

# AIOC Platform Full-Field Development Project



# AIOC Platform - Full-Field Development Project

## Background

Azeri-Chirag-Gunashli (ACG) celebrated its 25th anniversary in 2019, this is a very important milestone for the government, BP and ACG partners.

On 20th September 1994, the Government of Azerbaijan and a group of international oil companies representing eight countries signed the ACG Production Sharing Agreement, which later became known as the “Contract of the Century”. The contract was extended in September 2017 until mid-century.

It is with this contract that the massive developments, turning Azerbaijan once again into one of the world’s major energy suppliers and transforming the country’s economy, started.

The 25th anniversary marked an important milestone in the new history of Azerbaijan’s oil and gas industry. It is also a historical date for SOCAR, BP and all other partners in the Azeri-Chirag-Gunashli contract.

## Some Key ACG Facts:

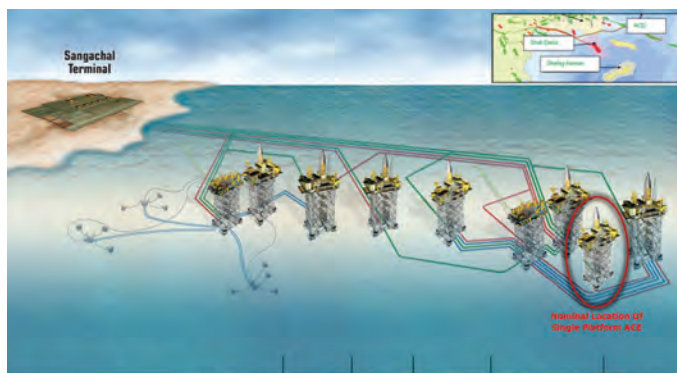
- From the start of production in November 1997 till the end of 2Q 2019, ACG produced about 488 million tonnes (more than 3.6 billion barrels) of oil.
- Around 3.3 billion barrels of ACG oil have been exported to world markets via the Baku-Tbilisi-Ceyhan pipeline.
- Since 2006, 4,300 tankers loaded with ACG oil have been lifted from the Ceyhan terminal.
- More than 44 billion cubic meters of associated gas were delivered to Azerbaijan since the start of production till the end of 2Q 2019.
- Capital expenditure in the ACG project by the end of 2Q 2019 was \$36 billion.
- From the start of ACG project in 1994 till the end of 2Q 2019, BP and its co-venturers spent around \$84 million on sustainable development projects in Azerbaijan.
- As part of the ACG project – one platform (Chirag 1) was renovated and seven new platforms were built, one of the largest oil and gas storage and processing terminals of the world was constructed, a sophisticated web of subsea pipelines was laid at the bottom of the Caspian Sea.
- At the end of the 2Q of 2019, 124 oil wells were producing, while 44 wells were used for water and 7 for gas injection.
- ACG has had excellent safety record and, as an environmentally sound project, it has conducted around 140 Environmental Impact Assessments and 266 offshore, onshore and near-shore monitoring surveys.

<b>Project</b>	ACG Full-Field Development Project, Baku, Azerbaijan
<b>Client</b>	Azerbaijan International Operating Company (AIOC) Operated by BP
<b>Installation date</b>	On going
<b>Pipe system</b>	Bondstrand™ Series 7000M and 3416 Conductive Pipe and fittings with Quick lock and Taper/Taper Adhesive-bonded joints Diameters: 25 to 750 mm (1 to 30 in.)

Operating conditions - Azeri Project Platforms			
Applications	Diameter range	Working pressure	Test pressure
<b>Firewater</b>	2 to 10 in.	15 bar	24 bar
<b>Seawater</b>	1 to 12 in.	15 bar	24 bar
<b>Cooling water</b>	2 to 30 in.	4 to 8 bar	24 bar
<b>Sewage and non-hazardous open drains</b>	1 to 8 in.	Atmospheric	Leak test
<b>Atmospheric vent</b>	1 to 8 in.	Atmospheric	Leak test
<b>Design temperature</b>	40°C (104°F) all systems except cooling water at 65°C (149°F)		



C&WP platform in production



ACG platforms

DWG Phase 3 Start Up 2006	West Chirag COP Start Up 2014	Chirag EOP Start Up 1997	West Azeri Phase 2 Start Up 2005	Central Azeri Phase 1 Start Up 2005	East Azeri Phase 2 Start Up 2006
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## AIOC Platform - Case Study

Azerbaijan, the oldest known oil producing region in the world, experienced an oil boom at the beginning of the 20th century and served as a major refining center in the former Soviet Union. Oil production peaked at about 500,000 barrels per day during World War II and then fell significantly after the 1950's as the Soviet Union redirected exploration resources elsewhere. Azerbaijan had 1.2 billion barrels of proven oil reserves, as well as enormous potential reserves in (yet) undeveloped offshore fields in the Caspian Sea.

