops)	1	1	3	1	1	3
4.2 Communities	15	15	1	15	15	1
Average Societal Value	8.0	8.0	2.0	8.0	8.0	2.0
5. Legislative Compliance						
5.1 OSPAR 98/3	n/a	n/a	n/a	n/a	n/a	n/a
5.2 NFFO Guidance	1	1	4	1	1	6
Average Legislative Value	1.0	1.0	4.0	1.0	1.0	6.0
6. Commercial						
6.1 Economic	6	9	2	3	6	2
6.2 Ongoing Liability	1	1	6	1	1	6
Average Commercial Value	3.5	5.0	4.0	2.0	3.5	4.0
Overall Comparative Score	**6.89**	**6.72**	**4.56**	**7.44**	**7.06**	**4.89**

Table 3.5 Comparative Assessment of Pipeline Crossings Decommissioning Options

	OPTIONS	
	1	**2**
	Remove	**Leave *in situ***
1. Safety		
1.1 Risk to other users of the sea (post ops)	4	2
1.2 Risk to those on land (during ops)	1	1
1.3 Risk to 3rd party assets / vessels (during ops)	15	1
Average Safety Value	6.7	1.3
2. Environmental		
2.1 Chemical discharge	1	1
2.2 Hydrocarbon discharge	1	1
2.3 Seabed Disturbance	25	1
2.4 Energy Usage	10	5
2.5 Estimated Discard to Sea (% of total material)	20	25
2.6 Estimated Discard to Landfill (% of total material)	20	1
Average Environmental Value	12.8	5.7
3. Technical		
3.1 Technical Challenge	12	1
3.2 Level of Diving Intervention	12	1
3.3 Weather Sensitivity	9	1
3.4 Risk of Major Project failure	6	1
Average Technical Value	9.8	1.0
4. Societal		
4.1 Fisheries Access (post ops)	1	3
4.2 Communities	10	1
Average Societal Value	5.5	2.0
5. Legislative Compliance		
5.1 OSPAR 98/3	n/a	n/a
5.2 NFFO Guidance	1	6
Average Legislative Value	1.0	6.0
6. Commercial		
6.1 Economic	12	1
6.2 Ongoing Liability	1	3
Average Commercial Value	6.5	2.0
Overall Comparative Score	**8.94**	**3.11**

Table 3.6 Comparative Assessment of 8" Flowlines Decommissioning Options

8 " Flowline OPTIONS									
	1	1a	1b	2	2a	2b	3	3a	3b
	Clean, Flush & De-pressure			Flush & De-pressure			De-pressure only		
	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried	Cut on Seabed & Remove in sections	Remove, cut into sections on surface	Leave *in situ*, ends buried
1. Safety									
1.1 Risk to other users of the sea (post ops)	1	1	4	1	1	4	1	1	4
1.2 Risk to those on land (during ops)	6	6	1	6	6	1	6	6	1
1.3 Risk to 3rd party assets / vessels (during ops)	4	4	2	4	4	2	4	4	2
Average Safety Value	3.7	3.7	2.3	3.7	3.7	2.3	3.7	3.7	2.3
2. Environmental									
2.1 Chemical discharge	1	1	1	1	1	1	1	1	1
2.2 Hydrocarbon discharge	15	15	12	20	20	16	25	25	20
2.3 Seabed Disturbance	25	25	10	25	25	10	25	25	10
2.4 Energy Usage	20	20	10	20	20	10	20	20	10
2.5 Estimated Discard to Sea (% of total material)	1	1	25	1	1	25	1	1	25
2.6 Estimated Discard to Landfill (% of total material)	20	20	10	20	20	10	20	20	10
Average Environmental Value	13.7	13.7	11.3	14.5	14.5	12.0	15.3	15.3	12.7
3. Technical									
3.1 Technical Challenge	20	12	6	20	12	4	20	12	4
3.2 Level of Diving Intervention	16	8	8	12	6	8	8	4	6
3.3 Weather Sensitivity	12	9	6	12	9	6	12	9	3
3.4 Risk of Major Project failure	20	8	6	20	8	4	20	8	2
Average Technical Value	17.0	9.3	6.5	16.0	8.8	5.5	15.0	8.3	3.8
4. Societal									
4.1 Fisheries Access (post ops)	1	1	3	1	1	3	1	1	3
4.2 Communities	20	20	1	20	20	1	20	20	1
Average Societal Value	10.5	10.5	2.0	10.5	10.5	2.0	10.5	10.5	2.0
5. Legislative Compliance									
5.1 OSPAR 98/3	1	1	1	1	1	1	1	1	1
5.2 NFFO Guidance	1	1	4	1	1	4	1	1	6
Average Legislative Value	1.0	1.0	2.5	1.0	1.0	2.5	1.0	1.0	3.5
6. Commercial									
6.1 Economic	15	12	6	15	12	4	15	12	4
6.2 Ongoing Liability	1	1	6	1	1	6	1	1	6
Average Commercial Value	8.0	6.5	6.0	8.0	6.5	5.0	8.0	6.5	5.0
Overall Comparative Score	**10.53**	**8.74**	**6.42**	**10.58**	**8.89**	**6.32**	**10.63**	**9.05**	**6.26**

