

# dimensions



## INTERNATIONAL

# SEISMIC

PUSHING THE  
**BOUNDARIES**  
IN FRONTIER  
**EXPLORATION**



# 2

## Seismic: pushing the boundaries in frontier exploration

More than seven decades after the Dammam Well No. 7 breakthrough, Saudi Aramco's ability to determine what lies beneath the subsurface has taken a quantum leap thanks to emerging technologies.



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## After long hiatus young Saudis bring Zuluf GOSP-3 back online

Commitment of a dedicated team and supporting organizations allows plant to be successfully resurrected following a 21-year gap in production.



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## Building the first booster gas compressor station facilities in the Kingdom

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### About the cover:

This 65-ton truck has the ability to release a steel plated vibration platform that is attached to its chassis into the ground, causing seismic waves that deliver raw data to geologists — making it the safest proven energy seismic source for information gathering and knowledge accumulation.

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# SEISMIC

PUSHING THE  
**BOUNDARIES**  
IN FRONTIER  
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Turayqa is home to Seismo-76, a crew of approximately 900. The 24-hour operation is just one of 10 seismic crews across the Kingdom operating under direction from Saudi Aramco's Geophysical Data Acquisition Division.

BY JAMSHEED M. DIN  
PHOTOS BY BRIGIDO D. ALCAYDE

WHEN THE EARLY PIONEERS  
SET FOOT IN SAUDI ARABIA IN  
THE 1930s, THEIR MISSION WAS  
SIMPLE: EXPLORE FOR OIL. THOSE  
EARLY YEARS WERE FRAUGHT  
WITH HOPE AND DISAPPOINTMENT  
IN EQUAL MEASURE – BUT  
PERSISTENCY PAID OFF.





*Top:* An early seismic crew works near Abu Hadriya, circa 1939. The employee in the foreground is planting an S-10 seismometer weighing 10 pounds, which was considered an improvement over what was used in 1930 when S-2 seismometers weighed 30 pounds. Continued advancements and emerging technologies over time have drastically changed the Exploration landscape.

*Above:* Solar panels are used to help power operations in Turayqa. Chinwike Jeremiah, a seismic crew supervisor with GDAD, shows visiting GDAD team members how the solar panels are utilized.

**T**heir refusal to throw in the towel when the odds were stacked against them resulted in a breakthrough at Dammam Well No. 7, which along with subsequent discoveries, formed the opening chapters of the ever-evolving Saudi Aramco story.

Seven decades later, hydrocarbon exploration continues in the Kingdom — exploring, it seems, is weaved into the company’s DNA.

But the methods now deployed for oil and gas exploration are a world away from those that were known to the early explorers.

Nothing demonstrates this better than seismic operations, and as expected, Saudi Aramco, through its Geophysical Data Acquisition Division (GDAD), is at the forefront.

It’s a dynamic operation that pushes the frontiers on all levels; human and technological.

“These are exciting times to be in exploration,” noted Saleh A. Al Maghlouth, manager of the Exploration Operations Department.

“We are exploring from North to South and from East to West and our GDAD team is at the heart of this. The development of the technology in seismic over the last few years is truly mind-boggling and amazing.”

In every sense of the word, seismic technology is quite literally, earth moving.

## Quantum leap

It’s a colossal sight. The 65-ton vibrator truck stands deceptively motionless in the desert sand. It is preparing to release a steel-plated vibration platform that is attached to its chassis into the ground below. When the plate lands, it begins vibrating, causing a barely felt shake in the area around the truck.

The location is Turayqa, deep in the Rub’ al Khali (the Empty Quarter), an eight-hour road trip from Dhahran.

GDAD chief geophysicist Turki Al Ghamdi (center) with members of his team as they discuss seismic operations. From left are Van Do, Zuhair Al Amri and Fuad Al-Somali.

This is about as remote as it gets.

The resultant seismic waves created by the vibrations are the raw data that forms the core of Saudi Aramco's seismic operations. The vibrator truck is the safest proven energy seismic source.

This is not how Max Steineke and company explored for oil. Right up until the 1970s, geologists would rely upon the structure of the outer surface in exploration zones to gauge the possibility of hydrocarbon traps below.

"They drilled in areas where they approximated," noted GDAD chief geophysicist Turki Al Ghamdi. "Even with Dammam Well No. 7, they almost gave up. But with developments in seismic, the risks in drilling and finding nothing have been reduced significantly."

In the decades following the 1970s, due in no small part to seismic technology, there has been something of a quantum leap in our understanding of what lies beneath in the subsurface.

Seismic technology uses acoustic waves generated by vibrations to collect information and data. The gleaned information from the acoustic waves offers a window into the world of the subsurface — a dream for geologists in bygone eras.

As a result, across the Kingdom seismic crews are busy working around the clock in the quest to recover hydrocarbon reserves that remain dormant beneath the Kingdom's surface.



Seismic opens the door for exploration on a scale and in a time frame that a few decades ago would have been wholly impossible.

## In the middle of nowhere

The sun has barely risen in Turayqa and already there is a flurry of activity in the camp. Jeeps are being revved up and equipment is being loaded.

Turayqa is home to Seismo-76 — a seismic crew of approximately 900. It is just one of 10 crews operating under the instructions and guidance of GDAD.

As the day shift are preparing to head to the field, their colleagues on the night shift are heading to their sleeping quarters — a full night's work behind them. This is a 24-hour operation.

Here, in this apparently barren desert land, a massive exploration operation is currently underway. This is unexplored territory for Saudi Aramco — true frontier exploration. The crew are miles from life, yet paradoxically, their operations are monitored and guided by GDAD in Dhahran. As with many instances in modern life, technology makes distance seem irrelevant.

"We collaborate closely with the team on the ground," said Hussain Al-Ghanim, a geoscientist with GDAD. "We supply the ground crew with the coordinates and parameters for seismic exploration and they begin their work. Our job is to make sure we receive the highest quality data possible from the field."

The location of the 10 Kingdomwide seismic crews is anything but random. Like pieces on a chess

On a daily basis, seismic data is transmitted to GDAD in Dhahran for further analysis.



# TAKING CARE OF SAFETY AND THE ENVIRONMENT

Seismic crews across the Kingdom are operating in a vast array of differing terrain, from the Rub' al-Khali to the Red Sea, and all that lies in between. But one feature is consistent: no matter where the location, there is no compromise on safety.

For Sadeq Al-Jubran, GDAD's Health, Safety and Environment (HSE) adviser, it means ensuring seismic crews adhere strictly to Saudi Aramco's HSE policies.

"At every project we identify the top five hazards on-site," explained Al-Jubran. "We have projects in the middle of the desert, close to communities — we have to control the hazards."

In Turayqa, one such hazard is transportation. Each day, seismic teams leave the camp as they carry out their daily activities in an operations area that spans 15,400 km<sup>2</sup> in size, with no mobile phone reception. Each time a vehicle leaves the camp, it must follow strict journey management procedures that include being logged into a vehicle tracking system. In a nutshell, whoever leaves the camp must be trackable.

The crews are also required to submit comprehensive HSE plans that must be verified and approved. Beside Saudi Aramco crew supervisors, HSE teams visit the

10 crews periodically to ensure strict adherence. The system works and the crews, wherever they are, take it seriously. In some cases, they have even reached 8 million man-hours without a lost-time injury.

Along with safety, environmental protection is always at the forefront of any company operation, with seismic being no different. All 10 seismic crews are mandated to follow GDAD's and Saudi Aramco's rigorous wastewater treatment procedures through a sewage treatment plant. Sanitary wastewater and sewage systems for effluents are to be reused as irrigation water or dust abatement in unrestricted areas.

