147– Offshore Norge Recommended guidelines for Best Available Technique (BAT) assessments

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Offshore Norge is an employer and industry association for oil companies and supplier firms engaged in the activities on the Norwegian Continental Shelf. Offshore Norge is affiliated with the Confederation of Norwegian Business and Industry, NHO.

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1 INTRODUCTION

1.1 Objective and target groups

This guideline provides guidance for how to perform Best Available Technique (BAT) assessments for all relevant phases of offshore oil and gas (O&G) activity at the Norwegian Continental Shelf (NCS); project screening, FEED and detailed engineering, operations, modifications, and decommissioning. As part of BAT assessment of offshore O&G activity, value chain effects for onshore O&G facilities shall be addressed when relevant.

The guideline is not directly applicable for onshore O&G activity, as the requirements to BAT for onshore facilities deviate from offshore requirments. But, the general approach described in the guidline may be used by other sectors if found appropriate.

The guideline aims to fulfil the following needs:

- Describe why BAT assessment is necessary
- Advise on when to start the BAT assessment process and identify which systems that should be assessed
- Identify resources that should be involved in the BAT assessment
- Provide a method for BAT assessments, (including data quality requirements)
- Describe how BAT assessments should be documented and followed up
- Address relationship between BAT and ALARP assessment

The target group for this document is managers and technical personnel involved in project planning, project execution, operation of fields or decommissioning of assets. The document may further provide relevant information to other stakeholders involved in O&G field development and operations like authorities, NGOs, and technology suppliers.

1.2 Structure of the document

The guideline is structured with an introductory section describing the regulatory basis and relevant reference documents in section 1, followed by a general description of the BAT assessment method in section 2. The sections thereafter provide more specific guidance for defined phases; project screening, FEED and detailed engineering, operations, modifications, and decommissioning respectively. The intention is that the user of the guideline can review the general requirements and guidance in section 2, and supplement this with specific requirements and guidance for the relevant phase.

More specific guidance for defined phases is only given when relevant. This means that the sub-section numbers in section 3-7 will deviate fom the sub-section numbers in section 2 where the general guidance on the method is presented. But, sub sections titles should provide sufficient information on the areas where more specific guidance is relevant.

1.3 Background and stakeholder process

Demonstrating BAT is a key issue in development projects as well as for modification projects to fulfil regulatory requirements (Pollution Control Act §2, 3rd letter1, ref. HSE regulations) and to ensure selection of techniques that is up to date with regards to environmental impact. BAT is a key priority area for the environmental regulators and NEA is always focusing on BAT in e.g. consultation comments to Impact Assessment (IA) processes. However, the regulations give no specific guidance

for how to perform BAT assessments, level of details, criteria, documentation etc., with the result that the approach to BAT assessments has varied between operators on NCS. Such variation entails a risk of not meeting legal requirements or stakeholder expectations in technology choices, which might again lead to costly changes later in time.

BAT assessment is a methodology or process targeting to decide the best available technique for a relevant system or technology decisions for a project or a facility in operation. BAT assessment is not applied for superior decisions as drainage strategy, or selection of field development concept – which are documented in the PDO/PIO deliverables, however focused on detailed systems/technology functions following on from such key decisions.

The current document is the result of joint industry project collecting best practise on BAT assessment from operators at NCS and defining a method for BAT assessment covering all phases from project screening, FEED and detailed engineering, operations, modifications, and decommissioning. The project has been led by Offshore Norge, with broad participation from its members. A reference group consisting of key persons from Equinor, Repsol, Vår Energi, Wintershall DEA, Lundin Energy and ConocoPhillips ensured relevant input and guidance during development of the BAT guideline. Important stakeholders like NEA, NPD and MPE were informed and given the opportunity to comment on the process and results. DNV facilitated the work and documented the process and method.

1.4 Abbreviations

ALARP	As Low As Resonably Practicable - Expresses that the risk shall be reduced to a level that is a slow as reasonably practicable
BAT	Best AvailableTechniques (see also section 1.7)
BATC	BAT Conclusions
BOK	Concretisation Decision (Beslutning om Konkretisering)
BREF	Best Available Techniques Reference Documents
CoP	Cease of Production
DP	Decommissioning Plan
EIF	Environmental Impact Factor
ENVID	Environmental Hazard Identification
FEED	Front End Engineering and Design
IA	Impact Assessment
IED	Industrial Emissions Directive - Directive 2010/75/EU of the European Parliament and the Council on industrial emissions
MPE	Ministry of Petroleum and Energy
NCS	Norwergian Continental Shelf
NEA	Norwegian Environmental Agency
NGO	Non-Governmental Organisation
NPD	Norwegian Petroleum Directorate
O&G	Oil and Gas
OSPAR	OSPAR is the mechanism by which 15 Governments & the EU cooperate to protect the marine environment of the North-East Atlantic
PA	Petroleum Act
PIO	Plan for Installation and Operation
PDO	Plan for Development and Operation

1.5 Regulatory basis

BAT is founded on international conventions and agreements[1], and implemented in Norwegian legislation. The Petroleum Act (PA) §4-2 requires a Plan for Development and Operation (PDO) for a petroleum resource (and a Plan for Installation and Operation (PIO) for infrastructure projects), which includes an Impact Assessment. BAT forms an important part of the Impact Assessment for new developments, major modifications, and field decommissioning (PA section 5-1).

Norwegian environmental regulations require BAT assessments on a general basis (ref. Pollution Control Act §2, section 3[2]). For offshore oil and gas activity this is further emphasized in the Framework regulations §11, section 2[3].

BAT is defined in the Pollution Regulation; "Forurensningsforskriften §36, vedlegg II"[4]. This regulation requires that applications for discharge permit shall be based on that best available techniques have been selected (§36-10). Further the Pollution Regulation §36-15, states that discharge and emission levels shall be set in line with BAT conclusions as defined in §36, Appendix II or the general principles for BAT defined in §36, Appendix II.

Units with thermal effect above 50 MWt on NCS are covered by the Best Available Technique Reference Documents for Large Combustion Plants (LCP BREF). This follows the commission implementing decision (EU) 2017/1442" adopted under the Industrial Emissions Directive (IED). According to the LCP BREF Dry Low-NOx burners (DLE-turbines) is considered BAT for these units (BAT 53b). Other turbine types and burners may be considered BAT in the case of retrofitting turbines on existing units that are covered by the LCP BREF. This must be concluded through an individual BAT assessment following the relevant guidance within this document. The BAT conclusion may require authority review and approval as this would be an exemption from the BREF conclusion.

NEA's guidance document on permit applications (Link) provides additional information on the expectations to BAT assessment from the regulatory stakeholder. It states that the company shall provide information on how the BAT requirement has been applied for all relevant areas, as well as mentioning BAT requirement specifically for certain areas of application. The requirements to BAT assessment are also mentioned several times in the guideline to the Activity Regulations and the Framework Regulations

For offshore development projects, BAT forms an important part of the documentation in the plan for development and operation (PDO), including the Impact assessment. Before production commences, specific environmental performance requirements/conditions will be given as part of activity specific

[1] Appendix 1 of the OSPAR Convention defines Best Available Techniques (BAT) as "The latest stage of development (state of the art) of processes, of facilities or of methods of operation which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste".
BAT is further defined in the EU Industrial Emissions Directive (2010/75/EU) – implemented in Norway - to prevent and minimize pollution to air, land and water; "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practicable suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent, and where that is not practicable, generally to reduce the emissions and the impact on the environment as a whole".

[2] Efforts to avoid and limit pollution and waste problems shall be based on the technology that will give the best results in the light of an overall evaluation of current and future use of the environment and economic considerations.

[3] In reducing the risk, the responsible party shall choose the technical, operational or organisational solutions that, according to an individual and overall evaluation of the potential harm and present and future use, offer the best results, provided the costs are not significantly disproportionate to the risk reduction achieved. The guidelines to the regulation further specify: The second subsection provides e.g. the principle regarding best available technology (the BAT principle). This implies that the party responsible for the activities shall use as a basis for its planning and operations the technology and methods that, following a comprehensive assessment provide the best and most effective results. The principle is also expressed in Section 2, first subsection No. 3 of the Pollution Control Act.

[4] It should be noted that the specific requirements given in this regulation do not apply to offshore petroleum activities (ref. attachment I to the regulation), as such requirements are covered by sector regulations. However, the general definitions of BAT and its application are considered valid also for offshore oil and gas.

permits and based on BAT. The BAT evaluation shall cover relevant alternatives and document company's assessments and shall be performed in the life cycle perspective. Company's BAT assessments and decisions shall be documented (as per general requirements on documentation of environmental/HSE related decisions).

It should be noted that an offshore field development project normally has a relative short time schedule from proving an economic field development concept (Concretisation Decision - BOK[5]) until the plan for development and operation (PDO) is submitted, often in the order of 1-3 years, including BAT assessment in the different project phases during planning.

