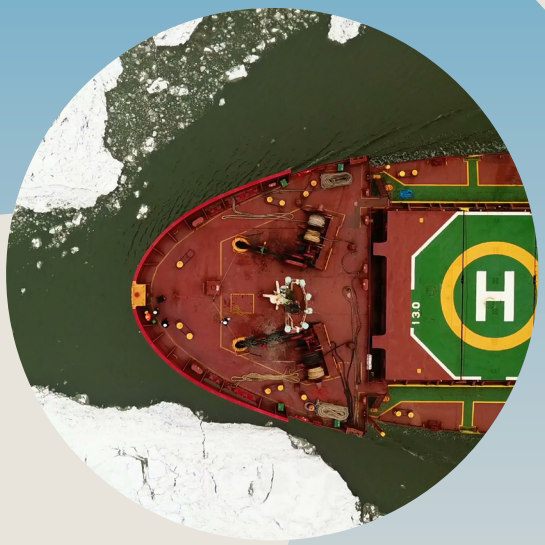

Arctic and Cold Climate

Capability & Experience

Intecsea
Worley Group

CAPABILITY OVERVIEW

Worley and Intecsea are world leaders in design and construction of oil and gas production facilities located in remote, hostile environments such as the Arctic.

Innovative solutions have consistently been implemented to solve unique challenges associated with revamp, modernization, and grass roots projects above and below the ice in these environments.

Engineering design and construction management of Arctic pipelines have been one of Intecsea's core activities since the company was formed in 1984. There are distinct and unique aspects of pipeline design for offshore Arctic environments which offer challenges to the designer. Intecsea has been responsible for feasibility assessments, designs, and construction of Arctic pipelines for more than 35 years.

Unique pipeline design aspects for Arctic conditions include analysis of the potential effects of Arctic-specific environmental loadings (ice scour, strudel current scour, permafrost, upheaval buckling), and the effective use of probabilistic assessments and limit state design for extreme loading conditions. Addressing these unique loading conditions and the application of advanced design philosophies have been successfully performed by Intecsea for offshore Arctic pipelines.

Arctic and cold regions oil and gas pipelines on the continental shelf must be trenched as much as 6 m deep for seabed ice scour protection. The construction of these projects involves the use of floating construction equipment working two or three months during the summer open water season, or the use of land-based equipment operating from nearshore stable ice in winter. Intecsea has engineered all three pipeline systems currently operational in the Beaufort Sea using innovative design approaches and is presently supporting the energy industry as planned conventional and subsea field developments move deeper into Arctic and other ice-covered waters.

Intecsea actively supports our customers in planning for offshore developments in the Arctic and has assisted in customer tenders for leasing new Arctic offshore acreage. Our structural and naval architecture expertise has also been active in developing composite steel and concrete gravity-based designs that handle Arctic ice loads as part of concept development for customers planning Arctic drilling and production facilities.

Services

- Arctic development concept evaluation
- Subsea and early field development planning
- Pipeline FEED and detailed design
- FPSO and GBS design
- Offshore and overland route selection
- Construction management and support
- Logistics and materials selection
- Project management

Intecsea's experience in the Canadian, US, and Russian Arctic regions positions us at the forefront of Arctic technology development for onshore and offshore pipelines and associated facilities.


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Engineering and Construction Management Services

Pipeline Design

Unique pipeline design aspects for Arctic conditions include analysis of the potential effects of Arctic-specific environmental loadings (ice scour, strudel current scour, permafrost) and the effective use of probabilistic analyses for extreme loading conditions. Evaluation of these unique design- loading conditions and use of a reliability- based, limit state design philosophy have been successfully implemented by Intecsea for offshore Arctic pipelines.

Structures and Marine Systems

Intecsea provides a full suite of engineering services for offshore Arctic structures and marine systems to encompass the full range of project development and execution. These include the development of design criteria, ice load analysis, feasibility studies of different support sites, and fixed structures design.

The Arctic GBS hull, scantling, ice walls, and materials are all part of the structural design process.

Insulated Flowline Design

Intecsea has extensive expertise in the design and repair of flowlines related to High Pressure/High Temperature (HP/HT) applications. Pipe-in-Pipe (PIP) and bundled flowline methodologies have been the primary HP/HT flowline design concept in the Arctic. Insulation has been evaluated for Arctic applications to limit permafrost and sea ice degradation. Flexible pipe can also be utilized to absorb expansion loads/ displacements at the ends of the flowline, or they can be utilized for the entire flowline to absorb expansion and relieve axial stress.

Construction Management

Intecsea's Construction Management team has a proven track record for providing innovative solutions in the implementation of frontier projects, by providing contract and execution planning, coordination, engineering, interface and offshore execution throughout the lifecycle of the project. This ensures a seamless transition from design through commissioning for our clients.