Table 3.7 Comparative Assessment of Control Umbilical Decommissioning Options

	Control Umbilical OPTIONS					
	1	1a	1b	2	2a	2b
	Flush & De-pressure			De-pressure only		
	Remove, cut into sections on surface	Remove in one piece reeled	Leave *in situ*, ends buried	Remove, cut into sections on surface	Remove in one piece reeled	Leave *in situ*, ends buried
1. Safety						
1.1 Risk to other users of the sea (post ops)	1	1	4	1	1	4
1.2 Risk to those on land (during ops)	2	2	1	2	2	1
1.3 Risk to 3rd party assets / vessels (during ops)	2	2	2	2	2	2
Average Safety Value	1.7	1.7	2.3	1.7	1.7	2.3
2. Environmental						
2.1 Chemical discharge	1	1	1	10	10	10
2.2 Hydrocarbon discharge	1	1	1	1	1	1
2.3 Seabed Disturbance	25	25	10	25	25	10
2.4 Energy Usage	10	10	10	10	5	5
2.5 Estimated Discard to Sea (% of total material)	1	1	25	1	1	25
2.6 Estimated Discard to Landfill (% of total material)	25	25	10	25	25	10
Average Environmental Value	10.5	10.5	9.5	12.0	11.2	10.2
3. Technical						
3.1 Technical Challenge	16	12	4	16	9	2
3.2 Level of Diving Intervention	8	4	6	4	2	4
3.3 Weather Sensitivity	9	9	6	9	6	6
3.4 Risk of Major Project failure	8	6	4	8	6	2
Average Technical Value	10.3	7.8	5.0	9.3	5.8	3.5
4. Societal						
4.1 Fisheries Access (post ops)	1	1	3	1	1	3
4.2 Communities	20	20	1	20	20	1
Average Societal Value	10.5	10.5	2.0	10.5	10.5	2.0
5. Legislative Compliance						
5.1 OSPAR 98/3	n/a	n/a	n/a	n/a	n/a	n/a
5.2 NFFO Guidance	1	1	4	1	1	4
Average Legislative Value	1.0	1.0	4.0	1.0	1.0	4.0
6. Commercial						
6.1 Economic	6	6	4	6	6	4
6.2 Ongoing Liability	1	1	6	1	1	6
Average Commercial Value	3.5	3.5	5.0	3.5	3.5	5.0
Overall Comparative Score	**7.67**	**7.11**	**5.67**	**7.94**	**6.89**	**5.56**