The trucking of sanitary wastewater from the point of generation to appropriate sewage treatment plants is also closely monitored and must comply with Saudi Aramco's Hazardous Waste Code.

"There is always room for improvement," noted Al-Jubran. "We make sure they (the crews) are in compliance to GDAD standards. Our rigorous inspection means that even if we find anything, we see the crews implement the recommendations speedily."

One such example is medical evacuation. Turayqa's remote location means that

the nearest medical hub for evacuations are the Shaybah Producing facilities.

According to industry standards, access to a tier-three hospital from remote areas must be within four hours.

Emergency drills in the area showed that the quickest time to get the injured to the required medical care was seven hours. For Saudi Aramco, this would not do.

Plans were put forward by GDAD for an aircraft to be sourced to service the area.

An aircraft capable of landing in the challenging environment was hired. Now based in Turayqa, the medevac aircraft is ready on standby for any emergency evacuation — sparing workers at the site from the grueling long car journey.

"We got the approval from management and then got in touch with the aviation team. This was a joint effort by both Exploration and Drilling," said Fuad Al-Somali, who led the medevac aircraft provision effort. "Turayqa is a very remote area and if someone is in distress or pain, every minute counts. Now we have three flights a week for those who are working there — saving them the travel by road, and the aircraft is stationed at Turayqa ready to evacuate if needed at any time."





*Above:* At Turayqa, the crew is exploring an area that measures some 15,400 km<sup>2</sup>. The area is acquired by more than 50,000 “strings” that contain nine geophones each — nearly half a million geophones.  
*Right:* Saleh A. Al-Maghlouth notes that since 2005, there has been a 2,500-fold increase in the data generated by seismic operations.

board, they are positioned and moved with strategy and planning. And with GDAD in support, the crews are far from being alone.

“Our job is to manage the day-to-day tasks of the crew. We are the interface between the crew and the proponent,” said Zuhair Al Amri, group leader of field operations at GDAD. “We monitor the daily data production, health, safety, and environment activities, and mobilization ... we also receive the daily reports from the crews. Every day is different and things are not static or routine. We are using the latest technology and this is exciting.”

The loop goes like this: Geologists examine 2-D imaging of a suspected hydrocarbon trap. The results are positive, although far from conclusive, but justify the next stage: 3-D seismic exploration. GDAD is contacted and maps the coordinates and parameters of the exploration area after extensive planning and location analysis. A proposal is created and shared with the seismic team that deploys to the proposed exploration area.

Seismic testing now begins to gain a deeper understanding of the structure of the subsurface. Complex data is transmitted





*Left: The vibrator trucks place steel-plated vibration platforms onto the ground to cause seismic waves. Below: GDAD HSE adviser Sadeq Al-Jubran spends much of his time visiting seismic operations across the Kingdom ensuring strict adherence to company HSE policies.*



to GDAD on a daily basis, who work with other teams across Exploration to process and interpret the 3-D seismic data. The loop is now complete.

## State-of-the-art technology

The leaps in technology that facilitate seismic testing are phenomenal. At Turayqa, the crew is exploring an area that measures some 15,400 square kilometers (km<sup>2</sup>) — a staggering size. The area is acquired by more than 50,000 “strings” that contain nine geophones each — nearly half a million geophones — the conduits for transmitting the seismic data. This is transmitted through fiber optic cables reaching

more than 4,000 km in length. So advanced is the technology that if at any point a cable is cut or damaged, the data will reroute itself to another cable. The data is fed through multiple frequency channels; previously there were only 24 channels available to pick up the seismic frequencies. Today, Saudi Aramco seismic operations have access to more than 50,000 channels.

In addition, thanks to simultaneous “shooting” of vibration points, data that would have previously taken 15 to 20 years to collate can now be consolidated in two to three years.

“In 2004, we would do around 2,500 shots a day,” noted Al-Ghanim. “But now, thanks to simultaneous shooting, we can do 14,000 shots per day.”

The “shots” that Al-Ghanim refers to are sound waves that are picked up by the strategically placed geophones in the exploration area. The geophones send the sound waves to data collection trucks stationed at the exploration site.

All action from the field is done in real time with extensive quality control systems in place to ensure that data reaching Dhahran is as accurate as possible. In Turayqa, a quality control center filters the data received via the data trucks stationed at the exploration site.

As a result, three terabytes of data — the equivalent of 3,000 gigabytes — is sent daily to GDAD for analysis and quality control.

It is this data that serves as the roadmap for searching for hydrocarbon traps, serving as the eyes to the underworld.

## Economic sense

“Seismic is important for the company as it prevents us from drilling unproductive wells,” noted Chinwike Jeremiah, a seismic crew supervisor with GDAD. “It allows us to identify traps.”

Previous exploration methods could prove costly, with drilling rigs often sent to exploration sites without truly knowing the structure of the subsurface below. Now, drilling rigs are brought in only after extensive seismic data collection — significantly increasing the likelihood of hydrocarbons being found.

“Seismic takes a snapshot of the image over a wide area of the subsurface, which could give rise to several wells. If you bring in a rig without seismic it is like drilling blind — you lose money. Seismic allows drilling to target and get it right — there is no guarantee still, but it gives very strong indications,” added Jeremiah.

But with the varying terrains across the Kingdom come varying challenges.

“You are given an area to explore and don’t know the terrain,” he explained. “It can be very difficult, like the Shaybah sand dunes. But you can’t have it all — if you do seismic in a city environment the logistics are easier — but you have the problem of noise.”

Whatever the terrain, the data produced by seismic opera-

tions has changed the game in exploration. Wider areas can now be mapped in record time. And as the technology improves, so does the quality of the data.

“Seismic has evolved tremendously mainly due to the contributions of theoretical geophysics,” said Al-Maghlouth. “Due to sophisticated mathematical formulas and digitization, now we can image at the foot level as opposed to hundreds of feet. This helps us to further streamline our interpretation of data making drilling more cost-effective and efficient.”

In fact, Al-Maghlouth explains that since 2005 there has been a 2,500-fold increase in the data generated by seismic operations. This increase requires teams from across the Exploration organization to be at the top of their game.

The GDAD team works with the Exploration Computer Center, which provides the computing capability to process the data. All of the processing and analysis of data is done in-house, with company scientists even developing their own algorithms to solve complex data challenges.

## Staying at the forefront

And as seismic technology continues to advance, GDAD is ensuring Saudi Aramco remains at the forefront.

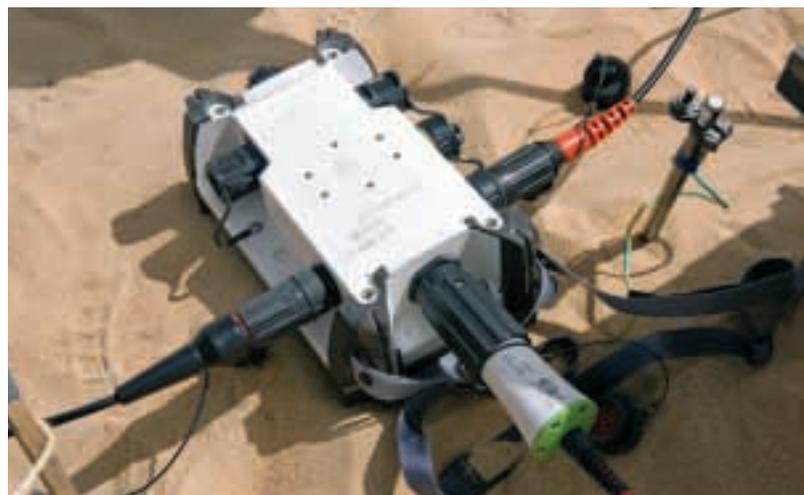
“We design the field parameters to image the geological targets in a survey,” noted Fuad Al-Somali, GDAD Technical Support group leader. “We also ensure that we have

*Right:* The CX 508 is a cross line unit that collects data from a number of Field Digital Units (FDUs) and transmits it to the recorder. *Below:* Vibrator trucks take their place in the desert as they carry out seismic operations.

the latest available technology in the most efficient way. All of our land 3-D crews are high channel, high productivity crews with around 50,000 operational channels. We are always on the search for new and better technologies. We have continuous discussions with industry leaders to test new concepts and technologies.”