1.6 Reference documents

Relevant guidance documents on BAT and BAT assessment can be found below. General guidance documents, and Best Available Techniques Reference Documents (BREFs) and BAT Conclusions (BATC) are presented separately. BREFs and BAT conclusions may be relevant for offshore and/or onshore O&G activity:

General guidance documents:

- NORSOK S-003:2017 Environmental Care (Can be ordered here)
- Best Available Techniques Guidance Document on upstream hydrocarbon exploration and production (Wood/European Commission, 2019) Link
- International Finance Corporation (IFC) Environmental Safety Health (ESH) Guidelines for offshore oil and gas development Link
- Add Novatech, 2016. Cold venting and Fugitive Emissions from Norwegian Offshore Oil and Gas Activities. Module 3A report Best available technique (BAT) assessments. Prepared for the Norwegian Environment Agency. Link
- IUCN, 2021. Mitigating biodiversity impacts associated with solar and wind energy development: Guidelines for project developers. Link
- IFC, 2015. Environmental, Health & Safety Guidelines for Wind Energy. Link
- The World Bank, 2011. Greening the Wind - Environmental and Social Considerations for Wind Power Development. Link
- European Comissions 2010. Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control). Link

BREF documents and BAT conclusions

- European Commission, 2010. Best Available Techniques Reference Documents for Large Combustion Plants (LCP) Link
- European Commission 2009/2021. Reference Document on Best Available Techniques for Energy Effiency (ENE). Link
- European Commission, 2006. BAT Reference Document (BREF) on Economics and Cross-Media Effects (ECM). Link
- European Commission, 2015. Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas (REF). Link
- European Commission, 2018. Best Available Techniques (BAT) Reference Document for the Management of Waste from Extractive Industries (MWEI). Link
- European Comission, 2017. Production of Large Volume Organic Chemicals

[5] Milestone where licensees have identified at least one technical and financially feasible concept that provides a basis for initiating studies that lead to concept selection.

(LVOC) - BREF / BATC (12.2017). Link
- European Comission, 2016/2017. Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW) - BREF / BATC (06.2016). Link
- European Comission, 2018. Waste Treatment (WT) - BREF / BATC (08.2018). Link

1.7 Definition of BAT

Best Available Techniques (BAT) is defined in in the Norwegian regulations: Pollution Regulation §36, appendix II". This definition is aligned with the definition in the Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control), Article 2 and Annex IV. The meaning of the term BAT is described and illustrated below:

- **"Best"** means most effective alternative in achieving a high general level of protection of the environment as a whole.
- **"Available"** techniques means those developed on a scale which allow implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced in Norway or not, as long as they are reasonably accessible to the activity.
- "**Techniques"** shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.

Thus, the BAT approach does not only consider the environmental performance of techniques, but it also ensures that those techniques are economically accessible as well as technically applicable to projects.

It follows that BAT for a particular technique will change with time in the light of technology advances, economic and social factors, as well as changes in scientific knowledge and understanding.

A common 'globally accepted' definition of BAT does not exist, however the concept of BAT is applicable globally. For simplicity the following short-hand definition could be applied: "Techniques with the highest environmental performance achievable over the lifetime, considering technical and operational feasibility, energy, safety and economic factors. "

1.8 Relationship between BAT and ALARP

This guideline adheres to the overall principle that the mitigation hierarchy shall be followed when managing environmental aspects. This means that the following mitigation hierarchy apply (ref. NORSOK S-003):

1) Avoid
2) Minimize
3) Compensate /Remedy

NORSOK S-003 recommends that following these principles BAT assessment should be performed to identify and conclude on the best available technique. The selection of best available technique implies that environmental impacts are avoided or minimized. In addition barriers should be applied to reduce risk and prevent spills. This will further minimize the environmental impacts of the selected technique.

During BAT assessment the risk of spills from the alternative techniques should be evaluated. Barriers should be identified and applied to reduce risk and prevent spills. Before finally concluding on BAT and which barriers to apply, the risk associated with the technique should be demonstrated to be as low as reasonably practicable (ALARP).

For further guidance on use of the ALARP principle and demonstration of ALARP, see NORSOK Z-013, Annex A and NORSOK S-003.

2 BAT ASSESSMENT METHODOLOGY

2.1 Introduction

The application of BAT is a primary principle of the environmental requirements and should be used both in project development and in operation. The BAT assessment process consists of the following main steps, and the BAT process is illustrated in Figure 2-1.

- **Identify** techniques/system relevant for BAT assessment
- **Screen** possible alternatives
- **Assess** the alternatives
- **Select** the best technique(s)

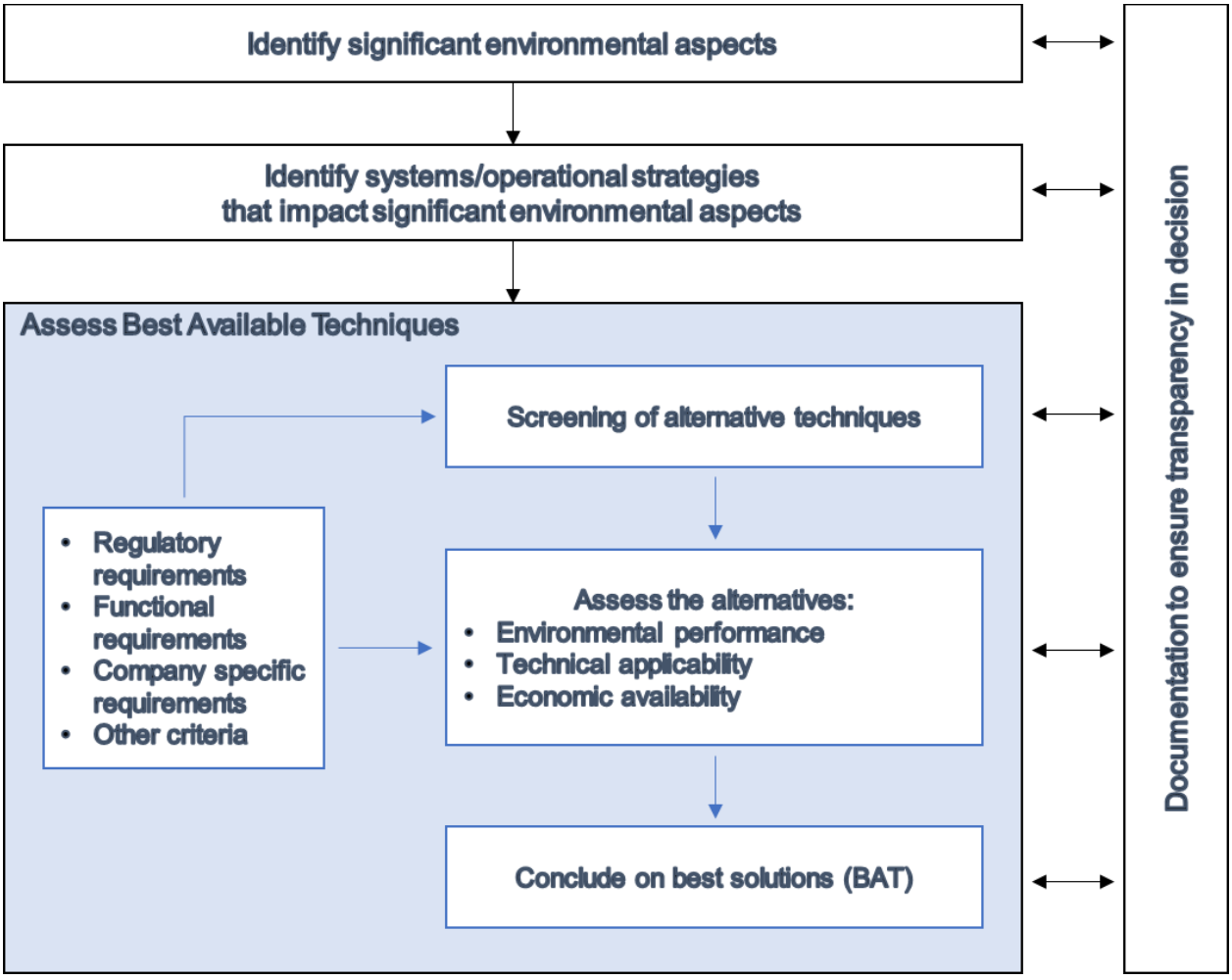

Figure 2-1 Process of selecting the best solution (BAT). The illustration is modified based on figure 2 in *NORSOK S-003:2017.*

Safety and occupational aspects should, if relevant, also be considered in screening, assessment of alternatives and conclusion, as a holistic HSE evaluation of alternatives is in most cases required (see section 2.7 for further information).

BAT for a given system is defined through BREF documents (ref section 1.6), or on a case by case basis according to the process described in Figure 2-1 above. The generic method and process for BAT assessment is the same independent of the techniques to be assessed, the phase of the activity or the stage of projects. However, the complexity of the process, data need, assessment criteria etc. may

vary significantly. The generic method and process is described in section 2 of this guideline,whereas more detailed recommendations for development project, modifications or other phases of oil and gas activity, is presented in the following sections. BAT assessments for development projects should be performed and refined at all decision stages of the development.