Table 3.8 Comparative Assessment of Mattresses Decommissioning Options

	OPTIONS		
	1	2	3
	Remove	Bury *in situ*	Minimum Disposal Option (Leave On Site)
1. Safety			
1.1 Risk to other users of the sea (post ops)	1	4	4
1.2 Risk to those on land (during ops)	1	1	1
1.3 Risk to 3rd party assets / vessels (during ops)	3	2	1
Average Safety Value	1.7	2.3	2.0
2. Environmental			
2.1 Chemical discharge	1	1	1
2.2 Hydrocarbon discharge	1	1	1
2.3 Seabed Disturbance	20	20	1
2.4 Energy Usage	10	10	5
2.5 Estimated Discard to Sea (% of total material)	1	25	25
2.6 Estimated Discard to Landfill (% of total material)	25	1	1
Average Environmental Value	9.7	9.7	5.7
3. Technical			
3.1 Technical Challenge	12	8	1
3.2 Level of Diving Intervention	20	1	1
3.3 Weather Sensitivity	6	4	1
3.4 Risk of Major Project failure	4	2	1
Average Technical Value	10.5	3.8	1.0
4. Societal			
4.1 Fisheries Access (post ops)	1	2	2
4.2 Communities	20	1	1
Average Societal Value	10.5	1.5	1.5
5. Legislative Compliance			
5.1 OSPAR 98/3	n/a	n/a	n/a
5.2 NFFO Guidance	1	4	8
Average Legislative Value	1.0	4.0	8.0
6. Commercial			
6.1 Economic	6	4	1
6.2 Ongoing Liability	1	3	6
Average Commercial Value	3.5	3.5	3.5
Overall Comparative Score	**7.44**	**5.22**	**3.44**

4 Quantitative Risk Assessment

A preliminary Quantitative Risk Assessment (QRA) was conducted for the available decommissioning options by RPS Energy (Ref. 3). The QRA calculated the Potential Loss of Life and these figures are presented below in Table 4.1. This information was used to further advise the selection of preferred decommissioning options for the Welland field infrastructure.

Table 4.1 PLL for Decommissioning Options for the Welland Field

	Options (refer to Table 1.1 for details of options)									
	1	1a	1b	2	2a	2b	3	3a	3b	4
Jacket & Topsides	0.00926			0.0516			0.00151			
Subsea Wellhead Protection Structures	0.00792			0.0104			0.00652			0.00
16" Export Pipeline	0.0322	0.0229	0.00728	0.0315	0.0221	0.00651	0.0281	0.0187	0.00317	
3" MEG Piggyback Pipeline	0.00253	0.00253	0.00147	0.00246	0.00246	0.00105				
Pipeline Crossings	0.0137			0.00						
8" Subsea Flowlines	0.0372	0.026	0.0102	0.0362	0.025	0.00916	0.034	0.0228	0.00697	
Subsea Control Umbilicals	0.0182	0.0125	0.00741	0.0149	0.00933	0.00432				
Mattresses	0.0133			0.00258			0.000175			

5 Conclusions

This Comparative Assessment provides an assessment of the various decommissioning options available for the Welland field against a set of defined assessment criteria. The QRA provides further information to augment the Comparative Assessment process.

The conclusions identify the preferred decommissioning options that will form the basis for further technical investigation and evaluation. These are summarised in Table 5.1.

Table 5.1 Preferred Decommissioning Options for the Welland Infrastructure

Infrastructure	Selected Decommissioning Option
Jacket & Topsides Structures	One-piece removal (Heavy Lift Vessel)
Subsea Wellhead Protection Structures	One-piece removal (Crane Vessel)
16″ Export Pipeline	Flush, Depressure & Leave *in situ*
3″ MEG Piggyback Line	Depressure & Leave *in situ*
8″ Subsea Flowlines	Flush, Depressure & Leave *in situ*
4″ Subsea Control Umbilicals	Depressure & Leave *in situ*
Pipeline Crossing Points	Leave *in situ*
Mattresses	Bury

It is important to note that the methodology used for comparison allows for only a relatively high-level comparison of the decommissioning options. Additionally no weighting has been applied to the assessment criteria. The overall comparative score calculated for each decommissioning option allows for a comparison of options and generally, the lower the comparative score, the more favourable the option.

5.1 Topsides & Jacket

Overall, the comparative assessment of the removal options for the topsides and jacket indicated that Option 1 (removal in one piece using a Heavy Lift Vessel (HLV)) was the most favourable decommissioning option. Additionally, the calculated PLL for the HLV removal option is an order of magnitude lower than for dismantling the jacket and topsides offshore and removing piece small. Piece-small techniques for small, southern North Sea installations, are not sufficiently understood at this stage to accurately assess personnel risk.

Decommissioning of the jacket and topsides using a HLV is the preferred option.

