



CASE STUDY #1.

Client:  **Harouge (Ex. VEBA) Oil Operations B.V. Libyan Branch**

Project: **Replace Main Distribution Board, Ras Lanuf Terminal**

First Stage:

Contract No. 2007-58
Total Contract Value: **€ 676,450.00 plus LYD 271,500.000**
Contract Start of Execution Date: 6.09.2007.
Duration – 9 months;
Completion Date: 23.5.2008.

Second Stage:

Replace Main Distribution Board, Ras Lanuf Terminal – Change Order No. 1.
Replacement of MV Cables at Ras Lanuf Terminal

HOO Contract No. 2007-58 – CO No. 1
Award Value for CO No.1: **€ 557,059.86 plus LYD 111,290.82**
Contract Effective Date: September 28, 2008; Duration - 12 months;
Completion Date: October 1, 2009

Project includes Engineering with Detail Design, Procurement of Equipment and Installation materials, Construction and Installations with Commissioning & Changeover to the new Power Supply system and Operations & Maintenance personnel training.





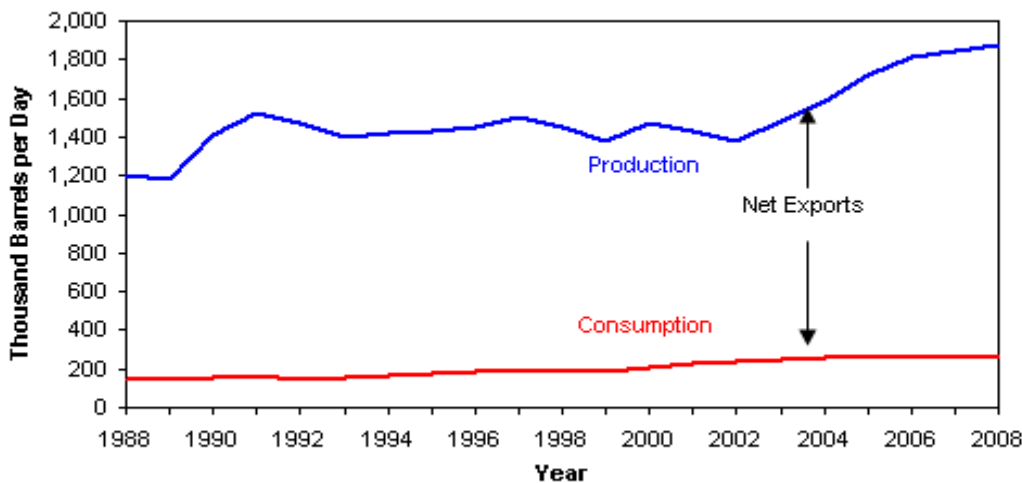
HAROUGE Oil Operations - Ras Lanuf Terminal Background

Libyan Crude Oil Production & Exports

Production

Libyan oil production peaked at over 3 million bbl/d in the late 1960s and has since been in decline. The National Oil Company (NOC) would like to raise oil production capacity to 2.3 million bbl/d by 2013. While this is a significant increase from EIA's 2008 production estimates of 1.88 million bbl/d of total oil (and crude capacity estimates of 1.75) this represents a downward revision for the NOC whose earlier target for the period was 3 million bbl/d. Most of the short-term oil production increases are expected to come from enhanced oil recovery (EOR) processes. Any major new production in Libya will require additional pipeline capacity.

