
TENDER DOCUMENT - APPENDIX 1 – SCOPE OF WORK

Reprocessing – Gardarbanken High - 2020

Ref no 2020/222



**NORWEGIAN PETROLEUM
DIRECTORATE**

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1 2D Reprocessing Programme 2020

In the 2012-2014 & 2016-2017 seasons, the Norwegian Petroleum directorate (NPD) acquired substantial volumes of 2D seismic data in the Barents Sea North and Northeast. These modern acquisitions supplemented a large number of 2D lines acquired from the 70s to the 90s. In 2020 the NPD wishes to reprocess a number of already acquired lines to ensure a set of uniform 2D lines in the Gardarbanken High area of the Northern Barents Sea. These lines will be primarily from 2012-2017, but with a selected number of lines from the 1990s that are considered be parameterized such that they have a large potential for uplift.

The project will be structured into two main parts, one of which will be subdivided into two subparts:

Project Part 1:	High-Resolution Reprocessing – Gardarbanken High	
	a. Phase I	Approx. 1 000 km
	b. Phase II	Approx. 13 000 km
Project Part 2:	PSDM Reprocessing – Arctic Lines	1 142 km

The 2020 2D seismic reprocessing program consists of approximately 15 000 km of data.

The project will commence shortly after the award, and total duration will be agreed upon by the selected vendor and NPD after discussion of capabilities and availability of resources. Continuation of the project Part 1 from Phase I to Phase II is dependent on satisfactory results of reprocessing in Phase I. The NPD reserves the right to withdraw the project should a satisfactory result in the Phase I reprocessing not be achieved. The timeline for the PSDM processing is to be determined through discussion between vendor and the NPD.

1.1 Project funding

The project is subject to funding from the Norwegian Government. NPD therefore reserves the right to stop the bidding process or declare it null and void or reduce the volume of the programme due to budgetary reasons or unforeseen circumstances outside NPD's control.

2 Description of required services

2.1 2D Seismic Data Parameters and Information

The surveys to be reprocessed represents a number of surveys acquired using different parameters, with the bulk of the project being seismic data acquired between 2012 and 2017, with a small subset of lines dating from the 1990s. Acquisition parameters for the surveys can be found in Appendix IV.

2.2 2D Survey Reprocessing objectives / Zone of Interest

The area of interest is primarily the Gardarbanken area of the Northern Barents Sea. The area is a natural continuation to the North from the Hoop area. The objective of the reprocessing is to improve imaging of shallow (< 3 seconds) geology, resolving multiple problems generated by shallow water depth and hard seafloor and improving data quality through migrations using better velocities.

A secondary area of interest is where the NPD wants three PSDM lines processed in the northernmost Barents Sea, in the shelf to deep seafloor transition to the arctic ocean. These lines will vary in water depth from <100m to 2000m, and depth imaging work is desired in order to get an estimation of depth for targets of scientific drilling, better imaging through overburden from mass transport deposits, as well as accurate geometries of oceanic crust.

Map of the seismic lines can be found in Appendix V.

2.3 2D Survey Overview and total distance to be reprocessed

There are 63 lines to be reprocessed at an average length of 208 km, from a total of 10 surveys.

Survey	Year	Km
NPD 1301	2013	2 133
NPD 14001	2014	4 141
NPD 16001	2016	2 162
NPD 17001	2017	4 617
90s data	1989-1994	1 221
Total PSTM:		14 274
Total PSDM (NPD1204):	2012	1 142

2.4 Proposed processing sequence (PSTM)

Algorithms and parameters used at each step in this processing sequence must be agreed upon with the NPD in writing prior to the production processing. Deviations from the basic sequence must be in agreement with the NPD. The order of these processes may change depending on testing.

The goal of this project is to process the seismic line in high resolution with shorter trace length and shorter offset. The data should be binned at a grid spacing of 6.25m CMP separation.

After the initial nav-merge of SEG-D and navigation data, the NPD will expect a plot of the nav-merged SEG-Y compared with the original navigation which shall be validated before commencing the remainder of the processing sequence.

The following points need special attention:

- I. Nav-merge
- II. Multiple removal because of shallow water depth
- III. Noise removal
- IV. Velocity analysis

The basic processing sequence should include (but not limited to):

- **Trace Length - 4 sec.**
- **Offset limitation - 5000 m**
- **Maintain 2ms sample rate for the whole processing sequence**
- Reformat from SEG-D to contractor's own data format. Static shift correction for source/receiver depth. Bad shot and channel edits. Gain recovery
- Merging the seismic traces to the navigation.
- Spherical divergence correction
- Noise attenuation. The data will be searched for spikes, spurious high amplitudes and swell noise.