The scale of the BAT assessment should also reflect the size of the project, and the potential environmental impacts, meaning that e.g. for a small project with limited environmental impacts, the requirements to data, assessments processes and documentation is lower compared to a larger project. Typically BAT assessments of systems with limited environmental impacts will be done qualitatively.

A BAT assessment is typically performed as a combination of desk-top assessments and multidisciplinary workshops, where identification of concept/techniques/systems relevant for BAT assessment and screening of alternatives is done as a desktop study while the assessment of alternatives is done in a workshop, especially in early phases of a project when the availability of data is limited. In later phases the quantification of environmental-, technical- and economic impacts are normally performed as desktop work (stand alone or as input to workshops to conclude on BAT). A Terms of Reference (ToR) should be prepared ahead of workshops as preparation for the participants and to ensure efficiency during workshops (see section 2.8.1).

2.2 Identification of systems for BAT assessment

A BAT assessment shall be performed for all systems/ sub-systems which influence significant environmental aspects, however should also be considered for other aspects if relevant. This could be during project phases or operation (improvement initiative, replacement of equipment/parts, or changes in maintenance and operation strategy for such systems).

An ENVID workshop can be a good approach for establishing an environmental aspect register. In many cases the environmental aspect register also form the basis for functional requirements in the design basis. Establishing an environmental aspect register is a requirement within company management systems and specified in ISO 14001, thus most projects and operations will have this in place[6]. The environmental aspect registers normally provide an overview of environmental hazards and impacts of the activity, including a qualitative evaluation of the severity of the environmental impacts. Companies may differ in how they assess and select the significant environmental aspects, but the significant aspects should be identified. Normally such registers will be updated per decision gate for projects and annually for fields in operation. The environmental aspect register of the project or an activity forms a good basis for identification of systems for BAT assessment (NORSOK S-003: 2017). All systems with identified significant environmental aspects or which contribute to significant environmental aspects should undergo BAT assessment. Using project specific environmental aspect registers for identification of systems for BAT assessment will ensure that the identification consider project specific aspects (e.g. location including geopolitical and/or environmental framework, or the sensitivity of the environment).

Check lists can be used to ensure environmental best practise is being implemented based on current standards (see section 1.6 for relevant standards and reference documents). This is a systematic and good engineering approach for reviewing all systems and techniques that can have environmental impacts. Check lists can be part of environmental design review (see also section 2.8.4 on studies providing input to BAT assessment), as well as a tool to identify systems for further BAT assessment. But such a check list cannot directly replace BAT assessments for the techniques that have an impact on significant environmental aspects.

[6] See ISO 14001:2015 or NORSOK S-003:2017 for further guidance on developing environmental aspect registers, and assessing the significance of environmental aspects.

On the other hand the check list can be developed to provide an overview of company specific priorities for BAT assessment based on experience. In the case of using check lists to identify systems for BAT assessment it is important to consider project specific aspects which may impact the prioritisation of significant environmental aspects of the project. This may not be covered in more generic check lists if such are applied. Check lists also needs to be reviewed and updated on regular basis to stay relevant.

See Appendix A for examples of systems and techniques that can require BAT assessment.

2.3 Establishing BAT scope and context

Each technique decision requiring a BAT assessment (ref. section 2.2) should define the actual scope of application, including its wider context and boundaries. This will vary among applications, from a simple selection of a technique having no significant dependency or influence on other systems, to technology decisions impacting on other processes on either own installation, a possible host installation or even an onshore processing plant. For applications having a potential for impact on other processes or installations, the scope of the BAT assessment shall include these to enable for the overall best decision basis (reference is made to section 2.8.1 for futher guidance).

2.4 When to initiate BAT assessment

The general guidance is to initiate BAT assessments early in the project phase – "better too early than too late". However, as projects may be very different both in their context and complexity a clear guidance on timing cannot be given. It is important that the BAT assessment has been performed before each decision gate to ensure that the required decision basis is in place. Failing to do so entails a risk of not meeting legal requirements or stakeholder expectations in technology choices, which might again lead to costly changes later in time.

In the early project phases focus for BAT assessment will be on the concept, larger systems and most important decisions, e.g. power solutions and produced water management solution. In later project phases BAT assessments will be required for other systems and sub-systems like venting and flaring, leak detection system, subsea control system etc.

2.5 Ownership and involvement of internal stakeholders/personnel

BAT assessments are a project deliverable that shall be part of decision support documentation. The assessments include evaluations of both environmental impacts, technical availability, and economic availability of alternative techniques. In addition safety aspects shall be included as relevant. Thus, it is imperative that the team performing the BAT assessment consists of people with experience and competency within all the relevant dicipline areas. The composition of the team will vary among the actual BAT assessments. The BAT assessment is often facilitated by the environmental/sustainability discipline, however this can vary among companies and projects.

Key decision makers in projects or operations should be informed about the main results of the BAT assessments and its implications to the project/operation, and be involved in making the BAT conclusions. Project management should approve the BAT by e.g. signing decision notes or similar documents.

2.6 Selection of techniques for the assessment

All techniques that potentially can provide the best environmental performance should be included in the BAT assessment. This includes evolving techniques[7] that can be matured within the time frame of the project/modification period, and techniques previously not used within the sector or geographical region.

The selection of techniques can be identified in a workshop with relevant technical, economical and environmental personnel or be based on a desktop study of alternatives with input from the same diciplines. The combination of the two may be preferable to work efficiently and at the same time ensure e.g. that evolving techniques are included.

The initial list of techniques should be comprehensive (e.g. 5-15 techniques).

2.7 Establishing screening and assessment criteria

Each project needs to identify and apply specific criteria for screening/assessment which are relevant to the BAT assessment and having significance in the overall evaluation. The criteria should cover technical (incl. safety), environmental, and economic parameters, however also other criteria may be of relevance for BAT evaluations and decision. The criteria could be pre-find e.g. in a Terms of Reference to the BAT assessment process/workshop, and be adjusted as relevant to actual scope and issues (to be functional for the actual process).

Based on industry experience a generic list of relevant criteria is presented in

[7] Depending on the size and nature of a project, a project may early undertake a technology qualification review, which should consider the relevance of evolving techniques to the actual project.

Table 2-1. The project should screen out irrelevant criteria and add new as applicable. Depending on the nature of the project and relevant options for the actual application (technology/technique), some criteria may also be further detailed, e.g. "emissions to air" divided in two or more sub-criteria to differentiate between CO_2, NO_X, etc. The criteria should reflect location specific concerns e.g. related to sensitive habitats and species that may be impacted.

Project and/or company prioritisations may be applied by form of weighting the selected criteria. Prioritisations may be based on company strategy, reputational and society/stakeholder issues (e.g. fisheries)[8], etc. This type of prioritisation may also be part of the process to select assessment criteria, ensuring the best and most relevant decision basis. Weighting or prioritisation must be transparently documented and substantiated before the BAT assessment is performed.

For quantitative BAT assessments it may be beneficial to define the levels that signifies if a criterion that is being assessed is to be considered to have good performance, challenging performance, or not acceptable performance. This can be done for all or some of the criteria that are selected. See Appendix C for an example of definition of criteria performance.

[8] Concern has been raised on how to consider fishery in the BAT assessment. Impact on fisheries is considered out of scope for BAT assessment. This and similar activities are generally considered in the PDO/Impact Assessment process.

Table 2-1. Reference list of generic criteria for use in BAT assessments

Environmental	Technical	Economic
Emissions to air, incl. GHG	Technology maturity	CAPEX
Power/energy demand/energy efficiency	Reliability/regularity	OPEX
Planned discharges to sea	Maintainability	Production impact
Waste (generation and waste handling)	Operability (complexity/ experience)	Schedule
Accidental spill/Environmental risk	Physical footprint (size, weight)	Cost savings/ revenue (e.g. CO_2 tax / sale of gas)
Consumption of materials (incl. chemicals, reuse-/ recycling potential, etc.)	Technical safety	Abatement cost
Physical environmental footprint	Operational safety	End of life/decom. costs
	Working environment	Life time cost (NPV)

2.8 Assessing alternatives

2.8.1 Introduction

The techniques that are part of the BAT assessment (ref. section 2.6) should be assessed applying an adequate and transparent method which should:

- Enable for a harmonised and structured assessment of all short-listed alternatives and for all relevant decision parameters
- Enable for presentation and communication of decision related information and provide the necessary level of documentation
- Ensure transparency in assessments

The appropriate method to be applied in a BAT assessment will differ depending on the stage/maturity of the project; starting with a method for qualitative BAT screening in the early phase and performing more detailed evaluations, with quantification as applicable, in later phases when more data and documentation are available. For more details see section 2.8.2 and 2.8.32.8.2. It may be necessary to revisit the qualitative early screenings at a later stage in the project, as changes in the project development may have impact on the results of the original screening.