Al-Ghanim added, “Seismic is exciting and challenging, and each day the technology is evolving and developing. One thing is for sure, at Saudi Aramco we will always be at the forefront when it comes to seismic technology.”

Saudi Arabia has been blessed with an abundance of hydrocarbon reserves, and under the guardianship of Saudi Aramco, exploration continues — it’s the heart of the Saudi Aramco story. 🌐



AFTER LONG HIATUS  
YOUNG  
SAUDIS BRING

# ZULUF GOSP-3

⚓  
BACK ONLINE



**WRITTEN BY**  
ADIL A. AL-SADIQ

**PHOTOS BY**  
HASAN ALMUBARAK

## Working day and night, a group of diligent employees in the relatively deep waters of the Arabian Gulf recently, and successfully, demothballed the Zuluf Gas-Oil Separation Plant 3 (GOSP-3) after several months of hard work on the plant's platforms.

### RESUMPTION OF OPERATIONS AFTER 21 YEARS

As part of Saudi Aramco's continuous efforts to manage the Kingdom's resources for maximum value, the company suspended GOSP-3 in 1995, as there was low demand for Arabian Medium crude oil at the time. But some two decades later as part of the same efforts, company management determined that the plant should be demothballed.

Led by a team from the Safaniyah Offshore Producing Department (SOFPD), GOSP-3 was recently brought back online after a 21-year hiatus of operations in the Zuluf field, which was discovered in 1965.

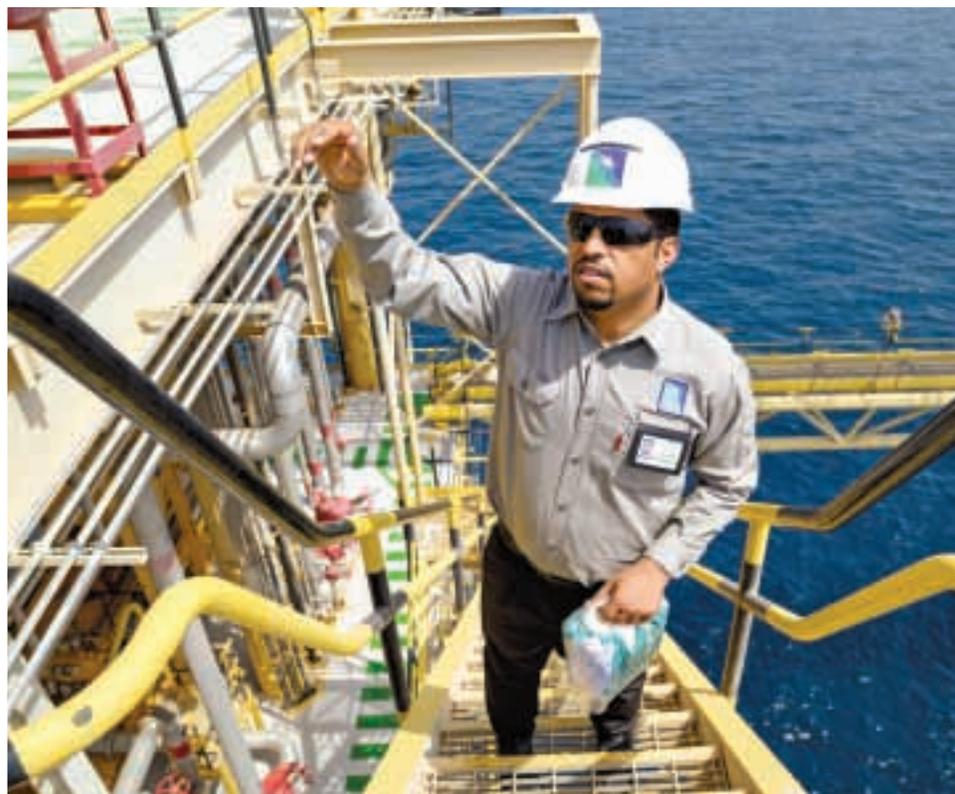
In July 2016, when the company's management decided to demothball the plant, SOFPD formed a team to carry out the project. After a thorough study and evaluation of GOSP-3, which included an inspection of equipment, pipes, and utility

services, it was determined that weather conditions in the harsh marine environment of the Gulf had made it economically disadvantageous to simply bring the existing GOSP back online. Much of the equipment, instruments, and devices on the GOSP had rusted out and become unfit for operation.

With this in mind, SOFPD went to work in August 2016 to demothball the plant with a goal of completing the project in 12 months. "The plan was drawn up to achieve work of the highest quality in the shortest time possible and at the least cost," said Khalid M. Al Khalb, SOFPD manager.

However, a growing demand for oil prompted the department to expedite the project's execution. In response, it increased the number of workers, supporting the team with marine vessels, boats, and maintenance barges. Still committed to the usual highly disciplined approach and commitment to the highest standards of safety and quality, work continued around-the-clock to complete the project and meet the company's needs.

*Left: Abdullah A. Al-Salam watches closely the activity of his group from Saudi Aramco Maintenance Barge No. 1 on Zuluf GOSP-3. Right: Saleh A. Al-Shahrani walks up the stairs to follow up on his required tasks on the Zuluf GOSP-3 platform, where the gas is separated from the oil and then pumped to Berri and Safaniyah.*





Ali H. Al-Janabi, *below*, monitors operations through a set of gauges, and Hussain M. Al Ibrahim, *left*, opens a valve aboard Zulfu GOSP-3. The two are among dozens of young employees responsible for the operation of the offshore plant in the waters of the Arabian Gulf.



“To ensure the quality of control and operation, we inspected and repaired more than 1,700 instrument loops for the emergency control and shut-off system. We also efficiently rebuilt all service utilities, including energy, air, and water systems using our internal resources,” Al-Salam said. “We also repaired and reconfigured the fire protection system and gas and smoke detection systems in view of our concern for the safety of the employees and properties.”

Meanwhile, the team also renovated the residential platform and provided all services at the plant to ensure that the workers were living in a conducive environment. This included printing operation manuals and providing lessons to operators — along with help from the training unit in Tanajib — to ensure safety, above all else.

In the end, efforts such as these helped the team bring GOSP-3 back online by May 19, 2017 — four months ahead of schedule. And the plant continues to carry out its work — separating gas from oil and pumping it to Safaniyah onshore plants for further processing.

Al Khalb commended the support of senior and executive management, as well as the help of other divisions in the Northern Area Oil Operations departments and other company support organizations.

Among these departments were Aviation, Marine Operations, Loss Prevention, and Inspection, as well as others. “They all demonstrated a team spirit throughout the period of execution with their eagerness to meet the needs of the local and world markets. The project was completed ahead of schedule with the least cost and with no work-related injuries. The highest standards of safety, environment protection, and operational excellence were observed in keeping with the company’s vision,” he said.