The platform manufacturing project was carried out in two manufacturing sites located at the coast of the Caspian Sea, near Baku, the capital of Azerbaijan. One yard was 15 km from Baku, operated by ATA (joint venture ATA site) now AZFEN and the other site was situated 30 km from Baku, operated by McDermott (SPS site).

After completion, the platforms were shipped 120 km from the Azeri coast to their final destinations. Once in production, oil was conveyed to the Sangachal oil terminal outside of Baku. From that location, the oil was transported to Europe via the 1760 km Baku-Tbilisi-Ceyhan pipeline. This pipeline has a capacity of one million barrels a day and had the capacity for 10 million barrels of oil. In July 2006, the first Caspian oil arrived at Ceyhan at the Black Sea.

## Azeri project platforms

Bondstrand Series 7000M (quick-lock joint) was used for lines up to 4 in. (100 mm). This product can be used for pressure ratings up to 16 bar.

Bondstrand Series 2416C and 2420C (taper joint) was used for lines from 6 to 30 in. (150 to 750 mm) with a pressure rating of 16 bar. Both pipe series are electrically conductive and limit static electricity by connecting it to the ground. In explosive danger areas, such as platforms, this is an important safety concern.

All pipework was designed to the ISO 14692 specification. The firewater piping is L3 fire rated (wet piping). The dry deluge pipework in the process area is L3 fire rated plus 5 minutes dry, jet-fire rated.

This project spanned the change of seasons. During hot summer days, the pipe fitters were trained to be aware of the relative short pot life of the adhesive. During wet and cold winter days, the pipe fitters were required to preheat the bonding surface before beginning the bonding process.

The workshop for pipe fabrication of spools was an enclosed, conditioned area so no temperature or moisture influence affected the bonding of joints. The adhesive resin and hardener were stored in a conditioned room with a temperature varying between 18 and 24°C.

We worked collaboratively with KBR and BP for the supply, manufacture, technical review and project management of two Bondstrand GRE pipe series (Bondstrand 7000M and 2400C / 3400C) for 9 platforms in the ACG full field development and Shah Deniz stage 2 full field development, including; 4 platforms in the Azeri field; 2 platforms in the Guneshli field; 1 platform in the Chirag field; 2 platforms in the Shah Deniz field. In addition, 3 km of 24-inch pipe systems were installed for the water disposal line at the Sangachal oil terminal, and current platform BP ACE.

Both pipe series can be used for pressures up to 20 bar (test pressure was 30 bar) and design temperatures of 65°C. For the most recent

supply to BP ACE, the use of GRE composite pipe resulted in a weight saving of approximately **190 TONNES!**

We provided a resident engineer located at KBR offices (near London) for the duration of the design, to carry out piping layout verification and confirm compliance with the manufacturer's recommendations and project specification. Our engineers also aided in material take off (MTO) of specialist materials, specification preparation and technical support as well as providing stress analysis verification to UKOOA piping code. Other services included:

- Qualified personnel at the fabrication site to provide training and supervision
- Qualified design personnel for design calculations and isometric checks
- Reviewed the isometrics for fabrication, testing and fire protection



Installation of Bondstrand seawater line



Caspian Sea

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Bondstrand cooling water lines in service



Field joint of pipe spools



Flanges to connect to steel piping



12 in. Bondstrand firewater ring line



Over-wrapping of fire-protected spool with boat tape

### Pipe systems

To fulfill the demand of the dry deluge piping, Favuseal® mat was applied to the Bondstrand pipes. The spools were pressure tested to detect any leaks and then overwrapped in the following manner:

- 1 layer of Combimat (glass)
- 2 layers of Favuseal sheet
- 1 layer of boat tape (glass)
- The top layer was impregnated with a cold-curing, two-component epoxy resin.