The assessment of alternatives can be performed in a workshop, as a desktop study or a combination of the two (ref section 2.1). To prepare for a workshop it is recommended to develop a Terms of Reference for the BAT assessment. The Terms of Reference should describe the objective of the workshop, the method and approach to be used and the scope of work to be accomplished. This provides a good basis for an efficient workshop. A template for a Terms of Reference can be found in Appendix B

The scope of the BAT assessment may involve systems that can influence the environmental or technical performance of third-party installations down-stream or onshore. Examples of such projects

could be tie-back projects with potential to cause e.g. increased methane emissions or challenges for the produced water handling at the host platform, or projects with potential to cause e.g. increased emsissions or discharges at receiving onshore facilities . In such cases it is recommended to collaborate in finding solutions that are BAT for the overall scope (short and long-term perspective), take ownership of the down-stream challenges and agree on cost sharing solutions. Subsea tie-back projects are often applying for fulfilled duty of Impact Assessment, thus not having a formal consultation with input on expectations to BAT assessments. However, BAT assessment should be undertaken on the same level as for projects being subject to a standard Impact Assessment process

2.8.2 BAT screening method

The highest level of assessment suggested is a screening process applying a simple colour code system ("traffic light") using green, amber, and red to indicate relative performance or adequacy. Similar methods are widely used both for BAT assessment and other comparative assessment processes (e.g. Oil&Gas UK method for comparative assessment in decommissioning programmes, 2015).

Table 2-2. BAT screening colour coding.

Performance
Good performance/low impact, technically and economically feasible
Challenging performance/moderate impact, technical availability issues, economically challenging - or high uncertainty
Not acceptable/feasible
Not relevant

The main objective with this screening approach is to screen out alternatives which are found to clearly not be applicable to the project, e.g. being non-compliant with regulatory requirements, not technically feasible or economically impossible to the project. It is however deemed important not to screen out options too early; if the technique has some potential to be applicable during the project, including possible schedule delays etc., the alternative should be included and brought forward to the next phase. This could be of particular relevance to evolving techniques for which a possible later change in project schedule could reintroduce its relevancy and ultimately be BAT. However, if all techniques considered at this stage are found viable, based on the current available knowledge, all should be brought forward to a more thorough assessment in next project phase.

Further, the colour coding approach will provide a visual overview of the key findings from the screening, often being a relatively apparent means to rank or group techniques relatively due to their overall attractiveness to the project. Some BAT methods apply scoring (numbers) as part of the relative ranking[9]. However, this should be done carefully, as this could over-simplify or possibly hide essential information behind the numbers. Hence, relative ranking by numbers is not recommended in general, although it may be proven useful in some cases.

An example matrix for a BAT concept screening is shown below, considering 1-n techniques for 1-n criteria on environmental, technical, and economic parameters respectively. The outcome of the screening is that technique #1, 3 and n is brought forward to the next project phase (subjected to more detailed BAT assessment) while technique #2 and #4 are screened out. The basis for this conclusion should be properly documented (see also section 2.11).

[9] Examples include simple ranking between options; e.g. 1, 2, 3…etc. or the application of performance categories, for which different options assumed having similar performance are scored/rated the same.

Table 2-3. Example on concept level / early phase BAT screening.

Criteria	Technique				
	1	2	3	4	n
Env 1					
Env 2					
Env n					
Tech 1					
Tech 2					
Tech n					
Ec 1					
Ec 2					
Ec n					

2.8.3 BAT assessment method

For the actual BAT assessment, when relevant techniques are shortlisted and subject to proper assessment based on a decent level of documentation (ref. section 2.11), an evidence-based and holistic assessment approach is recommended. No ranking is necessary. However with reference to the initial screening, where techniques are categorised as amber due to insufficient information or uncertain assumptions, improved documentation should be provided to reduce the uncertainty of the assessment. This could result in a better performance categorisation. Documentation should consist of a narrative text with supporting tables and findings presented per technique and criteria, where relevant. No guidance is provided here on the magnitude of documentation to be provided, however documentation shall be sufficient to support the assessments and ensure evaluations are transparent. Appendices can be used for additional data and documentation purposes.

A summary of findings per criteria can be presented, and if applicable point at the technique having the best performance, or the group of techniques that have acceptable (based on company definitions/prioritisation) performance, and finally pointing at possible performances below acceptable level.

Companies and projects may prioritise differently among the assessment criteria (section 2.7), depending on possible environmental sensitivities in the actual area, company policies or national/regional management framework. Hence, the current guideline presents no weighting or prioritisation to any of the criteria over others. This will be decided and applied by the actual project based on the relevant framework, as applicable. It is therefore important that the actual weighting and the rationale behind it is properly documented to ensure transparency (section 2.11).

An example of a BAT summary is presented in Table 2-4, continuing from the screening in Table 2-3. In this example, new documentation is achieved for Technique n on criteria Tech n, for which information previously had high degree of uncertainty (amber) and which with the current information is proved to be non-economic, hence screened out (with proper documentation to support that decision). Further, updated information (and less uncertainty) for Technique #3 on criteria Tech n, upgraded this evaluation to green level (technical feasible, sufficient level of uncertainty). Hence, Technique #1 and 3 are brought forward to the next/final level of BAT assessment.

Table 2-4. Example of BAT summary.

Criteria	Technique		
	1	3	n
Env 1	Short summary of information, text, numbers, as applicable	Short summary of information, text, numbers, as applicable	Short summary of information, text, numbers, as applicable
Env 2	Short summary of information, text, numbers, as applicable		
Env n	Short summary of information, text, numbers, as applicable		
Tech 1	Short summary of information, text, numbers, as applicable		
Tech 2	Short summary of information, text, numbers, as applicable		
Tech n	Short summary of information, text, numbers, as applicable		
Ec 1	Short summary of information, text, numbers, as applicable		
Ec 2	Short summary of information, text, numbers, as applicable		
Ec n			

2.8.4 Studies providing input to BAT assessment

BAT assessments are closely linked to other deliverables that are normally prepared for oil and gas projects; including environmental-, technical- or economical studies. Examples are the environmental aspect register that is important for selecting systems for BAT assessments (see also section 2.2), the environmental budget, or reliability studies. Figure 2-2 presents key environmental deliverables that provide useful information on environmental performance to the BAT assessment.

But also other environmental or technical deliverables provide relevant input to the BAT assessment. These can provide information on the technical, economical, safety or environmental criteria of the techniques under evaluations. Examples of such deliverables or information are:

- Functional and Design Requirements
- Production profile
- Reliability and maintainability analysis
- Studies providing the philosophy for or assessing specific systems; e.g Produced water treatment study, Open/closed drain philosophy, Sand treatment and Produced water philosophy etc

A BAT summary report can be developed providing a high-level overview of all BAT conclusions in the project (see section 4.6).

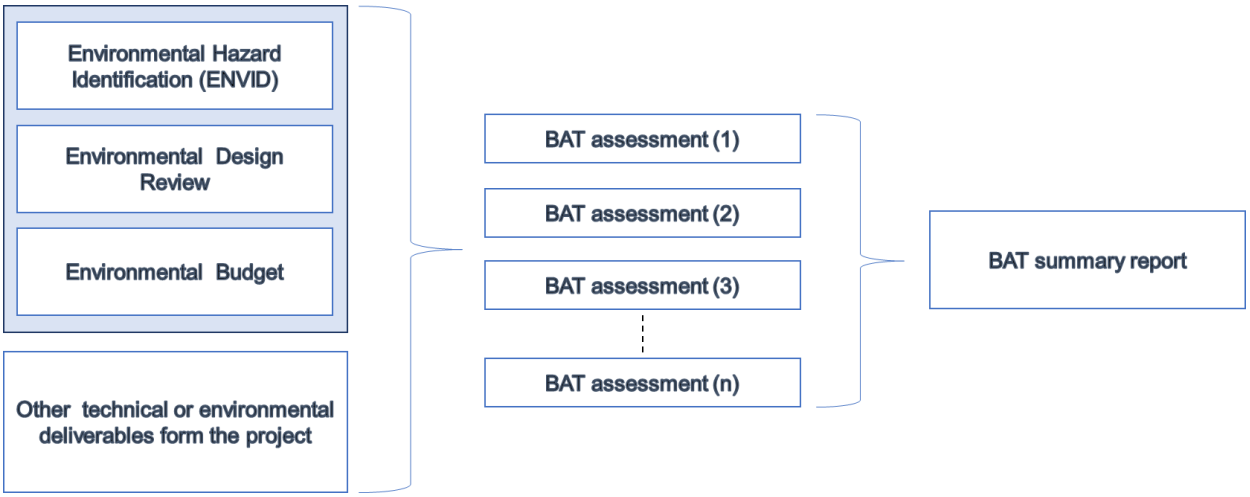

Figure 2-2 Key environmental deliverables like ENVID, environmental design review and the environmental budget provide useful information on environmental performance to the BAT assessment. Other technical- and economical deliverables will also provide important information to the overall assessment.