## SAFETY AND SUPPORT

Abdullah A. Al-Salam, a senior operation adviser for SOFPD, noted that Saudi Aramco Maintenance Barge No. 1 at GOSP-3 was among those at the ready to provide the needed support to meet the needs of the plant, and the company. Working diligently to help maintain and repair equipment and pipes for the plant with cooperation from the Mechanical Services Shops Department in Dhahran, the team managed to repair more than 35 motors, pumps, and 2,200 valves as part of its role on the project.

## PRODUCING SAFELY

Salah A. Al-Shahrani, operations foreman at GOSP-3, first worked as an operator at GOSP-3 before becoming a unit head and operations foreman.

Like others on GOSP-3, Al-Shahrani is part of a team that helps separate gas from oil, and with normal pumping, sends 140,000 barrels of crude oil per day to Safaniyah onshore plants for further processing. When needed, they can pump 250,000 barrels per day (bpd).

All of Zuluf's four GOSPs produce about 700,000 bpd. If pumps are operated, production can rise to 800,000 bpd — among the world's highest production rates for an offshore plant.

Saudi Aramco makes safety a priority in all of its facilities and plants. In accordance, operators at GOSP-3 must take specific measures during their 12-hour shifts. Operators are responsible for all equipment, instruments, and devices at the facility. A worker, even if he is a Maintenance Division employee, can only start work after obtaining relevant work permits and licenses. Each shift is manned by six employees, including the head of the group, an employee in the control room to monitor all operations, and four operators.

The plant itself is designed for safety, as well. Huge escape survival capsules are located outside the control room — each a rescue boat that can carry 50 people to safety in case of emergency.

## TEAMWORK

Al-Salam, an electrical engineer, began working for the company in 2005. He first worked in the Safaniyah Onshore Producing Department before moving to SOFfPD.

Al-Salam says working and living on the marine platforms is very challenging to the employees, especially those who worked to demothball GOSP-3. With residential platforms rising five stories — two for housing and three for support services and each story able to house as many as 100 employees, conditions are amenable.

The huge employee residential platform consists of two stories with 44 rooms each. About 65 employees currently work at GOSP-3. Huge pumps and tanks of desalinated water for drinking, bathing, washing, and cooking are available on the platforms. There are also tanks for firefighting water and foam.

Fire safety is critical in such quarters. Firefighting instruments, devices, and equipment are located throughout the facility. In case of a fire, alarms go off automatically, with

various alarms throughout the facilities with an individual sound for different kinds of emergencies.

Environmental safety is important, too. A flaring system uses atmospheric pressure to burn off gases released from safety valves and gas discharge lines that cannot be discharged into the air due to their impact on the environment. These are considered a safe method for burning gases, protecting workers, equipment, and the environment.

Working with a competent team of 48 workers (24 operators, 20 maintenance technicians, and four engineers) on this important project helped make it easier to work, Al-Salam noted.

## HIGH ABOVE THE GULF, FAR FROM SHORE

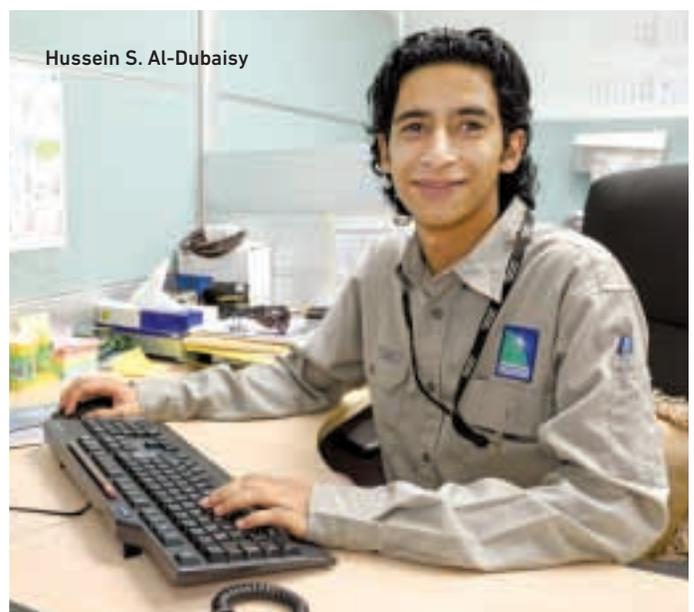
Employees move from one platform to another by using ladders with as many as 1,000 rungs, and then an iron bridge from which they can see the blue water beneath. The platform is 65



Sabree A. Al-Medah



Khalid M. Al Khalb



Hussein S. Al-Dubaisy

# Facts and Figures FOR Zuluf GOSP-3

- ➔ Built in 1983.
- ➔ Operated in 1994.
- ➔ Tested and inspected in 1994.
- ➔ Closed in 1995.
- ➔ Decision to demothball was made in July 2016 to increase oil and gas production to meet market needs.
- ➔ Demothballed in May 2017 after six months of continuous work.
- ➔ The team comprised 48 employees — 24 operators, 20 maintenance technicians, and four engineers.
- ➔ The residential platform consists of five stories, two for housing and three for support services.
- ➔ The area of each story is approximately 750 m<sup>2</sup>.
- ➔ The housing accommodates 100 employees.
- ➔ The capacity of the plant is 250,000 barrels of oil and 100 million standard cubic feet of gas per day.

meters above sea level; the depth of the water is 50 meters.

The nature of work here requires much walking and climbing. To climb to the production platform, one must ascend three levels of ladders. On the second level, huge pumps push oil to Safaniyah onshore.

## THE HEART OF OPERATIONS

The control room is the throbbing heart of the plant. Turki S. Al-Sharari works in the control room as an oil and gas operator, notes the work is simultaneously significant and sensitive. Following up on his work on multiple computer screens, Al-Sharari finds his work interesting.

His colleague, Ali H. Al-Janabi, works as an operator and safety officer. He was passionately involved in the demothballing of the plant, which provided him significant experience.

Dhaifallah A. Al-Ghamdi, a shift supervisor at the control room, said he decided to join Saudi Aramco because it was a great opportunity. In his current role, Al-Ghamdi has many obligations to his team, including close follow up of work, maintenance and equipment, instruments and devices, and ensuring implementation of safety standards and the training of young colleagues.

Al-Ghamdi says he feels rewarded by the challenges of work, including the speed and accuracy needed for the completion of work, thinking outside of the box, and good practices to find solutions to technical problems.

Hussain M. Al Ibrahim first worked at Zuluf's GOSP-2 before moving on to GOSP-3. He focuses on his work of monitoring pipelines and the work of contractors and takes care of safety tools, working in the control room when needed. An adviser in the control room, Al Ibrahim said he likes his work because he is serving his homeland through increasing energy production needed throughout the Kingdom.

Ali H. Al-Janabi, Hussain M. Al Ibrahim, Ahmad D. Al-Khalidi, and Dhaifallah A. Al-Ghamdi, standing, join Turki S. Al-Sharari working in the control room at Zuluf GOSP-3, which is commonly called the "throbbing heart of the plant."



Large orange emergency boats hang high above the Gulf — each able to carry 50 people to safety in the event of an emergency.





Above: Nasir A. Al-Ojaimi (right) supervises a maintenance activity as part of his job at Zuluf. Left: Maintenance boats such as these provide critical services for the GOSP and the equipment at the plant.