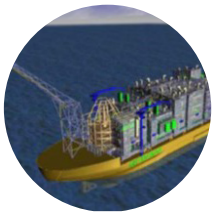
Intecsea's Construction Management personnel have experience working with contractors and operators in some of the most challenging and record setting projects in the world. This experience has allowed Intecsea's construction experts to garner advanced project delivery skills and specialized knowledge in a variety of areas; from early construction strategies through to construction management, production start-up and operational support.

Subsea Field Development

Numerous studies have been performed at Intecsea to develop potential subsea oil and gas production options addressing conceptual engineering and field layout of subsea wells, manifolds, and pipelines producing to a gravity based structure, a floating facility, or to shore. Intecsea also develops conceptual installation and construction execution methods and procedures, along with conceptual field development scheduling and cost estimating. This is done considering, among other factors, limited open water and seasonal ice cover. Activities also include the identification of operational risk and potential new technology applications pertinent to the project objectives.

Project Examples

Shtokman Phase 2 & 3 Pre-FEED and FEED



Customer:
Gazprom and Partners

Location:
Barents Sea, Russian Sector

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

Gazprom and its partners are planning the development of the Shtokman gas/condensate field in the Russian sector of the Barents Sea. The complete field is to be developed in three or more phases by means of subsea production systems tied back to floating production facilities. The produced gas will be conditioned onboard the production vessel and further transported to the Russian mainland via a subsea pipeline, where it will tie into the onshore transportation network. Intecsea/ Worley performed the pre-FEED, FEED designs and completed the Proyekt documentation package for the subsea production systems, the FPSOs, the export trunk lines and the FPSO disconnectable turret mooring systems.

Sakhalin I Development

Customer:
Exxon Neftegas Ltd

Location:
Sakhalin Island, Russia

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

The Sakhalin I project in eastern Russia has three offshore oil/gas fields in water depths of 15 to 37 meters (Chayvo, Odoptu, and Arkutun- Dagi). The Chayvo and Odoptu fields have seven (7) onshore and offshore pipelines. A 36-inch product line and a 24-inch gas re-injection line support production by connecting a gravity- based, offshore platform and an onshore wellsite to the onshore facilities. These lines extend 10 km offshore the eastern coast of Sakhalin Island and 10 km onshore. A 20-inch flowline, 8-inch water injection line, and 10-inch gas re- injection line support the onshore production. A 77 km, 12-inch onshore oil pipeline links the Odoptu and Chayvo fields. Sales oil is shipped through a 221 km, 24-inch oil export line to the Dekastri tanker loading terminal, on the Russian mainland. Intecsea was responsible for the Phase I FEED of the offshore pipelines and for owners engineering support during detailed design of the offshore pipelines during Phase I.

BP Alaska Northstar Pipeline Project

Customer:
BP Exploration Alaska

Location:
Northstar Oil Field, Alaska

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

Located in 37 feet of water, six miles offshore the Alaskan Beaufort Sea coast, this project was developed by expanding the exploratory gravel island to accommodate wells, production facilities, and living quarters. Produced oil is exported through a 10-inch pipeline to the Trans Alaska Pipeline System. This is the world's first offshore Arctic project to transport oil through a trenched subsea pipeline. The pipeline design utilized limit state, strain-based design criteria to meet the challenges of an Arctic environment and marginal field economics. Intecsea completed the design of the offshore and onshore pipelines, and supported BPXA from the concept phase on through start-up and operations.

Nikaitchuq Field Development

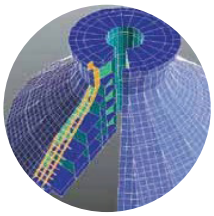
Customers:
Kerr-McGee Oil & Gas Corporation / Eni Petroleum

Location:
Beaufort Sea, Alaska

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

Similar to the Northstar and Oooguurk fields, the Nikaitchuq development consists of an offshore gravel island drillsite located in the Alaskan Beaufort Sea. The offshore gravel island drill center connects to the onshore facilities at Oliktok Point by subsea flowlines for transporting the three-phase production, diesel and injection water. The offshore flowlines were installed as a bundle, and the three-phase production flowline is a pipe-in-pipe system. This is the third successfully operating Alaskan Beaufort Sea subsea production line following Northstar and Oooguruk (also designed by Intecsea). Intecsea performed the pre-FEED and FEED designs for Kerr-McGee, and performed the detailed design, construction support and operational support for Eni Petroleum.

Steel Gravity-Based Structure



Customer:
Confidential

Location:
Alaksa

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

Preliminary and detailed design for an Arctic GBS structure was performed, including structure sizing and optimization, ice load calculations and analyses for various ice loading conditions using probabilistic methods, ice wall structural analyses/design and ice ride-up assessments, keel and skirt design, foundation analyses and design, and a review of acceptable installation and placement options for the specific location identified for the project. Work also included development of a program to optimize the global size of the GBS Platform for various environmental parameters, and a parametric study for ice walls designed using strain-based design criteria was performed.