5.2 Subsea Wellhead Protection Structures

The comparative assessment identified that decommissioning of the subsea wellhead protection structures should preferably be carried out using HLV or vessel with crane, as both of these options return the lowest (identical) average comparative score. The PLL for decommissioning with HLV or vessel with crane is an order of magnitude lower than for decommissioning with drilling rig. The PLL for decommissioning using vessel with crane is slightly lower than for using the HLV.

Decommissioning of the subsea wellhead protection structures using a vessel with crane is the preferred option.

5.3 16″ Export Pipeline

The comparative assessment identified that the most favourable decommissioning options for the export pipeline are to leave *in situ* with the ends buried once the pipeline has been cleaned, flushed and de-pressured or flushed and de-pressured. The PLL for these two options indicates that flushing and de-pressuring operations pose a lower health and safety risk than cleaning, flushing and de-pressuring operations.

Decommissioning of the 16″ export pipeline by flushing, de-pressuring and leaving *in situ* with the ends buried is the preferred option.

5.4 3″ MEG Piggyback Line

The comparative assessment identified that the most favourable decommissioning options for the MEG piggyback line are to leave *in situ* with the ends buried once the line has been flushed and de-pressured or de-pressured only. The PLL for these two options indicates that de-pressuring only operations pose a lower health and safety risk than flushing and de-pressuring operations. De-pressure only will entail chemical discharge. However, the only chemical discharged will be MEG (Monoethylene Glycol) – which is classed by CEFAS as a chemical whose discharge “Poses Little or No Risk” (PLONOR), and therefore it is considered that this option is preferred overall.

Decommissioning of the MEG piggyback line by de-pressuring and leaving *in situ* with the ends buried is the preferred option.

5.5 Pipeline Crossings

The comparative assessment clearly identified that decommissioning of the pipeline crossings should preferably be effected by leaving the pipeline crossings *in situ*. The most significant disadvantages associated with removing the pipeline crossings are with overall environmental, technical and health & safety aspects. The PLL further supports the leave *in situ* option (associated PLL<0.00).

Decommissioning the pipeline crossings by leaving *in situ* is the preferred option.

5.6 8″ Flowlines

The comparative assessment identified that the most favourable decommissioning options for the flowlines are to leave *in situ* with the ends buried once the pipeline has been flushed and de-pressured or de-pressured only. The PLL for these two options indicates that de-pressuring only operations pose a lower health and safety risk than flushing and de-pressuring operations. However, as the de-pressure only option will entail a higher discharge of hydrocarbons to sea than the flush and de-pressure option, it is not considered to be the preferred option as Perenco aim to reduce the potential for hydrocarbon pollution

Decommissioning of the 8″ flowlines by flushing and de-pressuring and leaving *in situ* with the ends buried is the preferred option.

5.7 Control Umbilicals

The comparative assessment identified that the most favourable decommissioning options for the control umbilicals are to leave them *in situ* with the ends buried once they are flushed and de-pressured or de-pressured only. The PLL for these two options indicates that de-pressuring only operations pose a lower health and safety risk than flushing and de-pressuring operations. However, de-pressure only will entail chemical discharge.

The chemicals discharged will be;

MEG (Monoethylene Glycol) – which is classed by CEFAS as a chemical whose discharge "Poses Little or No Risk" (PLONOR), and

Castrol Transaqua HT – although the current CEFAS categorisation of this chemical is OCNS C, at the time it was permitted for use and discharge, the CEFAS categorisation was OCNS E indicating a lower Hazard Quotient that currently assigned. Discharge of Castrol Transaqua HT was permitted previously under the Offshore Chemicals Regulations on PON15D/118 and therefore it is considered an acceptable decommissioning strategy to allow some discharge of Castrol Transaqua HT.

Decommissioning of the control umbilicals by de-pressuring and leaving *in situ* with the ends buried is the preferred option.

5.8 Mattresses

The comparative assessment identified that the minimal disposal option for decommissioning of mattresses has the lowest overall impact. However, as this option is not fully compliant with NFFO guidance, it has been discounted. Therefore the preferred decommissioning option is to bury the mattresses *in situ*. The PLL associated with burying *in situ* is an order of magnitude lower than that associated with removal.

Decommissioning the mattresses by burying *in situ* is the preferred option.