## MONITORING MACHINES, INSTRUMENTS, AND MORE

Ahmad D. Al-Khalidi is a deputy shift supervisor who monitors operations inside and outside the control room. He also works in the field with instruments, devices and equipment, monitoring all things related to safety measures and recording any violations.

Al-Khalidi can judge the condition of equipment, instruments, and devices by simply looking at them and hearing the sound they make. The crux of his work is to verify the dynamism and safety of equipment and devices.

“Safety is a top priority for us that we cannot overlook. High quality production is also at the crux of our work,” said Al-Khalidi, whose work in Knowledge Transfer requires accurate information to be delivered efficiently to his colleagues.

Ahmad M. Asiri came to work at Saudi Aramco about a year ago. An operator in the field overseeing inspection of tools and equipment, Asiri’s critical task is to immediately inform his supervisor whenever a technical fault is identified.

Not everyone monitors machines; some monitor people and locations. Sabree A. Al-Medah is one of them, as he works for Industrial Security. Moving about the platform, his smile never seems to leave his face.

Al-Medah started working for Saudi Aramco on Sept. 23, 1990 — a date he recalls with pride as it coincides with Saudi National Day. He has been working at GOSP-3 for four months. Working alertly to maintain the safety of the plant, and more importantly, the company’s human resources, Al-Medah notes that his tasks are conducted in coordination with the control room. He and his colleague Fahd Al-Enzi are responsible for the safety of all.

### THE IMPORTANCE OF WORK PERMITS

Maintenance work includes activities that require the use of huge machines. These operations are carried out by specialized employees with advanced skills, including Nasir A. Al-Ojaimi, Offshore Maintenance Services Boats supervisor. Al-Ojaimi said they receive maintenance requests from operation divisions and work permits — without which they cannot work.

A control room employee accompanies maintenance workers to monitor their work from the moment of their arrival until their determination of the type of technical fault and the actual repair. After completing the repair, the head of the Maintenance Division, who is accompanied by an inspector from the Inspection Department, ensures the work is carried out in a correct and safe manner.

Employees move from one platform to another by using ladders and an iron bridge, which stands about 65 meters above sea level.



The production platform contains a wide array of large facilities and machines for receiving and oil separation.

### OVERCOME CHALLENGES

Hussein S. Al-Dubaisy works as maintenance planner for SOFPD. He participated in the demothballing project as a maintenance officer. Al-Dubaisy must review all materials that enter or leave the plant. He also prepares procurement orders and follows them up step by step until their delivery.

Like all those who have participated in the Zuluf GOSP-3 demothballing project, Al-Dubaisy is proud to have put in hard work and overcome significant challenges in meeting company goals, responding to the call of duty of the Kingdom and the need to deliver more energy. 🌐