2.9 Selecting BAT

Depending on the project phase and the corresponding level of data/documentation, the outcome of the BAT assessment will provide a short-list of techniques for further assessment in next project phase. At the point when the short list is sufficiently documented it will ultimately form the basis to decide which technique is BAT.

In the final BAT assessment the evidence-based assessment per criteria and technique enables for a holistic evaluation across all the criteria.

The holistic evaluation shall take into account prioritisations of criteria and/or weighting of criteria as initially set forth and documented as basis for the BAT assessment (see section 2.7), in addition to possible company strategies or prioritisations. A holistic evaluation may include dilemmas like having to prioritise between similar environmental impacts in different compartments. Such dilemmas and the rationale behind the decisions should be documented.

Before finally concluding on BAT (for some decisions), the risk associated with the technique shall be demonstrated to be as low as reasonably practicable (ALARP), see section 1.8.

Note that a holistic evaluation, ref. the example in Table 2-4, is **not** to count "scores" with the same colouring (e.g. amber) – as score within same colour category could have different performances, priorities, and benefits. Technique 1 could be evaluated as the overall best (BAT) even with two amber vs. one amber for Techique 3 (ref. Table 2-4).

Finally, BAT will be concluded for the actual application and approved in accordance with the company proceures. The selected BAT will be described in relevant project documentation (Basis of design, Invitation to tender documents) to ensure it forms part of the final design/solution.

2.10 Data quality requirements

The data quality shall be sufficient for the decisions to be taken in the BAT assessment. This means that the data quality requirements will vary between phases, e.g. more detailed data is needed for BAT assessments during detailed engineering as choices are refined, compared to the concept phase.

Data quality, assumption and uncertainties shall be known before any decision are taken. It should be documented that the data quality is sufficient for the decisions to be taken. For more specific requirements to data quality, see the relevant phases.

2.11 Documentation

The BAT assessment shall be properly documented. The documentation is important to ensure transparency and provide the necessary background for potential third parties to understand the rationale behind the BAT conclusion. The bullet points below highlight some of the key documentation needs:

- All techniques that are identified for the BAT assessment shall be documented.
- Selection, weighting and/or prioritisation of assessment criteria shall be documented and substantiated before the BAT assessment is performed.
- Data quality, significant assumptions and uncertainties shall be documented, including scenario- or sensitivity assessments
- Any technique being screened-out in the different stages should be documented, clearly describing to which criteria it couldn't achieve an acceptable level of performance, referring to or providing as an appendix to the BAT assessment the documentation and possible assumptions behind this evaluation.
- The final short list of techniques in the BAT assessment should be documented by a narrative text with supporting tables and findings presented per technique and criteria. No guidance is provided on the magnitude of documentation to be provided, however sufficient to support the actual assessments and ensure evaluations are transparent. Appendixes can be used for additional data and documentation purposes.
- The final BAT conclusion including the holistic evaluations and potential effects of weighting on the evaluations shall be documented.
- In case of significant dilemmas in the prioritisation between techniques, the dilemma and rationale behind the decisions should be documented.

3 BAT IN CONCEPT PHASE

3.1 Introduction

This section provides further guidance on issues that are specific for the concept phase of a new development projects. The general BAT method guidance in section 2 is still applicable.

3.2 Addressing emerging/novel techniques in selection of techniques for the assessment

The concept phase represents the first phase of project development, and this process may take several years. Due to the potential duration of the process, it is important to include relevant emerging and novel techniques. These techniques may be matured within the industry during the project development and may represent BAT at the time of final BAT selection. Excluding emerging and novel techniques at this stage may represent a lost opportunity or lead to costly changes at a later stage.

Thus, emerging techniques should be included in the concept phase and be brought forward during BAT assessment if there is a potential for the technique to become BAT for the project. In this process it is important to have attention on research and qualification of the techniques done by other companies within or outside the industry. The project may also include undertaking a qualification process of relevant techniques (ref. section 2.6).

It is however recognised that fast track projects provide little opportunity for qualifying or awaiting qualification of emerging and novel techniques. Emerging and novel techniques should nevertheless be included at the early stage and then eventually be screened out during the BAT assessment

3.3 When to initiate BAT assessment

BAT assessment should be initiated early in the feasibility stage, finalising the assessment before concept select (DG2). Typically, the larger systems and the most important decisions for the environmental performance of the concept, e.g., power solutions and produced water management solution, should be assessed in the concept phase.

3.4 Establishing screening criteria

In the concept phase, the BAT assessment will focus on screening a larger number of alternatives and reducing them to a comprehensive but reduced number of promising techniques. At this stage the criteria should reflect the information and quality of data that will be available in the screening process, i.e. high level process. The criteria may be reviewed and further refined before the subsequent BAT assessment process in later phases.

Screening criteria, potential weighting and prioritization shall be documented.

3.5 Assessing alternatives

Alternatives should be assessed based on the screening process described in section 2.8.2

3.6 Selecting BAT

At this stage the focus is on screening a larger number of alternatives and reducing them to a comprehensive but reduced number of promising techniques that shall be brought forward into the FEED- and engineering phase.

The method, the techniques that are brought forward, and techniques that are screened out in the process must be documented.

3.7 Data quality requirements

In the concept phase, the data available has a higher degree of uncertainty than in later phases and more high-level evaluations are being performed. Qualitative comparisons and data may be sufficient. To compensate for the uncertainty, assumptions should be properly documented and sensitivity assessments should be performed for key assumptions.

4 BAT IN FEED- AND DETAILED ENGINEERING PHASE

4.1 Introduction

This section provides further guidance on issues that are specific for the FEED- and detailed engineering phase. The general BAT method guidance in section 2 is still applicable.

Where new developments impact brownfield modifications, reference is made to section 6 of this document (for example, in the cases of tie-in developments).

4.2 Identification of systems for BAT assessment

The general principles for identification of systems for BAT assessment is described in section2.2.

During FEED and detailed engineering, the BAT assessment that were started in the concept phase should be matured and more details be included in the assessment of the remaining options. Some BAT conclusion may already have been made e.g., for lead items for procurement.

In addition to ongoing BAT assessments from concept phase, new systems or sub-systems may be identified for BAT assessment. This could be triggered by progress in design and/or other changes that may impact the environmental performance of systems/techniques. Updated of the environmental aspect register in these phases may also trigger the identification of additional systems for BAT assessment.

4.3 Establishing assessment criteria

BAT assessments become more detailed and quantitative in FEED and detailed engineering phases. In this phses it may be beneficial to define the levels that signifies if a criterion that is being assessed is to be considered to have good performance, challenging performance, or not acceptable performance (ref. section 2.7).

4.4 Assessing alternatives

4.4.1 General recommendations

A Terms of Reference document is not commonly established for this phase, however it may be beneficial to plan and document the BAT process and premises (see section 2.8.1 and appendix B).

During FEED and detailed engineering phases the general approach for assessing alternative is the BAT assessment method described in section 2.8.3.

In some cases, it can be justified to use a more qualitative screening approach (section 2.8.2) also in this phase. This could be for assessment of e.g. systems or sub systems with limited impact on environmental performance, or where quantitative assessments are not necessary in order to differentiate between alternatives.

When performing BAT assessment of an overarching system that includes several technologies/sub-systems, it can be beneficial to perform the assessment in two consecutive steps. An example of this is BAT assessment of offshore leak detection systems. A two-step approach for BAT assessment of leak detection systems has been developed and used by several operators at NCS. In the first step specific

technologies are BAT assessed for a given application. Thereafter, alternative combinations of technologies defined as BAT, are assessed to conclude on BAT for the overarching system. For more guidance see DNVGL-RP-F302[10].

4.4.2 Recommendation for cost assessment

During FEED and detailed engineering phases, cost estimates are refined and the uncertainties are reduced. Actual cost estimates should replace comparative assessment of costs. In this stage of BAT assessments, actual costs should be compared between alternatives and cost efficiency assessed with the aim of finding the most effective alternative in achieving a high general level of protection of the environment as a whole..

When assessing the cost of alternatives, it is important to assess both direct cost and cost savings. When assessing techniques with taxable emissions to air, the tax savings shall be estimated and documented. Other relevant cost savings should also be included.

Sensitivity analysis should be used to document and evaluate cost of alternatives due to uncertainty in e.g. future CO_2 taxes, project lifetime, CAPEX/OPEX cost etc.

