BJ Process and Pipeline Services

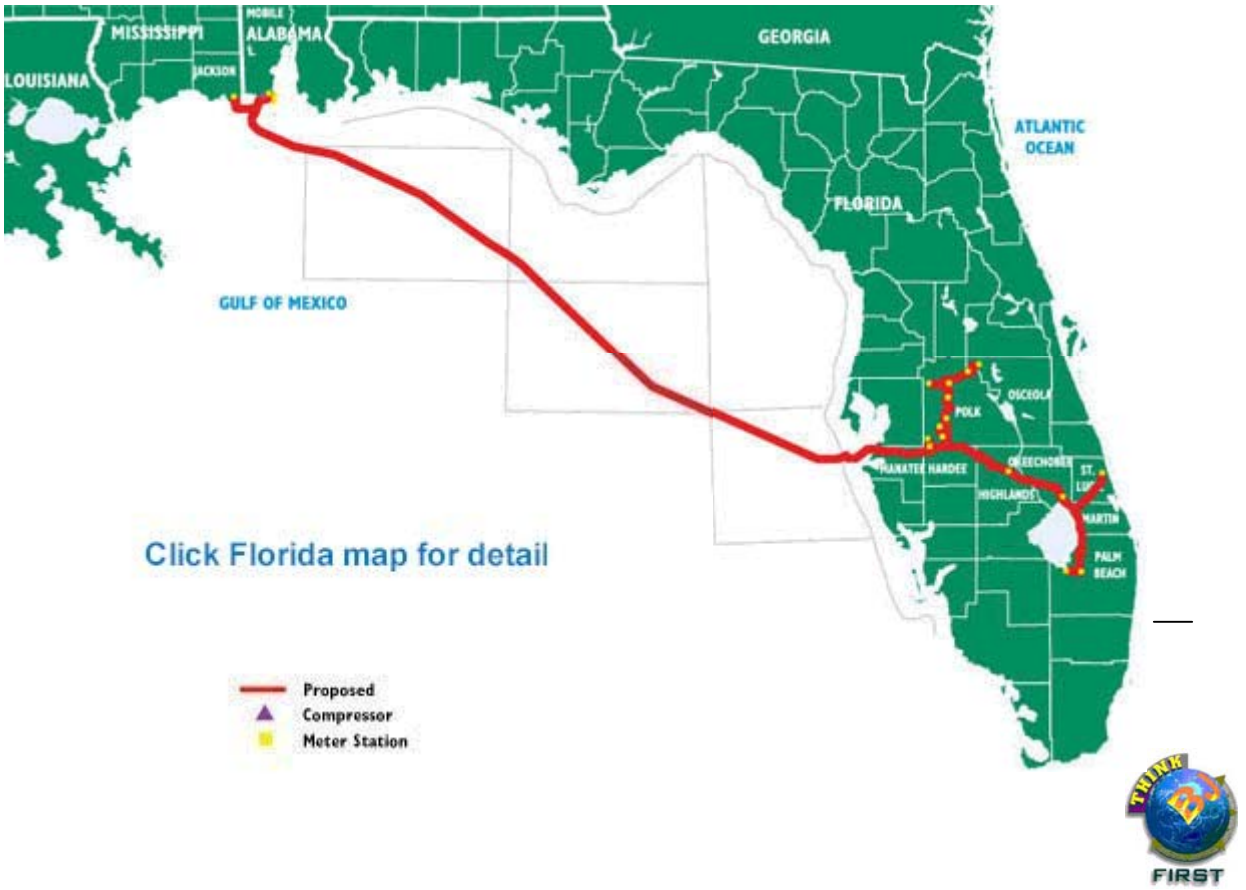
Gulfstream Pipeline Precommissioning

Following several years of detailed engineering and design, the pre-commissioning of the Gulfstream pipeline culminated in an industry leading achievement utilizing the air-drying technique to dry the pipeline in only five and a half days.

During the course of April 2002, Stolt Offshore completed the arduous task of installing 442 miles of 36" pipeline in coastal and federal waters offshore Gulf of Mexico. The pipeline system originates from a supply meter station at Pascagoula, Mississippi, then traverses the state waters of Mississippi making landfall in the close proximity of Coden, Alabama. The main trunk line then proceeds offshore in a southeasterly direction across the Gulf of Mexico making landfall in Manatee County, Florida. The gas transmission pipeline is designed to transport dry processed natural gas from onshore processing facilities located in Coden, Alabama to onshore Florida markets.

In September 2001 BJ Process and Pipeline Services were awarded a multi-million dollar contract to carry out the filling & hydrostatic testing operations, which was subsequently followed by the award of the dewatering and drying contract in March 2002.