An extensive test program was executed to prove the quality of the Bondstrand products for each platform. Numerous pipes and fittings were pressure tested according to ASTM D-1599. All tests were witnessed by Bureau Veritas. The total project was comprised of 30,000 m of Bondstrand pipe with diameters in sizes 2 to 30 in. (50 to 750 mm) and approximately 32,000 fittings and more than 4,000 pipe spools were prefabricated.

# AIOC Platform - Full-Field Development Project

Traceability - All pipe fitters were required to complete the following information on a form related to joints and materials:

- Pipe fitter's badge number
- Joints on spool drawings were numbered and the number of the joint was recorded on the traceability form.
- Batch number of the adhesive was noted on the form.
- The unique FGS pipe and fitting ID codes were noted on the spool drawing and traceability form.

## Spool manufacturing

Spool manufacturing was a major part of this project. The GRE piping systems for the first platform (Central Azeri) were completely prefabricated in the Netherlands by Amerplastics BV in Terneuzen. These pipe spools were transported to the site in wooden crates and the first Bondstrand spools arrived in Baku in 2003.

The spools for the other five platforms were prefabricated in a workshop set up locally in Baku. The main advantages of setting up spool prefabrication on site, were related to the ability to modify spools to site requirements and implement design changes that weren't in the original layout of the project. This lowered the cost of transporting the spools and improved the flexibility overall of work and planning.

The workshop consisted of the following areas:

- An area for cutting and shaving, keeping noise and dust away from the main work area.
- An area for bonding and applying Favuseal to the spools.
- A testing area for spools.
- A climate-controlled area for storing adhesive, resin, hardener, keys, and O-rings.
- An office for administration and drawing storage.

## Joining systems

Quick-lock adhesive-bonded joints are used for pressure ratings up to 20 bar (depending on size). Spigots (male end) are cylindrical; bell ends (female end) are slightly conical with a pipe-stop inside.

For the ACG project the quick-lock joint was used for pipe sizes 2 to 4 in. (50 to 100 mm). For larger diameters the taper joint was preferred, as this joint withstands dynamic loadings like pressure surges much better.

Taper/taper adhesive-bonded joints are used for pressure ratings up to 75 bar (depending on wall thickness and pipe size). Available pipe sizes are 2 to 40 in. (50 to 1000 mm). Both the spigots and the bell ends are tapered.

For the ACG project the taper/taper joint was used for pipe sizes 6 to 30 in. (150 to 750 mm).

Flanged joints are used to connect pipelines to pumps, valves, tanks, and other equipment. Flanges are available in both quick-lock and taper/taper configuration.

Only Van Stone (stub-end) flanges were used for the ACG. These flanges have the advantage of a loose steel flange ring, enabling easy installation.



Installation of spool



Spool building



Pipe shaver to shave pipe spigot

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## The following design aspects had to be considered during material selection of the pipe systems:

- The platforms are designed for a minimum lifetime of 25 years
- The air in the Caspian area is relatively salty
- No build-up of electricity is allowed inside the pipe systems, as explosive gases could be present

## Bondstrand pipe systems were selected because of the following advantages:

- Easy to handle, resulting in low installation costs
- Designed for a minimum lifetime of 25 years' service
- Non-corrosive
- Maintenance free
- Conductive, no static electricity is built up



Crossing of Several Pipe Systems

## Azeri Central East (ACE) platforms

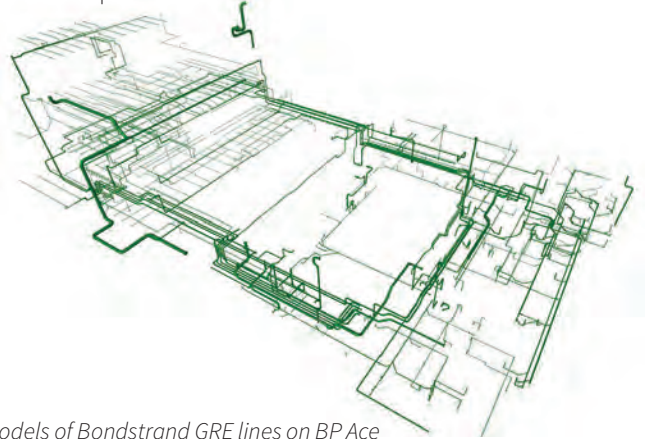
The ACE platforms are located between the existing Central Azeri and East Azeri platforms, situated in water depth of approximately 140m. The field is being developed in five phases known as Early Oil Project (EOP), ACG Phases one, two and three, and Chirag Oil Project (COP). Work began in 2019, and is due for completion in 2023, with the platform in operation until 2049.