For some companies abatement cost is the key parameter for evaluating cost of CO_2 reducing measures. Guidelines for assessing abatement cost can be found in Appendix D

As cost estimates are refined, and dilemmas might arise in the assessment of environmental impacts, it may become relevant to assess cost benefits from reducing environmental impacts or risks. There is limited external guidance for how this should be done in BAT assessment. Changes in Environmental Impact factor (EIF), as a measure of assessing impacts in the water column, have been proposed monetised with a fixed cost per change in EIF. Some companies have, for example, categorised the cost of environmental risk. Such information can be used as relevant input to monetising risk or risk reduction. Others have developed methods for monetising environmental impacts, e.g. Repsol and the READS method. READS is method for valuing and accounting impacts on natural capital from industrial activity. READS and similar methods, can be a good tool to assess cost benefits or costs of environmental impacts, thus providing a useful tool to differentiate alternatives when more information is needed.

4.5 Data quality requirements

In the FEED and detailed engineering phase, more detailed and normally quantitative BAT assessments are performed. Input data should be matured and uncertainty reduced compared to the concept phase.

In many cases it can be challenging to compare and assess the alternatives, and dilemmas in balancing environmental criteria can occur. This sets requirements to quantitative data with higher precision to ensure the right decision basis. Remaining uncertainties and assumptions should always be properly documented, and sensitivity assessments performed for key assumptions.

4.6 BAT summary report

Towards the end of a project it is recommended to develop a BAT summary report. This is a document with the purpose of providing a high-level overview of all BAT conclusions in the project (see Figure 2-2 in section 2.8.4). A BAT summary report should include information on the main options that have

[10] The document can be found following this link: https://www.dnv.com/rules-standards/

been evaluated in the BAT assessment and the key reasoning behind the BAT conclusion, referring to the specific BAT assessments for details.

5 BAT IN OPERATIONS

5.1 Introduction

BAT assessments are a natural part of project development and the operators have over time developed a common understanding of the method and its benefits in project development. The terminology has been less used in offshore operations, and there is little common practice for BAT assessments in operations. There is however a clear regulatory basis for performing BAT in operations (see section 1.5 and 1.7), but the best approach for implementation is more unclear. Thus, there is a need for management commitment for BAT assessments to be integrated in existing operational review processes (e.g. management of change).

The lack of a common approach for BAT assessment in operations does not signify that BAT is not implemented. In general, operators on NCS have a high focus on efficient operations, optimization of processes and good maintenance strategies. As an example energy efficiency and flaring management are generally well managed today through active energy management and flaring strategies.

At the same time there is uncertainty around which systems and operational strategies that should undergo BAT assessment, and how frequently this should be done. Section 5 provides further guidance on how BAT assessment can be implemented in operations. The general BAT method guidance in section 2 is applicable also to operations.

5.2 Identification of systems for BAT assessment

BAT assessment shall be performed for all systems, maintenance practises and operational strategies which influence significant environmental aspects (ref section 2.2). For fields in operation this means for example that BAT assessments should be available both for the system for energy production, the operational strategy for energy production and the maintenance strategy for e.g. gas turbines.

Examples of operational strategies and maintenance practise that may need BAT assessment are:

- the flaring strategy
- energy production and consumption (including different operating modes)
- use of chemicals
- waste handling
- leak detection strategy
- production drilling and rig selection
- maintenance strategy for main power producers and consumers, drain systems, produced water treatment system, monitoring system, valves (to avoid leakages, recycling of gas), etc.

5.3 When to initiate BAT assessment

Normally the BAT assessments for the technical systems on the assets will be available from the project phase. BAT assessments of maintenance practices and operational strategies should be performed during planning of operations or as early as possible in operations. Thereafter BAT should be reviewed and documented in the case of significant changes in frame conditions or as part of systematic processes. Such trigger activites can be:

- assessment processes performed with regular intervals due to regulatory- or company requirments
- changes in permits, regulations, or other requirements

- initiation of systematic improvement processes, e.g. for energy management or maintenance strategies
- replacement of equipment/systems due to defects or as part of planned maintenance
- new technology or improvement initiatives identified by personnel/organization
- technical problems or modification of operations
- significant changes in production, for example in connection with tie-ins or drilling of additional production wells

Review of BAT assessment in operations should be associated with change or existing processes, thus there is no requirement to regular updates per se.

BAT assessment for a plants/fields in operation may form part of the management system procedures (for continuous improvement).

5.4 Ownership and involvement of internal stakeholders/personnel

In operations the management of BAT will often be different to that of projects (ref. section 2.5), the responsibility being with the operations management. Hence, it will be the operations management responsibility to ensure BAT assessments are being performed and the results being implemented.

5.5 Establishing screening and assessment criteria

In operations the BAT assessment will primarily focus on comparing alternative strategies and practices. This is slightly different from the BAT assessments performed in project development, where the focus is on comparing alternative technical systems designs. Thus, the criteria for BAT screening or assessment must be carefully selected to reflect the purpose of the BAT assessment ensuring that the criteria have significance in the overall evaluation.

5.6 Assessing alternatives

During operations it is important to scale the BAT assessment according to the specific focus of the assessment process. Both high level screening processes and more detailed assessments may be used. For example, the review of the energy production system will most likely require a quantitative and detailed BAT assessment to conclude on BAT, whereas the review of the maintenance strategy for the turbines may be sufficiently documented through a BAT screening of alternatives.

For additional guidance on cost assessment see section 4.4.2.

6 BAT IN MODIFICATION PROJECTS

6.1 Introduction

Modification projects differ from normal development project in several ways. When implementing changes on existing offshore installations there are often many limitations to what is possible, e.g. in terms of space and weight of the proposed change. The technical challenges associated with integration into existing system are often not fully understood in the early phase. This may lead to significant changes in costs as engineering work develops. If the current solution is working satisfactorily, it can be challenging to demonstrate that another solution is BAT because of the additional costs and potential technical implications related to the change. Hence, focus on technical and economic feasibility is extremely important in modification projects.

Modification projects may be limited projects looking at a particular system, or large projects that include changes in several systems and overall performance. This entails that the BAT method needs to be scaled according to the project size and needs.

Section 6 provides further guidance on issues related to BAT assessment that are specific for modification projects. The general BAT method guidance in section 2 is still applicable.

6.2 When to initiate BAT assessment

BAT assessment(s) should be initiated as early as possible in modification project development. BAT assessment provides support during early phase, helping to evaluate alternative concepts; and it is necessary to improve the selected concept at a later stage of development.

6.3 Selection of techniques for assessment

The general recommendations for selection of techniques apply, see section 2.6.

6.4 Establishing screening and assessment criteria

Each project needs to identify and apply specific criteria for screening/assessment which are relevant to the BAT assessment and have significance in the overall evaluation. Focus on technical and economic feasibility is extremely important in modification projects, and this needs to be reflected when establishing the screening and assessment criteria.

When assessing the alternative techniques in modification projects, it is important to address specific technical benefits or cost savings that can be relevant in such projects. Technical benefits and cost savings should include relevant parameters, for example. value of increased resource extraction, reduced maintenance need and value of reuse. Other benefits and cost savings should also be included as relevant.

In modification projects it may be relevant to define the levels that signifies if a criterion that is being assessed, is considered to have good performance, challenging performance, or not acceptable performance (ref. section 2.7). The definition of the levels should consider that this is a modification project and recognize the additional complexity related to technical evaluations and associated costs in the BAT assessment of such projects.

6.5 Assessing alternatives

In modification projects the BAT assessment method should be selected and scaled according to the project size and needs.

Modification projects that include changes in several systems and overall performance will normally include the same phases as a development project. This means that there will be an initial screening of alternatives based on guidance in section 2.8.2 and at a later stage more detailed assessments as described in section 2.8.3. As the technical challenges with integration into existing system are often not fully understood in the early phase of a modification project, it is of particular importance not to screen out options too early. Frame conditions, costs and/or project schedule may change during the process, changing the attractiveness of the BAT alternatives. During the more detailed assessment of BAT alternatives in modification projects, there is a particular need to ensure proper and detailed documentation of the technical and economic parameters to be able to justify the BAT conclusion. For additional guidance on cost assessment see section 4.4.2.

The increased uncertainties in either environmental, technical, or economic parameters in modifications projects may entail the need to perform sensitivity analysis to document the robustness of decisions.

Limited modification projects focusing on changing a particular system would normally be assessed directly in line with guidance in section 2.8.2. It will be of particular importance to ensure proper and detailed documentation of the technical and economic parameters to be able to justify the BAT conclusion. If the environmental benefits are obvious and the technical and economic implications insignificant, a screening approach can provide sufficient decision basis.

6.6 Data quality requirements

The data quality shall be sufficient for the decisions to be taken in the BAT assessment, and uncertainties shall be known. Due to the nature of modification projects, there may be a need for higher precision and more detailed data to be able to assess and ensure BAT.

Remaining uncertainties and assumptions should always be properly documented and scenario- or sensitivity assessments performed for key assumptions (see also 6.5).

6.7 Selecting BAT

If the current solution is working satisfactorily, it can be challenging to demonstrate that another solution is BAT due to additional costs and potential technical implications related to the change. Such issues should be addressed in all aspects of the BAT assessment from criteria selection and definition to assessment and documentation. In the selection of BAT the evidence-based assessment per criteria and technique shall enable a holistic evaluation across all the criteria, and priorities and decisions should be properly documented to ensure transparency.