References

1. *DECC, 2009, Guidance Notes Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 Department of Energy and Climate Change, Version 5, January 2010.*
2. *Welland Decommissioning Programme, Perenco Controlled Document N^{o} BXX-ST-S-10000.*
3. *RPS Energy, 2010. PLL Calculation for Welland Decommissioning Options - Summary Report*
4. *Safetec, 2005. Risk Analysis of Decommissioning Activities. Joint Industry Project P20447.*

Bibliography

Det Norske Veritas, 1996, Rules for Planning and Execution of Marine Operations, viewed 4th December 2009.

Det Norske Veritas, 2002, Marine Risk Assessment, Det Norske Veritas for the Health and Safety Executive, ISBN 0 7176 2231 2 Dated 2002, viewed 4th December 2009 http://www.hse.gov.uk/research/otopdf/2001/oto01063.pdf

Institute of Petroleum, 2000, Guidelines for the Calculation of Estimates of Energy use and gaseous emissions in the decommissioning of Offshore Structures, The Institute of Petroleum, London, ISBN 0 85293 255 3, 85pp.

Society of Petroleum Engineers, Inc., 2001, Guidelines for Energy and Emissions Calculation in Offshore Decommissioning, Tim Curtis, Cordah Limited; Steinar Nesse, Det Norske Veritas; G.B. Picken, Cordah Limited, 66498-MS, http://www.onepetro.org/mslib/servlet/onepetropreview?id=00066498&soc=SPE

UK Health and Safety Executive, 1992, The Tolerability of Risk from Nuclear Power Stations, UK Health and Safety Executive Report, ISBN 0 11 886368 1, Dated 1988, Revised 1992., viewed 4th December 2009, http://www.hse.gov.uk/nuclear/tolerability.pdf

UK Health and Safety Executive, 2001, Reducing Risks, Protecting People, UK Health and Safety Executive Report, ISBN 0 7176 21510, viewed 3rd December 2009 http://www.hse.gov.uk/risk/theory/r2p2.pdf

UK Health and Safety Executive, 2009, Injuries in Great Britain by industry and severity of injury 2008/09p, viewed 7th December 2009
http://www.hse.gov.uk/statistics/tables/ind1.htm

Offshore Information Sheet No 2/2006; Guidance on Risk Assessment for Offshore Installations http://www.hse.gov.uk/offshore/sheet32006.pdf

Appendix A – Comparative Assessment Criteria & Guidance Tables

This table is based on original work by Project Development International Limited, 139 Gallowgate, Aberdeen AB25 1BU

Table A.1 Potential Impact Assessment Criteria

Assessment Criteria	IMPACT LEVEL				
	1	2	3	4	5
	Very Low	Low	Medium	High	Very High
1. Safety					
1.1 Risk to other users of the sea (post ops)	No Risk	Potential snagging hazard if protection deteriorates or is moved /	Loss of fishing gear / vessel infringes tow exclusion zone	Vessel Collision / Damage to vessel	Loss of vessel
1.2 Risk to those on land (during ops)	FAC or no specific treatment	MTC/RWC	RWC/Day Away from Work Case	Fatality or long term injury	Multiple fatalities or long term injuries
1.3 Risk to 3rd party assets / vessels (during ops)	No Risk	Standard operations required in 500m zones	Crossing 3rd party assets	Impact with 3rd party asset – no loss of containment	Impact with 3rd party asset – loss of containment
2. Environmental					
2.1 Chemical discharge	No or negligible discharge	Discharge causes changes which are unlikely to be measureable against background activities	Discharge causes change in ecosystem leading to medium term damage but with good recovery potential	Discharge causes change in ecosystem leading to long term damage but with good recovery potential	Discharge causes change in ecosystem leading to long term damage but with poor recovery potential
2.2 Hydrocarbon discharge	No or negligible discharge	Oil 1-100 litres Low hydrocarbon concentrations and/or very gradual release	Oil 100-1,000 litres Medium hydrocarbon concentration and/or moderate rate of release	Oil 1 - 10m^3 High hydrocarbon concentration and/or rapid rate of release	Oil >10m^3 Very high hydrocarbon concentration and/or very rapid rate of release
2.3 Seabed Disturbance	None	Localised disturbance (0-100% of equipment footprint)	Localised disturbance (100% of equipment footprint)	Wider area of disturbance (100-200% of equipment footprint)	Wide area of disturbance (>200% of equipment footprint)
2.4 Energy Usage	0-10Gj	10-100Gj	100-200Gj	200-400Gj	>400Gj
2.5 Estimated Discard to Sea (% of total material)	0%	0-20%	20-50%	50-80%	>80%
2.6 Estimated Discard to Landfill (% of total material)	0%	0-20%	20-50%	50-80%	>80%
3. Technical					
3.1 Technical Challenge	Regular construction task using generic procedures	Regular construction task using detailed procedures	Non-routine task. High level of historical experience	Non-routine task. Low level of historical experience	Novel technique or equipment. No industry experience
3.2 Level of Diving Intervention	<10 days	10-20 days	20-30 days	30-40 days	>40 days
3.3 Weather Sensitivity	General operations relying only on ability to launch ROV	Standard operations experiencing expected operational downtime for time of year	Requires specific weather window for small number of tasks. Non schedule critical	Requires specific weather window for certain tasks. Schedule can be optimised to accommodate	Requires specific weather window for prolonged period. Operation on critical path