The topsides drilling facility engineering, procurement and construction supervision contract, was awarded to NOV Rig Technologies. Work began in 2019, and is due for completion in 2023, with the platform in operation until 2049, and will produce over 300 million barrels of oil in its lifetime.

The ACE project includes the construction of a production, drilling, quarters (PDQ) platform.

Currently we have supplied 7500m of Bondstrand GRE piping for the sodium hypochlorite solution, open hazardous drains, sanitary drains, atmospheric vents, cooling water, fire-fighting water, portable water and sea water on the BP ACE platform. All due for installation in 2020-2021.

We have also provided engineering and design services, as well as carrying out design assistance and verification of both the isometrics and stress analysis. We are also conducting calculations for the quantities of support saddles required, adhesive quantities and Favuseal requirements.



Models of Bondstrand GRE lines on BP Ace

We are also designing, manufacturing and supplying Bondstrand phenolic FRP (Fiber Reinforced Polymer) structural components for the Topside and Jacket on the Azeri Central East project, due to their low-weight, and corrosion resistant properties, including:

- Approx. 600m MARRS™ (Multi Angular Rapid Railing System) offshore handrails complete with FRP ladders, with safety cages and safety gates, staircases, and grating
- Custom engineered drag chain
- Windwalls
- Working access platforms
- Other associated access structures (mud gutters, trough)

Our FRP structures are 70% lighter than metallic equivalents, drastically reducing overall topside weight. In total, our structures resulted in a weight saving of **140 tonnes!**

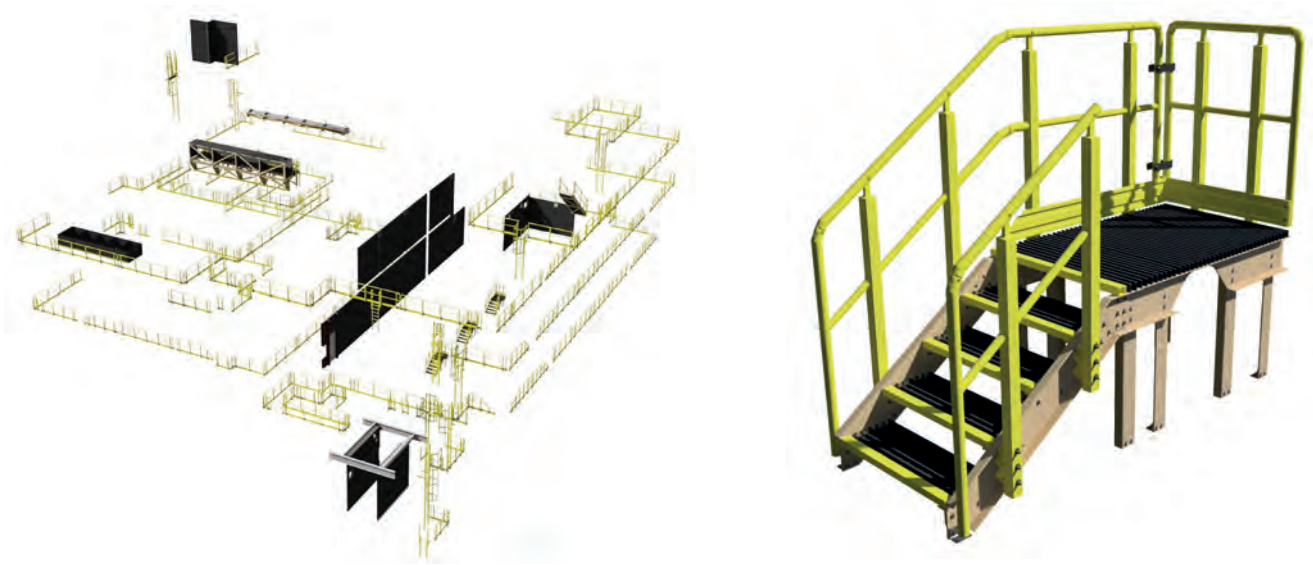
The total Bondstrand piping and structures weight saving is **330 tonnes!**



Hop up platform with MARRS handrails and FRP grating.

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*Designed and engineered in house, approx. 600m of MARRS offshore handrails and associated FRP access structures.*



*The Azeri Central East (ACE) project is part of the development in the Azeri, Chirag and Deepwater Gunashli (ACG) Contract.*

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