Kashagan East Field Development Experimental

Customer:
Adip KCO

Location:
North-East Caspian Sea and Eskene, Kazakhstan

IDENTIFY | EVALUATE | DEFINE | EXECUTE | OPERATE

A joint venture between Worley and Fluor, with subcontractors Tecnomare and NIPIneftegas, (known as Kashagan Development Project Contractors), was awarded the conceptual design, FEED and Management Support Services (MSS) contract for the development of the first block of the East Kashagan Field Development, the first offshore project in Kazakhstan. The Kashagan field is the largest oilfield in the North Caspian Sea PSA contract area and is considered to be one of the largest hydrocarbon discoveries of the last 30 years worldwide.

Arctic Pipeline Standards and Technology

Customer:
Bureau of Safety and Environmental Enforcement (BSEE)

Location:
US Arctic, Alaska

IDENTIFY › EVALUATE › DEFINE › EXECUTE › OPERATE

Intecsea is routinely involved in Arctic design standards reviews and updates, and most recently performed a desktop study project titled Status of Arctic Pipeline Standards and Technology. This study provided a comprehensive review and gap analysis of Arctic Pipeline standards and presented information on advancements in pipeline design, installation, and operations, that may be applicable to an Arctic environment. Offshore pipelines in an Arctic or ice-covered environment face challenges different from traditional subsea pipeline design. This study provided an overview of what these challenges may entail, including unique environmental phenomena such as ice scour, strudel scouring and permafrost thaw subsidence, how they have been overcome in past projects, and technology advancements that may help with future developments. An assessment and gap analysis of the standards, codes and regulations were detailed and perceived gaps in regulations were presented. The comparison and suitability of single-walled pipe versus double-walled (pipe-in-pipe) systems was reviewed and details from current regulations provided.

Arctic R&D / Technology Development

Customers:
Numerous

Location:
Global

IDENTIFY › EVALUATE › DEFINE › EXECUTE › OPERATE

Designing and constructing an offshore pipeline in an Arctic environment has resulted in technology advancements in leak detection, sub-ice scour deformation prediction, ice-soil-pipeline interaction, statistics on return period loadings, statistical analysis of ice gouge phenomena, construction methodologies, GBS approaches/risers, repair methods and trenching methods. Intecsea has completed numerous studies on: offshore pipeline leak detection systems that can meet stringent Arctic requirements; sub-gouge deformation evaluations to be used for pipeline displacements due to seabed ice gouging; alternative offshore installation method evaluations for both summer and winter installations; GBS riser design studies on how a buried line can best transition to a riser on a GBS; review of repair methods for pipelines in Arctic waters; study on ways to reduce strudel scour risks to pipelines; advancement of ice gouge statistical analysis methods; and trenching studies for the Chukchi Sea, Beaufort Sea and the east coast of Canada to evaluate various pipeline trenching systems suited to Arctic and harsh environments.

As-built / Start-up / Operational Support

Customers:
BPXA / Pioneeer Natural Resources / Eni Petroleum / Caelus Energy

Location:
Beaufort Sea, Alaska

IDENTIFY › EVALUATE › DEFINE › EXECUTE › OPERATE

For each of the existing offshore developments in the Alaskan Beaufort Sea (Northstar, Oooguruk and Nikaitchuq), Intecsea has provided as-built, start up and operational support. Due to the potential for upheaval buckling, as-built assessments were completed using baseline mapping pig surveys to obtain an accurate pipeline profile. Each of these projects had their offshore pipelines installed during winter which necessitated a period of warm-up prior to full operation. Following start-up, evaluation of the pipeline profile was periodically required to evaluate potential risks to pipeline integrity. Intecsea has provided operational support for these projects including: periodic reviews of temperature sensing data, backfill elevations, shoreline expansion, pipe settlement, shoreline erosion, 3rd party load evaluations, corrosion assessments and remaining strength of corroded pipe, operational parameter change evaluations and wall thickness survey reviews. For the Nikaitchuq project, Intecsea also completed design, procurement and construction support activities for a unique and innovative pipeline repair to the pipe-in-pipe system.

Intecsea
Worley Group

intecsea.com

Find out more

Mike Paulin
1 Church Hill, 176 Suite 201
St. John's, NL A1B 3Z7
e: mike.paulin@intecsea.com
t: +1 (709) 749 3316

Duane DeGeer
575 N. Dairy Ashford, 5th Floor
Houston, TX 77079
e: duane.degeer@intecsea.com
t: +1 (281) 925 2386