Libya's Total Oil Production and Consumption, 1988-2008



Exports

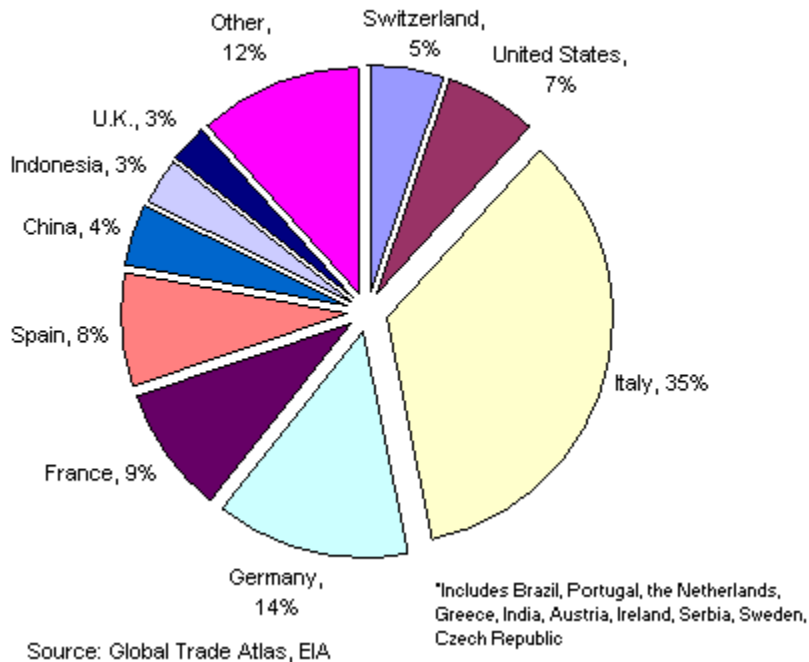
With domestic consumption of 273,000 bbl/d in 2008, **Libya had estimated net exports (including all liquids) of 1.6 million bbl/d.** According to 2008 official trade data as reported to the *Global Trade Atlas*, the vast majority of Libyan oil exports are sold to European countries like Italy (523,000 bbl/d), Germany (210,000 bbl/d), Spain (104,000) bbl/d and France (137,000 bbl/d). With the lifting of sanctions against Libya in 2004, the United States has increased its imports of Libyan oil. According to EIA estimates, the United States imported an average of 102,000 bbl/d from Libya in 2008, up from 56,000 bbl/d in 2005.

Libyan oil is generally light (high API gravity) and sweet (low sulfur content). The country's nine export grades have API gravities that range from 26° – 44°. While the lighter, sweeter grades are generally sold to Europe, the heavier crude oils are often exported to Asian markets.



NOC has six oil terminals and storage facilities along the coast from Tobruk in the east to Zawiya in the west: Tobruk's Marsa El Hariga, Zueitina, Marsa El Brega, Ras Lanuf, Es Sider, and Zawiya.

Libya's Oil Exports by Destination, 2008



Harouge Oil Operations (previously “Veba Oil Operations”) is the joint venture operator on behalf of Libya’s National Oil Corporation and Petro-Canada. The Company is engaged in developing and exploiting oil fields located in five contract areas onshore Libya. The origin of Harouge Oil Operations (previously “Veba Oil Operations”) can be traced back to 1955, when Mobil Oil began its exploration in Libya. Due to the large investments involved in exploration and development, Mobil Oil signed a contract with the German Company Gelsenberg AG (which later was renamed to “Veba Oil Libya”) to share its exploration and production rights and obligations.

In 1987, the joint operator, Veba Oil Operations, was established by the National Oil Corporation and Veba Oil Libya, to explore, develop and exploit 8 concessions, mainly located in central Libya’s Sirte basin. In 2002, Veba Oil Libya’s rights and obligations in these concessions were acquired by Petro-Canada. In 2004, Veba Oil Libya was renamed to “Petro-Canada Oil Libya”, and in 2008 Veba Oil Operations was renamed to “Harouge Oil Operations”. In 2008, the National Oil Corporation and Petro-Canada signed six new Exploration and Production Sharing Agreements (EPSA) for the eight former concessions, and agreed that Harouge Oil Operations continues to develop and exploit the oil fields located in these concessions on behalf of the owners. The exploration activities within the new contract areas were assigned to be under Petro-Canada’s responsibility.



Today, in 2009, Harouge Oil Operations develops and produces petroleum from five of the contract areas with more than 20 fields. Harouge Oil Operations employs over 2,000 employees based in the offices in Tripoli and Benghazi, as well as in self-sufficient field camps at the oil fields in Amal, Ghani, Jofra, Tibisti and En Naga, and at the terminal in Ras Lanuf.

Current oil production potential from all fields is in excess of one hundred thousand barrels of petroleum per day. The crude oil is pumped from the various fields via export pipelines to the coast to the Ras Lanuf Terminal, where it is stored in 13 tanks and loaded on tankers for export. Harouge is also responsible for shipping of crude oil from fields operated by other operators, and therefore the **Ras Lanuf Terminal handles about 450,000 barrels of oil per day** and services an average of 15 crude oil carriers per month on behalf of the National Oil Corporation and of the international partners of NOC.

Harouge's corporate objectives are to engage safely, responsibly, efficiently and profitably in oil field development and exploitation and to implement the latest technologies available in the development and exploitation of Libya's natural resources, to the benefit of the country and Harouge's owners. Ras Lanuf is a port at the Gulf of Sirte on the North African coast, 650 km east of Tripoli and 345 km southwest of the city of Benghazi.