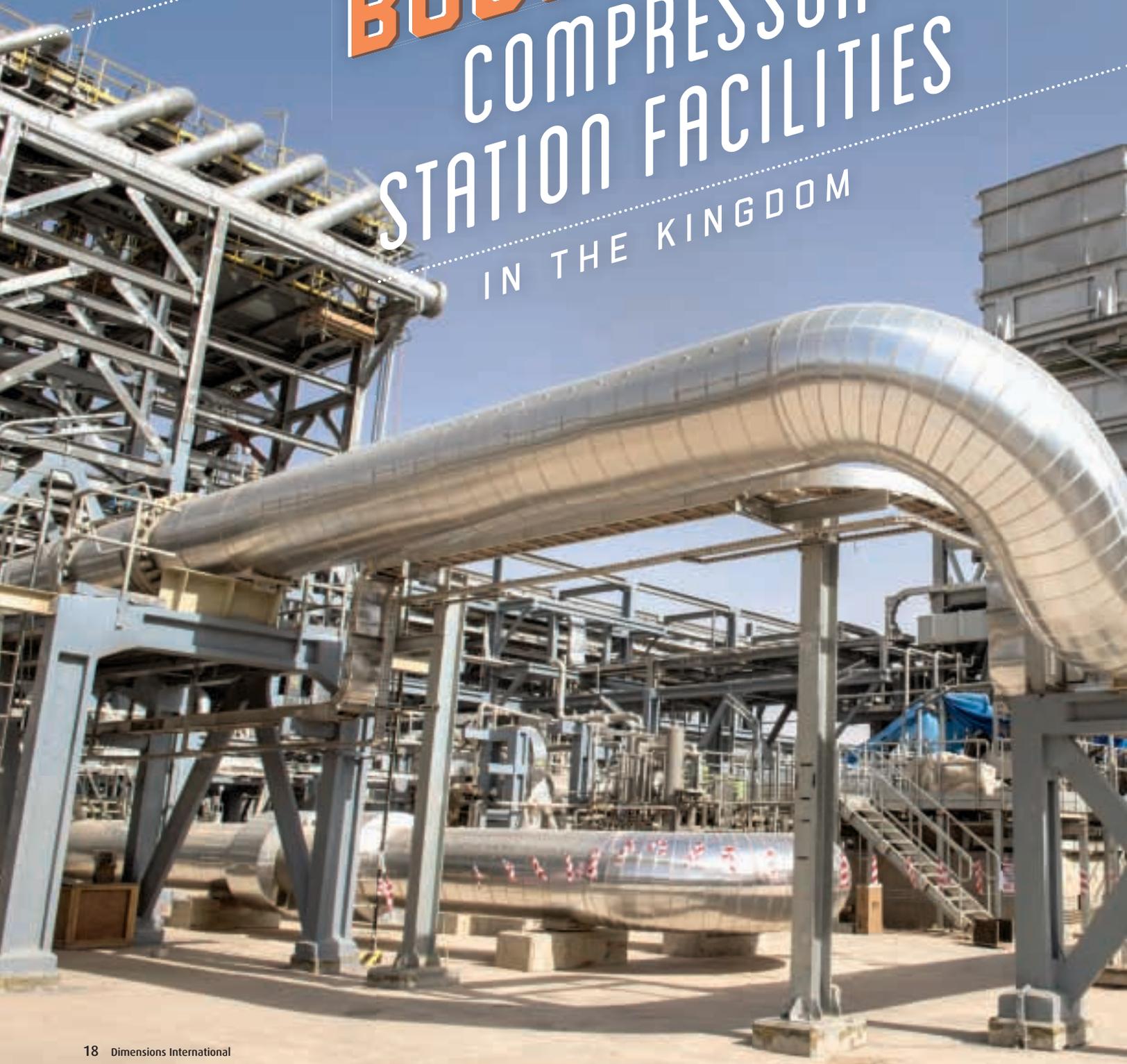


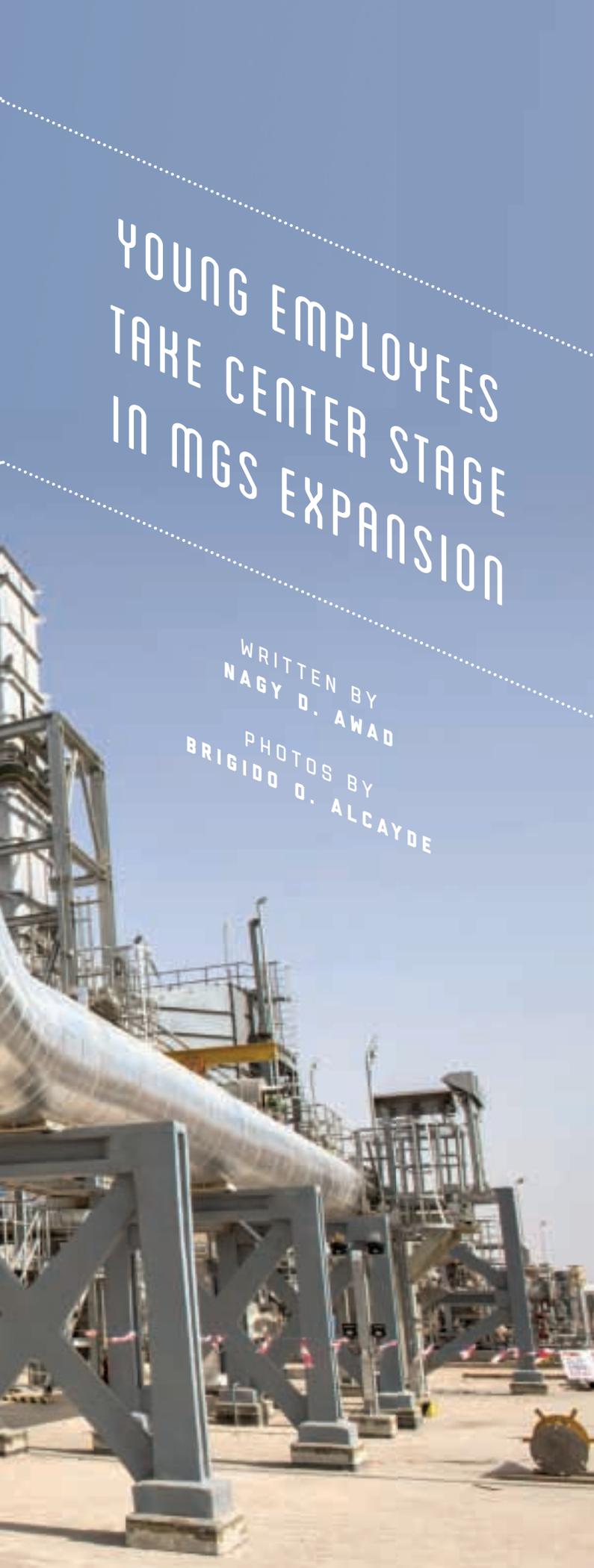
BUILDING THE FIRST

# BOOSTER GAS

COMPRESSOR  
STATION FACILITIES

IN THE KINGDOM





# YOUNG EMPLOYEES TAKE CENTER STAGE IN MGS EXPANSION

WRITTEN BY  
NAGY D. AWAD  
PHOTOS BY  
BRIGIDO O. ALCAYDE

**IN THE HEART OF THE DESERT, AND CLOSE TO PUMP STATION 3, WHICH IS ONLY 100 KILOMETERS (KM) FROM RIYADH, THERE IS A STORY WORTH TELLING — A STORY WHOSE HEROES ARE YOUNG SAUDIS WORKING AT SAUDI ARAMCO FACILITIES WHO ARE INVOLVED WITH THE IMPORTANT ACHIEVEMENT OF BUILDING THE FIRST TWO BOOSTER COMPRESSOR STATIONS IN THE KINGDOM.**

**T**hese are the first in a series of stations that will lead to a breakthrough and help meet the rapidly increasing demand for natural gas in the Kingdom. They will also reduce the demand for crude oil and its use in power generation, as well as promote environmental conservation through the use of natural gas as a clean fuel.

## PRESENT SITUATION

Domestic natural gas demand has been increasing, driven mainly by the facilities and industrial sectors. To meet this demand, the company has adopted a two-phase plan to expand the Master Gas System (MGS). The first phase will be completed by the end of 2017, increasing the capacity of the MGS to 9.6 billion standard cubic feet per day (Bscfd). The second phase will bring that

The company has launched a two-phase Master Gas System (MGS) expansion program. The capacity of the MGS would rise to 9.6 Bscfd upon completion of the first phase, by the end of 2017. The second phase will witness increasing the power of the MGS to 12.5 Bscfd by the end of 2019.



*Left to right, top to bottom:* 1. Mansour A. Al-Jamaan: "Working at the booster compressor project near Pump Station 3, close to Riyadh, has given me additional experience that would have taken years to gain." 2. Fahad F. Al-Rashid: "The project area that you see now was a desert, but we managed to turn it to a busy work field thanks to the devoted efforts and encouragement by management." 3. Ahmad Al-Daghestani: "Project administration believes in youth and their ability to produce results and this is why management trusted and helped them realize such achievements." 4. Thiyab M. Al-Oufi: "I consider this project my real beginning as an engineer. We have a mix of experienced youth and others who are working for the first time on such a mega-project."

capacity up to 12.5 Bscfd in 2019.

The first phase was accelerated to meet the scheduled commissioning date of the Rabigh II Independent Power Plant (Rabigh-2 IPP) at the beginning of this year to avoid burning high-valued liquid fuels.

## PROJECT SCOPE

The project includes the installation of 960 km of 56-inch pipelines. The pipeline project includes mainline valve stations, scraper-launcher and receiver facilities, hot tap installations with jumpovers, black powder filters, and custody metering facilities.

The scope also includes two booster compressor stations at East-West Pump Stations 3 and 5, which include major inlet and outlet piping, black powder filters, gas meters, multiple compressor units, and outlet gas coolers. Buildings will house gas measurement instruments, a compressor and drive unit, as well as control rooms and operations.

## WHY THIS PROJECT IS IMPORTANT

The main objective of this vital project is to maintain business continuity and fulfill demand, as the project will enable the company to meet its commitment to supply sales gas to King Abdullah Economic City (KAEC) and Rabigh-2 Integrated Power Plant (IPP). The project will also boost the Kingdom's economy by displacing the burning of crude oil with sales gas.

Sales gas will be pumped to the power plant through the MGS pipelines, and will be measured and purified from impurities inside the power plant facilities before being compressed in a single phase to increase gas pressure. Then, the compressed gas will be cooled before being measured and re-pumped to the MGS pipelines.

## A STORY WORTH TELLING

Perhaps the most striking aspect of this project is who makes up the majority of construction work supervisors: young people. It is a remarkable sign of the energy, competency, and



Saleh Al-Wadie: "One of the project initiatives was the agreement that we made with the contractor, a Chinese firm, to recruit Saudi youth who graduated from Chinese universities to be the linking point between us."

confidence of a new generation of leaders.

In the beginning, Mohamed Manzouri, an engineer on the project, said, "Most construction work supervisors since the beginning of the project have been young people. Although some of them are fresh graduates working on their first project ever, completion rates are outstanding across all project areas. These young men follow up work progress with contractors on a daily basis, and we discuss work and share experiences every day."

Fahad F. Al-Rashid, who is in charge of completing the

mechanical works of the project, says, "We started this project from scratch. All the area that you see now was a desert, but we managed to turn it to a busy work field thanks to the devoted efforts and encouragement by the management."

As for the nature of the mechanical work that he performs, Al-Rashid says, "We are now finishing work on the Black Powder Unit; a unit where impure gas is passed through 12 purification cycles, and then through another filter."

"We have more than 90 Saudi Aramco engineers here. Our role is to enhance communication between all project stakeholders, whether that be the contractor, operators or Saudi Aramco management. We work 12 hours a day without ever feeling tired or overworked, because we always keep our eyes on the ultimate objective — the accomplishment of a huge project that will contribute to our country's development."

### MY REAL BEGINNING AS AN ENGINEER"

Thiyab M. Al-Oufi, an assistant engineer, supervises the Utilities and Electrical Unit on the project. He stressed that since his first day at work, the project administration put their trust in him and asked him to supervise the creation of this unit despite being his first project.