- Linear noise attenuation in shot and receiver domain, focused on direct arrivals and refractions, contractor to specify methods
- Deterministic signature deconvolution (zero phasing) which shall be applied using an operator designed to transform the modelled far field source signature to its zero phase equivalent. This process shall also take care of source and receiver ghost as well as the air gun bubble pulse.
- 1st pass velocity analysis every 4 km
- Q compensation phase only (place in sequence to be decided)
- Up to 5-passes of demultiple before migration including (order and methods subject to testing)
- 1st pass demultiple: 2D Surface Related Multiple Elimination (SRME), as appropriate
- 2nd pass demultiple: Wave Equation Multiple Attenuation (required in shallow water areas)
- 3rd pass demultiple: Shallow Water Demultiple (SWD) (required in shallow water areas)
- Demultiple pass 1-3 applied either in sequential mode or using multi model least squares adaptive subtraction following testing.
- Tau-p dip filter (shot and receiver domains if necessary).
- 2nd pass velocity analysis every 2 Km. All velocity picking should be performed in agreement/co-operation with NPD staff. The data shall be muted (& proper pre-conditioned) prior to all velocity analysis.
- FX de-convolution on common offsets, if required
- Common offset linear noise attenuation
- Diffracted multiple attenuation, if required
- 4th pass demultiple: Hi-Resolution Parabolic Radon de-multiple with appropriate shotpoint interpolation
- 3rd pass velocity analysis. Automatic velocity analysis Input to Pre stack time migration (PSTM).
- Full 2D Kirchhoff Pre stack time migration (PSTM)
- 4th pass velocity analysis every 1 km. Final velocities which must be exported to EssoV2xy or diskos98.1 format
- 5th pass demultiple: Hi-Resolution Parabolic Radon de-multiple
- Residual CMP gather de-noise
- Residual diffracted multiple attenuation, if required
- NMO correction. Pre-stack scaling, inner trace mute and outer trace mute
- CDP stack
- CDP Relevant post stack signal enhancement procedures
- Q compensation amplitude only, if required
- Residual multiple and noise attenuation
- Post-stack Scaling.
- SEG-Y output

2.5 PSDM Reprocessing

The PSDM workflow should follow the processing steps above, but with notable exceptions:

- a. 8100m Offset (Full cable length)
- b. 8.5 and 10.5 sec (Full trace length)

We wish for the processing to still be done at 6.25m and 2 ms.

The deliverable PSDM product should be:

Offset: Full cable length (8100m)

Depth: Full trace length

CMP Spacing: 12.5m

Sampling rate: 2ms

The goal for the imaging should be to deliver a velocity model and image that gives reasonable depth values, improved imaging through mass transport overburden and more accurate geometries in deep faults and oceanic crust. The workflow should be discussed with the selected vendor upon award, but a basic workflow follows below:

Proposed PSDM imaging workflow:

- Conversion of PSTM velocity model to depth and smoothing velocity as input to VMB
- Initial PSDM migration
- Velocity model building using move-out analysis and tomography
- Potential FWI to introduce detail and improve imaging in shallow areas?
- Isotropic final

2.6 Testing

The NPD see it as necessary that processing parameters shall be tested on two or three parts from different lines and confirmed on two more lines before being applied in production. The test data should be available via FTP-server in SEG-Y format and as PowerPoint presentations.

3 Data delivery and final products

3.1 General

The data shall be delivered to the NPD after end of processing as specified below.

3.2 Data delivery

Products to be delivered after 2D data processing

PSTM:

Item	Format	Media
Final processing report	MS Word or PDF format	USB stick
Final PSTM stacking & migration velocities	SEG-Y	USB stick
Final PSTM stacking & migration velocities	EssoV2xy or diskos98.1	USB stick
Nav-merged Raw SEG-Y	SEG-Y	Hard disk
Raw common image gather (CIG) after PSTM	SEG-Y	Hard disk
Raw migration full-offset stack volume and sub stack volume (near,- mid- and far- angle)	SEG-Y	Hard disk

Final PSTM (unscaled true amplitudes full offset volume)	SEG-Y	Hard disk
Final PSTM (TVS full offset volume)	SEG-Y	Hard disk

PSDM:

Item	Format	Media
Final processing report	MS Word or PDF format	USB stick
Final PSDM stacking & migration velocities	SEG-Y	USB stick
Final PSDM stacking & migration velocities	EssoV2xy or diskos98.1	USB stick
Nav-merged Raw SEG-Y?	SEG-Y	Hard disk
Raw common image gather (CIG) after PSDM	SEG-Y	Hard disk
Raw migration full-offset stack volume and sub stack volume (near,- mid- and far- angle)	SEG-Y	Hard disk
Final PSDM (unscaled true amplitudes full offset volume)	SEG-Y	Hard disk
Final PSDM (TVS full offset volume)	SEG-Y	Hard disk

4 Costs

Prices shall be quoted in NOK exclusive VAT and shall comprise the specified basic processing sequence in accordance with Section 2.4 and 2.5, above. Test processing shall be included as part of the basic processing sequence.

The NPD intends to allocate up to NOK 5 500 000 to the Project, exclusive of any value-added tax.

We require the bid to be structured the following way:

- Rate per processed kilometer High-Resolution PSTM, based on sequence in Section 2.4
- Rate per kilometer PSDM, based on sequence in Section 2.5

4.1 *Optional processing sequence*

5 Timing

Data processing shall commence as soon as the field tapes / hard disk are delivered to the chosen processing Centre. Delivery of finalized product:

- Part 1 phase I should be completed 8 to 12 weeks after field tapes / hard disk are received.
- Part 1 phase II should be targeted for delivery within 8 months from completion of phase I.
- The timeline for the PSDM processing is to be determined through discussion between vendor and the NPD.