7 BAT IN DECOMMISSIONING

BAT is relevant to all stages of a petroleum development, including decommissioning and end disposal of facilities/structures.

The decommissioning phase introduces some differences for project planning stages to other phases of a field life. This section provides further guidance on issues that are specific for the BAT assessment related to decommissioning phase. The common BAT methodology presented in section 2 is considered applicable also for relevant BAT assessments in the decommissioning phase.

7.1 Introduction

For decommissioning projects, the administrative and legal framework gives a different timeline to that of field development (cf. Section 1.5) which will affect the scope and timing of BAT assessments.

According to Norwegian legislation decommissioning and disposal of redundant offshore petroleum installations should be considered already at the stage of design before field development. This should thus be incorporated in the pre-/re-development BAT assessments (cf. section 3, 4 and 6). Ensuring that an installation is removable is an absolute requirement from February 1999, based on OSPAR Decision 98/3 and implemented in the Petroleum Act (PA). The Act further put focus on the potential enabling for future reuse or other uses.

The PA requires a Decommissioning Plan (DP) to be submitted in the order of two to five years prior to expected cease of production (CoP)/cease of use, which enables sufficient time for evaluation of new or alternative use of installations, infrastructure, etc. However, submitting the DP this early, makes some of the documentation available at the time of submittal relatively high-level, also recognising that many installations and fields are subjected to extended life/deferred CoP. Focus in the DP is on alternative disposal solutions (with one recommended), ref. Step 1 in Figure 7-1, and methods or techniques for execution of removal/disposal at a conceptual level. These methods or techniques will be identified and assessed, following the formal authority disposal decision, when the decommissioning project organisation is established for a structured project execution prior to disposal (step 2).
Recommending the disposal solution is not subject to BAT assessment. Depending on the type of facility for decommissioning, end-disposal is either given (by regulatory framework) or disposal options exist (e.g. pipelines and cables). These are clarified as part of the "early" authority decision following submittal of the DP. In the case of more than one alternative disposal options, these are generally subject to Comparative Assessments as part of the DP process.

This authority decision process is of relevance to BAT assessments as follows:

- Main conceptual solutions are comparatively assessed prior to submittal of the DP. These comparative assessment processes (evaluating technical feasibility, environmental impacts, and costs) are documented in the DP and the corresponding Impact Assessment (IA), ref. Petroleum Act. Often the actual BAT assessment (cf. step 2 in the Figure 7-1) cannot be performed with an appropriate level of details during the IA process and correspondingly documented in the IA report. Hence, the IA may point to relevant detailed decisions being subject to a later BAT assessment during actual project planning.
- The disposal decision made by Norwegian authorities sets the premises for identifying the relevant methods/techniques for execution of the work. The exact selection is normally subjected to tendering processes in one or more steps. This evaluation may include BAT assessments.

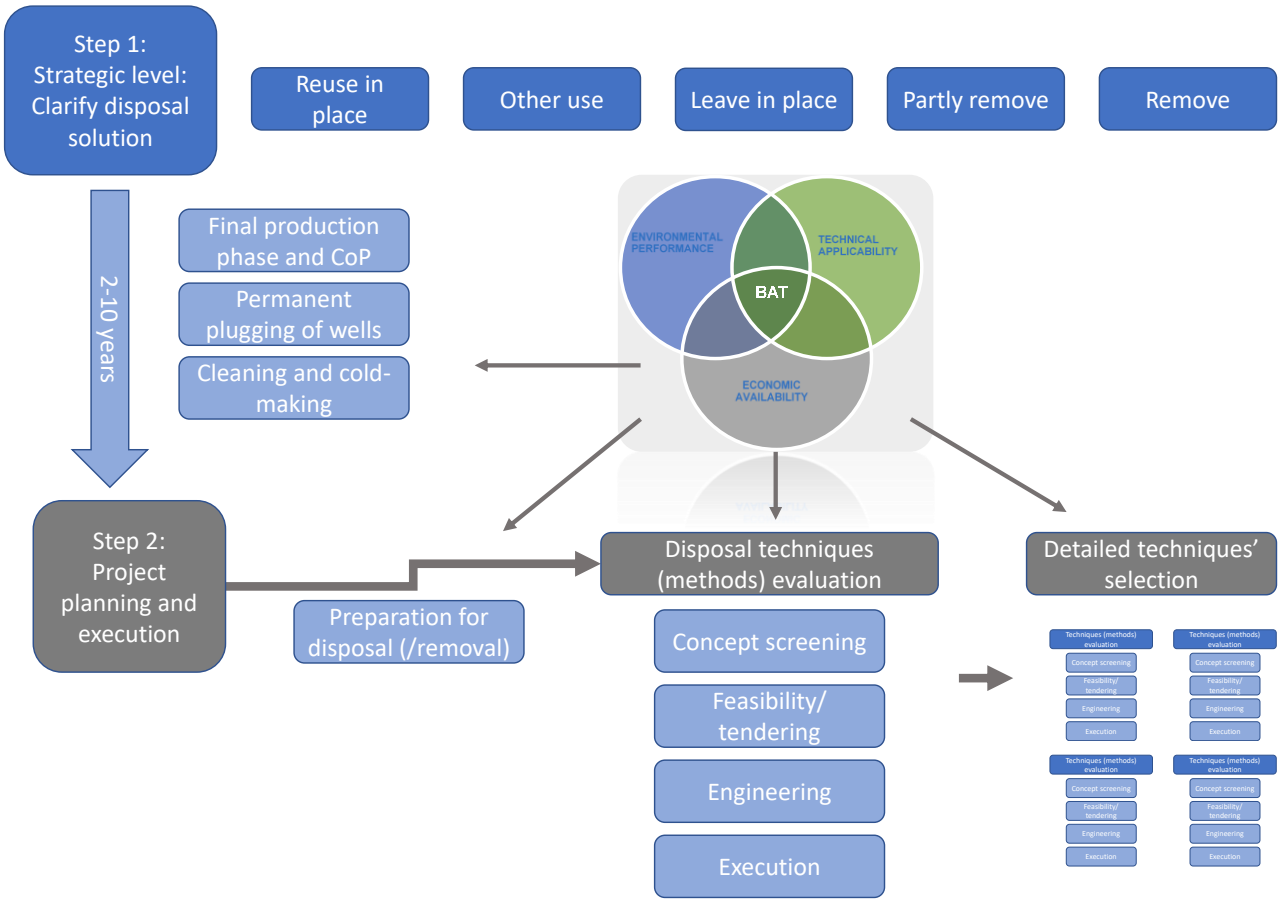

Figure 7-1. Schematic overview of main decommissioning decision phases in relation to BAT assessments.

7.2 When to initiate BAT assessment

The time period for developing and submitting the DP including the IA may be in the order of 2 years (±1 year). Further, the time between governmental decision until final removal may be in the order of 2 to 10 years, varying between fields. During this period the need of BAT assessment will arise; particularly during planning for the actual project execution phase when decisions are taken for specific techniques or management practices. Figure 7-1 indicates different stages of the decommissioning planning in which BAT assessments may be applicable.

7.3 Topics for BAT assessment in decommissioning execution planning

In an international decommissioning context options assessments are often referred as Comparative Assessments rather than BAT assessments, e.g. in the EU BAT guidance document (Wood, 2019), recommending the use of "Comparative Assessment in engineering design when assessing options in the decommissioning/execution phase". Comparative Assessments may be wider in their scope than BAT assessments, and may not have the best environmental option as reference case. As described in section 7.1, the assessment and recommendation of disposal solutions is not subject to BAT assessment, while the outcome of these (comparative) assessments are given in the DP.
During the project planning phases several decisions must be made on the best available technique (including best environmental practice[11]). If the decommissioning solution is not given, and the

[11] The term best environmental practice (BEP) means the application of the most appropriate combination of environmental control measures and strategies. The term is often used and referred to in combination with BAT.

decision will impact significant environmental aspects (see section 2.2), BAT assessments should be undertaken as part of the decision process.

The applications/technology decisions of relevance will vary among projects. The EU BAT Guidance document (Wood, 2019), section 25 provides some examples on relevant Comparative Assessment/BAT topics for offshore decommissioning. These and some additional topics are:

- Well plugging and abandonment.
- Facility decommissioning operations.
- Cleaning of process equipment and piping
- Cleaning of pipelines and cables (chemical/hydraulic lines)
- Management of facility infrastructure returned to shore.
- Underwater cutting
- Marine growth management
- Drill cuttings pile management.

7.4 Establishing screening and assessment criteria

The generic approach for establishing criteria (section 2.7) applies for decommissioning related BAT assessments. Relevance of criteria must be evaluated for the actual decommissioning related topic and project.