Mohamed Manzouri: "Although most construction work supervisors since the beginning of the project were young people, all work areas have record achievement rates."





Above: The project site at the beginning of construction work. The main goal of the project is to fulfill the rising gas demand of the Kingdom. Left: Saudi Aramco has launched a two-phase Master Gas System expansion program.

“I am eager to take part in this project. I consider it my real beginning as an engineer. We have a mix of experienced youth and others who are working for the first time on such a mega-project,” Al-Oufi said.

Ahmad Daghestani, a contract consultant, says the project administration believes in youth and their ability to produce results and this is why the administration trusted and helped them realize such achievements. Most of the construction work has been fulfilled ahead of schedule, and the Saudization rate is high in all project phases.



The project will help maintain business continuity and fulfill gas demand as it enables the company to meet its commitment to supply sales gas to the King Abdullah Economic City and Rabigh-2 IPP. The project will also enhance the Kingdom's economic growth by displacing the burning of crude oil with sales gas.

Mansour A. Al-Jamaan works in the Nitrogen Unit. He says the role of the unit is to extract nitrogen from the atmosphere and store it to be used in the station. Al-Jamaan sees this station project as an amazing opportunity, since it has given him additional experience in a short time that he could not have obtained in many years.

## LINKING THE EAST AND WEST

The acting project manager, Saleh Al-Wadie, explained the details of achievements in the project by saying, “This project is one of the strategic transformation projects in the Kingdom that targets displacing oil with gas, and linking the Kingdom’s East and West Coasts through the MGS. It will save more than \$500,000 worth of crude oil that would have been burned to generate power. This is the first time in the history of Saudi Aramco that we have established booster gas compressor station facilities.

“Thanks to the efforts of the citizens of this generous country, and with accurate follow up by the leadership, this project was awarded an international prize from the Construction Industry Institute in Orlando, Florida, before its

completion,” said Al-Wadie.

Al-Wadie added that the real hallmarks behind this achievement are teamwork, responsibility, and the exchange of knowledge.

“Although 90% of workers have less than two years of experience, and 17 of the new hires have joined the project only one year ago, we put them at the heart of the work and put our trust in them. In return, they have innovated and made this achievement possible. We gave powers to young people, under supervision of the administration, and made sure that they were able to overcome challenges. We now have a complete generation of young people who can manage a big project on their own; this is an achievement in itself to be added to our big achievements,” Al-Wadie said.

“One of the project initiatives was the agreement that we made with the contractor, a Chinese firm, to recruit all Saudi youth who graduated from Chinese universities, to be the linking point between us. We also translated the *Saudi Aramco Safety Handbook* into Chinese to be used by the contractor workers, to ensure that everyone applies safety laws and regulations. This was already achieved by completing 11 million hours of work without any workplace injuries reported.” 🌐

# UAVs TAKE FLIGHT FOR EXPLORATIONISTS



An unmanned aerial vehicle (UAV) in action acquiring high resolution images of the outcrop.



Fly view mode while following the planned path of the drone flight.

The search for oil and gas requires geologists and explorationists to conduct studies on outcrops of rock layers that hold hydrocarbons. Understanding the characteristics of such layers is essential in assessing their potential to hold and produce oil and gas.

There are many difficulties that explorationists face in the field. Accessing steep, rocky outcrops in remote sections of the desert to analyze and chart the structure in pursuit of new hydrocarbon deposits is challenging and physically takes time. The formations are also often hazardous to access or climb.

To eliminate such difficulties and reduce man-hours spent in the field, researchers from the Geological Technical Services Division (GTT) of Saudi Aramco's Exploration and Petroleum Engineering Center – Advanced Research Center (EXPEC ARC) have been developing a new concept and are now sending unmanned aerial vehicles (UAVs) to conduct “virtual geological field trips.” These UAVs will easily glide over and more accurately document challenging geological features and terrain. Bringing a “virtual” outcrop to the

office and working with it on a computer screen is a dream that has come true.

## REDUCING TIME IN THE FIELD

EXPEC ARC conducted the first field trip to the Lidam area — west of Dhahran along the Riyadh Highway — to trial test the new concept. About 5,000 aerial photos were acquired covering the entire outcrop (300 m × 50 m). Despite difficult weather conditions (rain, wind, turbulence),



A hexa drone with a high-resolution camera attached to the drone's gimbal, which allows it to move in different directions; and a GPS system on the top (white color) to accurately give the coordinates of each image captured while the drone flies over the flight path.



An acquisition control person and support personal for pilot assistance are needed to safely perform a flight. *Below:* Using the Polygonal Data Reconstruction process where the software acquires photos and positions them.

a resolution of 0.25 mm per pixel was achieved in some vertical sections. “Vertical sections” are how geologists describe outcrops of rock vertically from the bottom (oldest) to the top (youngest). Two half-day missions were needed to achieve this first milestone.

“This mission would have taken over two days and required more people by the conventional method of acquiring several geological measured sections and would not have provided us the detailed results of the UAV’s capabilities,” said Salem H. Al Shammari, GTT geological consultant and project leader. “This technology definitely saves us time and effort and will become quicker after a few more trials.”

Using the UAV enables geologists to track geobodies,

describe changes on facies both laterally and vertically, and interpret depositional settings. “Geobodies” are the geological shape and volumes of sediments and their relations with the units above, below and the lateral changes. “Facies” is a body of rock (formation) that is characterized by its formation, appearance, and composition.

The outcrop tested is part of the Tertiary age — about 20 million years old — section of interbedded sandstone, marl, and limestone units.

“We are building high resolution digital models of the outcrops from the UAV photos using photogrammetry techniques and can interact with these models directly from our offices using standard workstations,” said Mokhles B. Mezghani, GTT Multiscale Geological Modeling focus area champion. “The technology is truly cost saving and more accurate.”

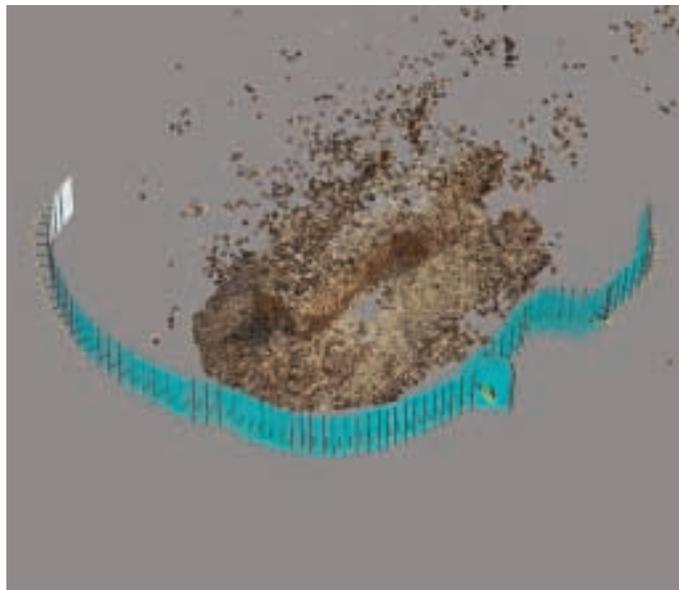
As part of the field trial and deployment stages, the team is developing processes and procedures for the safe and accurate field use of the UAV as well as guidelines for building, manipulating, and analyzing the models.

## BUSINESS IMPACT

“The novel application has significant business impact,” said Maher I. Marhoon, GTT chief technologist, “which we plan to fully implement to improve geological analysis for our Exploration customers and training for Saudi Aramco earth scientists.”