This article is intended to illustrate the engineering challenges encountered by BJ Process and Pipeline Services during the pre-commissioning activities on such a major pipeline project.



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Project Overview

Pipeline filling required the introduction of seawater filtered to 50 micron and chemically treated with a biocide at a dosage rate of 200 PPM. This medium was then used to propel a combination of bi-directional gauge and foam disc pigs within each pipeline section at a pig velocity of 1 to 3 ft/sec.

Following gauge plate acceptance, the specification required that the entire system be subjected to a hydrostatic test hold period of 8 hours. The acceptance criteria called for no loss in pressure during the hold period, irrespective of temperature, tidal and/or barometric fluctuations.

Upon hydrostatic test acceptance, and mechanical completion of the entire pipeline system, the specification required that the pipeline be dewatered and dried to a dewpoint of -45°F.

Federal discharge regulations dictated that chemically neutralized water could only be discharged at specific offshore locations, thus complicating the dewatering process. To facilitate this a hydrogen peroxide injection spread was located at the pipeline discharge point to neutralize all biocide within the seawater prior to overboarding.

Pigging of the pipeline was further complicated during the dewatering & drying phases due to the presence of a Y-piece and check valve assembly.

Challenges

As with all offshore projects, weather down time can have a detrimental impact on project schedule. This is a major concern for all parties involved. In an attempt to alleviate such concerns a jack up vessel was employed as the main platform for offshore flooding & hydrotesting operations.

The jack-up was fraught with its own unique challenges. Limited deck space and an operating elevation of 40ft complicated the installation of a filling spread capable of filtering, chemically treating and boosting 6,000 gallons per minute of seawater.

THINK FIRST

Addressing these challenges, BJ Process and Pipeline Services designed and built a self-supporting basket assembly that could hold five electric submersible pumps. Each pump had the capacity to deliver 3,500 gallons of seawater per minute to the pumping spread onboard the jack-up vessel. As well as supporting the submersible pumps, this basket assembly was designed to protect the pumps from adverse weather conditions and also be sufficiently robust to prevent potential collisions with the jack-up legs.

Given the confines of available deck space, a complex labyrinth of pump manifolds and hard pipe were fabricated to optimize pump-spread efficiency and equipment lay down area.

The filling spread was designed to deliver approximately 6,500 gallons per minute of chemically treated seawater filtered to 50 micron at a discharge pressure of 550 Psig. This comprised of three low head boost pumps each capable of producing 3,800 gpm; force feeding an 8,000 gpm self-cleaning filter unit. Filtered seawater was then passed through a 12” flow meter, electronically linked to a biocide chemical injection pump and additive skid. The injection package controlled the addition of biocide as flow rates fluctuated throughout the pumping operation. Chemically treated, filtered seawater was then supplied to a series of multi-stage high-pressure centrifugal pumps discharging at pressures ranging between 100 to 550 Psig. The delivery of the fill medium to the subsea pig launcher was then carried out via an 8” flexible hose.

The composition of the spread in terms of the suction & filtration remained unchanged for hydrostatic testing operations. A simple retrofit of the high-pressure multi stage pumps with BJ positive displacement pumps ensured a smooth transition between operations. The resulting spread facilitated a pressurization rate of 1 Psig per minute for the main 392-mile test section with 100% redundancy in the event of mechanical breakdown.

Given schedule constraints it was deemed necessary to simultaneously test & monitor pressure / temperature readings at five independent locations. In conjunction with these operations mobilisation of the dewatering and drying spread commenced in Alabama.

Dewatering & drying

From the outset the dewatering design philosophy was based on an average pig velocity of 1.5ft/sec, this in effect dictated a program of 15 days. As time was of the essence a last minute acceleration program was put in place to attain a velocity of 2ft/sec resulting in a 3-day reduction in schedule.

Notice to proceed with the acceleration program was granted 14 days prior to the event. A resourceful team of dedicated PPS engineers and considerable support from alliance partners secured equipment from all corners of the continental USA. Collaboration between BJ PPS and partners secured and mobilized a primary super dry air spread with a rated capacity of 52,500 scfm / 350 Psig at a dewpoint of -90°F. In addition, a combination of various rated capacity booster compressors with a total output of 37,500 scfm / 720 Psig completed what we believe to be the worlds largest dewatering spread employed to date.