7.5 Assessing alternatives

For the process of identifying relevant alternatives, reference is made to the general guidance in section 2.8.

Relevance of alternatives will vary among projects and new techniques will be qualified over time making the project specific alternatives identification and evaluation process important. Some examples on relevant techniques for evaluation for some topics are listed in Appendix E - .

7.6 Data quality requirements

Reference is made to the generic section 2.10 on data quality.

7.7 Selecting BAT

Selection of BAT will follow the generic process outlined in section 2, including as applicable different stages from screening to more quantitative assessments.

8 REFERENCES

DNVGL-RP-F302	Offshore leak detection. Edition 2019.
ISO 14001:2015	Environmental management systems — Requirements with guidance for use
NORSOK S-003:2017	NORSOK S-003:2017 Environmental Care. Standards Norway
NORSOK Z-013:2010	NORSOK Z-013 Rev.03 2010. Risk and emergency preparedness assessment. Standards Norway
Wood 2019	Best Available Techniques Guidance Document on upstream hydrocarbon exploration and production. European Commission.

APPENDIX A - EXAMPLE OF SYSTEMS SUBJECT TO BAT ASSESSMENTS

The table below gives examples of systems and techniques that may be subject to BAT assessment. The list is not exhaustive.

Systems/Techniques	**Comments**
Power production/energy management	Including large energy consumers both topside and subsea
Produced water injection/treatment facilities	
Flare gas recovery technology	To minimize flaring
Mud/cuttings solutions	
Pipeline solutions	Materials, route, and protection. E.g. choice of materials vs. use of chemicals for minimizing corrosion
Use of heat tracing vs. use of chemicals for hydrate inhibition	
Cooling water system	E.g. use of chemicals vs. choice of depth for the seawater intake to minimize biological growth
Sand treatment	
Rig selection	
Subsea control system (electric, hydraulic(open/closed))	
Leak detection system	Covers both subsea leak detection systems with sensors and surface leak detection systems as radars and satelite
Waste management	
Chemical managment	Limit consumption, use of environment friendly chemicals, contribute to low EIF etc.
Well clean-up (host vs. rig)	

APPENDIX B - BAT WORKSHOP – TERMS OF REFERENCE TEMPLATE

1 BACKGROUND

1.1 Field description / facility description

Short text with main facilities/infrastructure.

1.2 BAT – short introduction

Objective of BAT and terminology

1.3 Regulatory basis

Brief reference to national regulatory framework

1.4 Objective

Objective of workshop

2 BAT APPROACH AND METHOD

2.1 Approach

Approach, method, and reference documents.

2.2 Method and parameters/criteria

Short introduction to method, overview of pre-defined parameters (env aspects) and criteria. Spread sheet BAT assessment example.

3 SCOPE OF BAT WORKSHOP

List of systems/technology applications to be considered in the workshop, short description.

4 TIME AND VENUE

APPENDIX C - EXAMPLE OF DEFINITION OF CRITERIA

Example of definition/terminology used to describe the criteria that are being assessed.

Table C - 1: Terminology for CO2 reduction potential

Terminology- CO_2 reduction potential	% reduction in emissions compared to reference case emissions
Negligible reductions	<1%
Limited reductions	1-5%
Minor reductions	5-20%
Moderate reductions	20-50%
Large reductions	50-80%
Very Large reductions	>80%

Table C - 2: Impact category for CO2 emission reductions

Impact Category	Impact of emission reductions, tonnes of CO_2 reduced/year	Impact of emission reductions, tonnes of CO_2 reduced over lifetime
Negligible impact	<1000	<20 000
Limited impact	1000-10000	20 000-200 000
Minor Impact	10 000-20 000	200 000-400 000
Moderate Impact	20 000-50 000	400 000-1 000 000
Substantial impact	50 000-200 000	1 000 000-4 000 000
Huge impact	>200.000	>4 000 000

Table C- 3: Abatement cost

Decision criteria	Abatement cost (NOK/Tonne)
Business economic efficient measure with internal discount rate X% Socio economic efficient measure with typically 4-5% discount rate	ΔNPV =0 (value of saved CO2=Abatement cost)
These measures should be considered to be implemented if they are important wrt.: 1) Materiality: measures with high emission reduction potential in absolute tonnes per year and over the lifetime of the asset (typically also large production volumes). 2) Strategic value: measures with potential for technology development 3) Risk mitigation/national context: measures with potential for mitigating political/regulatory risk, e.g. related to national climate targets, carbon pricing or direct regulations.	ΔNPV is negative, but abatement cost <X NOK/Tonne
	X-Y NOK/Tonne
	Y-Z NOK/Tonne
Abatement cost too high. Decision not to implement.	>Z NOK/Tonne

APPENDIX D - CO_2 ABATEMENT COST CALCULATIONS

Parameters included in abatement cost calculations

The following parameters could be included in CO_2 abatement cost calculations (non exhaustive list). Remark that CO_2 fees and taxes are excluded in the abatement cost calculations.

CAPEX
- Distributed over investment years

Increased OPEX
- Distributed over production years
  - Increased maintenance
  - Increased manning
  - Increased energy cost (electricity)

Decreased OPEX
- Distributed over production years
  - Decreased maintenance
  - Decreased manning
  - Reduced NOx ta

Less income from production
- Distributed over production years
  - Reduced regularity
  - Lost production during project execution brown field

Increased income from production
- Distributed over production years
  - Increased volume of export gas
  - Increased regularity

Calculation principles for CO_2 abatement cost

The basic principles for calculating abatement cost are given below. Abatement cost can be calculated both for business economic purposes and for socio-economic purposes. Depending on the purpose, CO_2 may be discounted or not. Normally for business economics, the CO_2 is discounted. The Norwegian Environment Agency has as a policy not to discount CO_2.

The different approaches to abatement cost calculations for business economic purposes or socio-economic purposes will provide different results. Examples of this is given in Table D-1. This is good to be aware of in discussions of CO_2 abatement cost.

Table D-1: Different approaches to CO_2 abatement cost calculations

	Company	Norwegian Petroleum Directorate	Norwegian Environment Agency
Perspective	Business economic	Socio-economic	Socio-economic
Discount rate	Company internal	5%	4%
Discounting cost	Yes	Yes	Yes
Discounting CO_2 emissions	Yes	Yes	No
Calculation example	1400	1000	400
External funding included, eg, Enova, Nox fund	Yes	No	No
Area of use	Internal	PDO part 2, Impact Assessment	Klimakur 2030

APPENDIX E - DECOMMISSIONING PHASE EXAMPLES ON TOPICS AND ALTERNATIVES FOR BAT ASSESSMENT

Cleaning techniques (pipelines, umbilical lines, process equipment/piping)
The EU guidance document (Wood 2019) states that "sufficient cleaning of pipeline(s) should [also] be considered prior to removal." This will likewise apply to possible pipelines being left in place (i.e. disposal) and is considered a general requirement on the NCS (parliamentary white paper 47 (1999-2000)) and normally stated in disposal decisions. Specific requirements for cleaning may further be stated in activity permits from NEA under the pollution control act. Hence, based on environmental significance of the actual project, a BAT assessment should be considered. Relevant alternatives may include flushing, chemical pigging, mechanical pigging, bull-heading to a well, etc.

Material segregation - waste management/waste disposal (several waste streams/components)
Generally the waste hierarchy applies. However, wastes may be complex in its composition including possible contamination, not making BAT obvious. Hence, in some cases a BAT assessment is required to assess and document the best option, taking environmental and economic criteria into consideration, as well as availability of reception / treatment facilities.

Similarly, reuse is not necessarily BAT in a life cycle perspective and should be subject to BAT assessment including relevant alternatives.

Old drill cuttings accumulations
Generally, it is acknowledged that old drill cuttings accumulations (piles) should be left undisturbed. However, this is often not possible as the requirement to remove a fixed substructure or well template necessitate dredging of the drill cuttings to obtain access to the structure from the seabed. Hence, relocation or other management options for drill cuttings may be required, disposal alternatives being subject to a Comparative Assessment as part of the DP documentation (e.g. relocation, removal to shore). The actual relocation/dredging techniques may have significant difference in environmental impact, hence the selection should be subject to BAT assessment.

Underwater cutting techniques
Since the 1990-s, with the use of explosives for underwater cutting, significant technology development has taken place, including abrasive cutting, diamond wire, etc. Selection of cutting technique should, based on environmental significance of the actual project, be considered for BAT assessment.

Marine growth management
Some marine growth needs to be removed from substructures offshore in freeing areas for underwater cutting prior to removal. The remaining marine growth may be removed offshore (by various techniques), alternatively follow the structure to shore and be removed there. This topic has been subject for different studies and normal industry practice is to remove the growth onshore. The decaying processes generate odour which may cause a temporary nuisance locally. Further, bringing wet marine growth from an area to another may introduce a risk for transfer of invasive/alien species. Hence, the best management practice should, based on environmental significance of the actual project, be considered for BAT assessment..