The UAVs improve several areas:

- Safety — Geologists can safely and remotely navigate the UAV to acquire close-range photos of unsafe areas, e.g., cliffs, karsts, etc.
- Accuracy — Geologists are able to extract a complete





to Saudi Aramco’s upstream business challenges.”

The next expansive stage for this EXPEC ARC technology development is in collaboration with the eMap Division/ Remote Sensing Services group of the Support Business Applications Department to locate specific minerals, e.g., bentonite, barite, etc., used in Saudi Aramco drilling operations.

high resolution — up to mm scale — vertical section from any location in the outcrop by using the digital model.

- Effectiveness — Geologists can easily interact with the digital model to extract more vertical sections, or to focus on a specific area of the outcrop without any need to physically revisit the outcrop.
- Reduced operating cost — Fewer people are required, therefore, travel time and cost are reduced.

“This new technique will revolutionize the way we conduct aspects of our field work,” said Ali A. Al-Meshari, EXPEC ARC manager, “and illustrates how our researchers strive to deliver creative and effective technology solutions

In addition to the high-resolution digital camera (images and live videos), other tools and sensors can be attached to the UAV for various purposes, e.g., hyperspectral sensors, which are required in identifying the properties of minerals.

“Once this technology is deployed, it will open a highly advantageous window of field mapping for our explorationists, greatly facilitating how they conduct their field work,” said Al Shammari. 🌐

*Above: A 3D digital reconstruction of the outcrop compiling all UAV photos: half of the image is with mesh and the other half without (not an actual single photo). Below: The UAV’s sensors and remote control devices are tested prior to the flight for optimum image acquisition.*



# abbrev.

Saudi Aramco news in brief



Participants in the “Downstream Manufacturing Opportunities in Saudi Arabia” forum in Seoul, South Korea, ask questions about Sadara Chemical Company in Jubail.

## Kingdom opens investment chances to Korean businesses

**SEOUL, SOUTH KOREA** — Nearly 40 Korean companies and 100 participants attended the “Downstream Manufacturing Opportunities in Saudi Arabia” forum in Seoul, South Korea, as a way to promote investment opportunities in Saudi Arabia.

Organized by Aramco Asia-Korea (AAK) in collaboration with Sadara Chemical Company, the Royal Commission for Jubail and Yanbu’ (RCJY), and the Saudi Arabian Industrial Investments Company, the forum was designed to brief Korean industries and government representatives on

the rapidly changing business environment in the Kingdom of Saudi Arabia and ways to capture business opportunities in the region.

Korean petro-chemical companies, small- and medium-sized enterprises related to Sadara

downstream and conversion industries, venture companies, and government associates were among the attendees.

After the forum, AAK arranged individual meetings for Sadara and RCJY and six Korean companies that have shown initial interest to review potential investment opportunities within Sadara downstream and conversion industries.

Individual one-on-one meetings covered in-depth discussions of potential investment cases by exchanging the initial

idea of potential investment plan and the detailed information on the Sadara value chain and infrastructure of RCJY.

## Ground broken for Saudi Aramco–Norinco Refining, Petrochemical and Retail Project

**PANJIN, LIAONING, CHINA** — Saudi Aramco, China North Industries Corporation (Norinco), and Panjin Xincheng Industrial Group Co. Ltd. signed a joint development agreement and held a groundbreaking ceremony for the Saudi Aramco-Norinco Refining, Petrochemical and Retail Project in Panjin, in northeast China’s Liaoning province.

HE Khalid A. Al-Falih, Minister of Energy, Industry and Mineral Resources and Chairman of the Saudi Aramco Board of Directors, attended the ceremony where Saudi Aramco and Norinco signed an agreement to pave the way for a joint development agreement to build a refining, chemicals, and retail network in Panjin. Al-Falih was in Beijing to participate in the Belt and Road Forum for International Cooperation.

Later on-site in Panjin, Abdulaziz M. Al-Judaimi, senior vice president of Downstream at Saudi Aramco, attended a groundbreaking event, which was also attended by Yin Jiaxu, chairman of Norinco Group; and Zhang Lei, Liaoning executive deputy governor; Nabil A. Al-Nuaim,

Abdulaziz M. Al-Judaimi and Zhao Gang, both sitting, sign the “Norinco and Saudi Aramco Joint Framework Agreement on Refining, Petrochemical, and Retail Project” in Beijing in the presence of HE Khalid A. Al-Falih and Yin Jiaxu, Chairman of Norinco Group.





**Basil Abul-Hamayel gives the keynote address at an Aramco business forum in Houston for North American companies to learn about partnership opportunities.**

president of Aramco Asia; and Gao Ke, Panjin Municipal Party Secretary. Representatives from relevant ministries, provincial departments, Norinco, Saudi Aramco, and the Huajin Group also attended.

## Aramco business forum highlights partnership opportunities between North America, Saudi Arabia

**HOUSTON, TEXAS, USA** — During the Offshore Technology Conference (OTC), Aramco conducted a business forum for North American companies to learn about opportunities to partner with Saudi Aramco and invest in the Kingdom.

With a theme of “Doing Business in Saudi Arabia,” the event in Houston was the second of its kind held in conjunction with the U.S. Chamber of Commerce. The first was conducted last November in Washington, D.C.

Since the launch of Saudi Vision 2030 last year, interest among North American business leaders has grown. The Aramco forum was a good reflection of that, with more than 240 North American company owners, CEOs, investors, and others attending.

Participants represented more than 140 business organizations in a variety of sectors, including oil and gas, chemicals, information technology, telecommunications, and logistics.

In his keynote address, Basil

Abul-Hamayel, Aramco Services Co. president and CEO, highlighted the strong alliance between the U.S. and Saudi Arabia that began almost 90 years ago. “We want to continue building strong, successful partnerships,” he said.

## Saudi Aramco, China’s Development Research Center of the State Council agree to advance joint collaboration and research in the energy sector

**DHAHRAN, SAUDI ARABIA** — The long-standing business relationship

between Saudi Aramco and China was further consolidated during the recent visit to Saudi Aramco of HE Li Wei, president of China’s Development Research Center (DRC) of the State Council, and his meeting with Amin Nasser, president and CEO of Saudi Aramco.

Nasser and Li signed a Memorandum of Cooperation on “Promoting the Implementation of Joint Research.” In the memorandum, both parties agreed to explore collaboration and research opportunities between the People’s Republic of China and Saudi Arabia related to alignment and progression of China’s “Belt and Road Initiative” and “Saudi Vision 2030.”

The joint research collaboration areas include Saudi Aramco’s growing downstream presence in China, including oil refining, oil product marketing and retail, and oil storage. The joint research will also explore the interests of Chinese companies partnering with Saudi Aramco and other Saudi Arabian entities for possible investments and partnerships. 🌐

**Amin Nasser and HE Li Wei shake hands after signing a Memorandum of Cooperation on “Promoting the Implementation of Joint Research” in Dhahran. The memorandum confirms an agreement to explore collaboration and research opportunities between China and Saudi Arabia.**



## worldview



### *Sunrise over Lake Louise, Canada*

Mark P. Kaminsky took this summertime image of Lake Louise in Banff National Park, Alberta, Canada. He was touring through the Banff/Jasper area on a family vacation. The sun was just rising, illuminating the tops of the mountains with pastel colors that reflected nicely off of the lake below. Note the two canoes already out on the lake taking in the early morning view.

The photo was shot from their hotel room with a Nikon D3200 camera. Kaminsky works in the Process, Automation and Technology Unit at the Aramco Services Company, Houston, Texas.