Industry standards for carbon steel pipelines assume a residual water film of 0.1mm following an effective dewatering pig train. It is our educated experience that this water film can be reduced to 0.05mm in coated pipelines. As a result the premise of our engineering philosophy was to design a pig train that would reduce this water film even further. A combination of historical in-house data and software simulation resulted in a pig train design consisting of eight articulated bi-directional, high sealing, high performance “Diprane 1200 plus” polyurethane pigs. These pigs were specifically designed to accommodate various internal diameter changes, check valves and Y-piece assemblies. Further consideration was also given to the axial tensions and loads that maybe encountered in a worst-case scenario on the articulated joints. As such, extensive bench tests and quality assurance checks were conducted to ensure an axial load of 50 tons could be applied without damage to the articulated joints.

The pig train configuration was designed such that sufficient potable water slugs were encapsulated between a number of pigs thus ensuring that all salt deposits were removed from the pipe wall effectively. Residual salts can have a detrimental effect on drying times due to water entrapment within the deposits.

Given the pipeline profile and the numerous valve and Y-piece locations within the system careful consideration was given to the length of the air slugs between the rear pigs. This gave sufficient time to allow water to drain back into the main air stream behind the desalination slugs, thus allowing the rear part of the pig train to contain and sweep the residual water from the line.

The Operation

On completion of pig launch, 42 primary air compressors, 4 air drying units and 16 booster compressors were simultaneously brought online. Continuous operation, for a period of seven days, culminated in the injection of 281 mmscf of compressed super dry air. Based on real time data and

assessment of dynamic forces it was concluded that sufficient potential energy had been stored placing the lead pig at milepost 240. This in turn allowed the pig train to traverse the remaining 152 miles without further injection of air. At this predetermined mile post all compressors, air dryers and boosters were shut down.

Federal regulations required that all chemically treated water had to be neutralized prior to being dumped overboard. As described earlier, the fill medium was inhibited with biocide. Continuous analysis of the hydrogen peroxide dosage rate and its effect on the neutralization process dictated a hold period prior to discharge. This resulted in the utilization of the DLB-801's ballast tanks allowing for a fifteen-minute hydrogen peroxide reaction time. The treated fill medium was discharged into the 1,000,000-gallon ballast tank capacity at a rate ranging between 4,000 – 10,000 gallons per minute. Neutralization was carried out by introduction of hydrogen peroxide by means of a fully automated computer controlled chemical treatment facility. Following the necessary reaction time, neutralized water was then discharged overboard by means of a series of low head lift pumps. Hydrogen peroxide dosage rates ranged from 160 PPM to 720 PPM during the discharge of approximately 120,000,000 gallons of treated seawater. Analytical chemists onboard the vessel determined dosage adjustment based on remaining active constituent.

The condition of the pigs on arrival and the lack of residual water at the rear of the train gave strong indications that the pig train had performed an exceptional job.

Throughout the course of detailed engineering our philosophy was to minimize the residual water film. Critical to this minimization was the introduction of super dry air during the dewatering phase and the subsequent venting process that ensued upon pig receipt. During dewatering this super dry air had become fully saturated with water, which was subsequently removed during the venting operation. An effective venting operation, from a pressure of 290 psig reduced the residual water film that had to be removed in the subsequent drying phase.

Air Drying

A typical air-drying spread for a 36” line would require approximately 12,000scfm of super dry compressed air based on a pipeline length of about 100 miles. In this case, the length was in excess of four times a standard drying section.

Consideration was given to the anticipated gaseous phase mixture of water vapor and dry air; that fluctuate due to local flow variations, non-homogenous heat transfer and phase exchanges resulting from pipeline profile and pressure variations. Based on over 30 years of drying experience and field data collated from BJ PPS project archives this resulted in an air spread suitably sized to dry a pipeline of this magnitude. Further increase in the size of the spread would not have had a significant impact on reducing the drying time.

Environmental

Due to federal and state regulations, stringent environmental policies were enforced at all locations along the pipeline corridor. Emphasis was placed on a zero discharge edict as both noise and soil pollution would have a detrimental impact on wildlife and their natural habitats.

Our environmental conscience and strict adherence to federal and state regulations as well as corporate policies, ensured that all necessary precautions were in place and emergency response teams on alert during critical activities.

Conclusion

The aim of this article has been to provide an overview of the technical and logistical difficulties posed by a project of this size, and an insight into how BJ PPS solved these problems.

Last minute specification changes which required us to successfully engineer and mobilize both equipment & personnel within a constrained time frame, bears tribute to our resourcefulness and adaptability to change. This culminated in the largest super dry compressed air spread ever assembled in the USA. A considerable logistical feat in itself this was then successfully applied to dry 424 miles of 36” pipeline to -54°F dewpoint in a record 5.5 days!

Leading the way in pipeline pre-commissioning solutions throughout the world, BJ-PPS continues to provide industry-leading solutions to the ever-changing oil & gas market.