3.4 Risk of Major Project failure	Existing, proven equipment used for specific task for which it was designed	Existing, proven equipment used for new application.	Technology research and development required.	Unable to complete operation in scheduled timeframe. Re-work required prior to revisit.	Potential catastrophic failure of major component.
4. Societal					
4.1 Fisheries Access (post ops)	Free, unrestricted access to site	Unrestricted access to site - noted seabed disturbance	Access to site with over-trawlable charted obstructions	Access to site with charted obstructions	Site remains restricted
4.2 Communities	No impact	Low impact (dust, noise, etc)	Short-term impact to onshore communities (waste handling, traffic, etc)	Long-term impact to onshore communities (landfill, infrastructure, etc)	High impact to onshore communities (pollution, loss of amenity, etc)
5. Legal Compliance					
5.1 OSPAR 98/3	Fully Compliant	N/A	Compliant with derogation	N/A	Non-compliant
5.2 NFFO Guidance	Total removal of infrastructure	Burial 0.6m below natural seabed level	Buried but not to depth required	Exposed at some locations	Totally exposed
6. Commercial					
6.1 Economic	<£1M	£1-5M	£5-10M	£10-15M	>£15M
6.2 Ongoing Liability	No ongoing liability	Reactive survey regime	Survey inspection at increasing intervals	Bi-annual survey inspection + ongoing remedial work	Annual surveys + ongoing remedial work

The criteria for determining likelihood are presented in Table A.2. The assumption for operations with a low likelihood is that they have a lower probability of resulting in the associated impact.

Table A.2 Likelihood Assessment Criteria

		LIKELIHOOD RATING
Very Low	1	Very low likelihood. Very low level of uncertainty. Detailed definition and understanding of methodology, hazards and equipment.
Low	2	Low likelihood. Low level of uncertainty. High level definition and understanding of methodology, hazards or equipment.
Medium	3	Moderate likelihood. Moderate level of uncertainty. General definition and understanding of methodology, hazards or equipment.
High	4	High likelihood. High level of uncertainty. Basic definition and understanding of methodology, hazards or equipment.
Very High	5	Very high likelihood. Very high level of uncertainty. Limited definition and understanding of methodology, hazards or equipment.

The assessment matrix presented in Table A.3 is used to determine the risk associated with each of the assessment criteria. The assessment matrix provides numerical scores - these are then averaged for each option to provide an overall comparative score.

Table A.3 Impact and Likelihood Assessment Matrix

LIKELIHOOD	**IMPACT**				
	1.Very Low	**2. Low**	**3. Medium**	**4. High**	**5. Very High**
1. Very Low	**Low 1**	**Low 2**	**Low 3**	**Low 4**	**Medium 5**
2. Low	**Low 2**	**Low 4**	**Medium 6**	**Medium 8**	**Medium 10**
3. Medium	**Low 3**	**Medium 6**	**Medium 9**	**Medium 12**	**High 15**

4. High	Low 4	Medium 8	Medium 12	High 16	High 20
5. Very High	Medium 5	Medium 10	High 15	High 20	High 25