The port started operating in 1964. The Terminal consists of the administrative offices, an industrial area, a residential area and a control centre that are located on a ridge some 20 m above sea level and approximately 3 km inshore.

The Ras Lanuf tank farm is some 9 km inshore from the coastline. *There are 3 main pipelines connecting the oil fields with the tank farm, which consists of 13 oil storage tanks with a total nominal capacity of 6.5 million barrels of oil.* The tanks are 100 m above sea level allowing the oil to flow to the port by gravity. Oil is metered before entering into the tanks. It is then filtered under full control, stored in a recovery tank prior to delivery to the ships in the port.

Loading into the crude oil carriers takes place at four offshore berths. Berths 1 & 2 are of the roadstead conventional submarine type and are located approximately 1 mile offshore. They are designed to handle tankers from 30,000 to a 100,000 DWT with a maximum draft of 18 meters, at a maximum loading rate of up to 52,000 barrels per hour. Berths 3 & 4 are single buoy moorings and are located approximately 2 miles offshore. They are designed to handle tankers up to 30,000 DWT with a maximum draft of 23 meters, at a maximum loading rate of up to 46,000 barrels per hour.

PROJECT OBJECTIVES

Existing 2.16 kV Distribution System, based on former BBC Switchgears (11 panels) with vacuum circuit breakers, since being in operation for more than 25 years and spare parts are becoming obsolete, and overall reliability insufficient for such critical application is to be completely redesigned, upgraded and replaced with most up-to-date equipment and technology. Through the second stage of project execution downstream MV underground cables are to be



upgraded and replaced with new properly rated to suite current and anticipated future needs. Shutdown period on the Terminal should be reduced to minimum possible.

PROJECT RESULTS

ABB as a main Vendor for this project has been selected as the largest and most complete supplier in the world of switchgear and systems for electric power transmission and distribution. ABB substations, cables, transformers, control systems and switchboards are used by our customers for efficient use of electric power.

Complete Engineering and Detail Design were finalized in-house by Petrolcomet's engineering team.



MAIN TECHNICAL DATA

Type of switchgear	ABB UniGear ZS1
Service voltage	2,4 kV
Rated voltage	12 kV
Rated frequency	50 Hz
Rated current - busbars	2000 A
Rated short - time withstand current	16 kA / 1 sec
Rated peak withstand current	40 kA max.
Degree of protection	IP 4X
Ambient temperature	-5°~40°C
Relative humidity	65%

STANDARDS



International Electrotechnical Commission

IEC

Manufacturer: **ABB s.r.o., PPMV Brno Czech Republic**

SPECIFICATION OF EQUIPMENT

2,4 kV SWITCHGEAR

POWER CIRCUITS

-QB1	Gas insulated MV circuit breaker (OUTGOING FEEDER)
Type:	HD4/P 12.06.16 P150
Rated voltage:	12 kV
AC test voltage:	28 kV, 50Hz, 1 min.
Impulse withstand voltage:	75 kV
Rated current:	630 A
Rated breaking capacity:	16 kA
Short time current, symm.:	16 kA/ 1 sec
Making current:	40 kA
Pole center distance:	150 mm
<u>Equipped with:</u>	
Springs charging motor	-MS : 24V DC
Shunt opening coil	-MO1 : 24V DC
Shunt closing coil	-MC : 24V DC
Truck locking magnet	-RL2 : 24V DC
SF6 gas pressure control device	-BP : Two levels without LEDs
Auxiliary switches:	-3 NO, 2NC
Additional aux. contacts	-2 NO, 3 NC
Transient contact	-BB4
Truck position signalling contacts	-BT1,-BT2
With mechanical counter of switching cycles	
Manufacturer:	ABB Sace, Italy



-QE1

Earthing switch

Type EK6/ZS1 1208 - 150

Rated voltage: 12 kV

Rated impulse test voltage: 75 kV

Short time current, symm.: 34 kA/ 3 sec

Pole center distance: 150 mm

Auxiliary contacts: 5NO / 5NC

Blocking coil -RL3 24V DC

Manufacturer: ABB s.r.o., PPMV - Czech Republic

-TA1, -TA2, -TA3

Current Transformers

Type: TPU 40.13, 400 / 5 / 5 A,

10 / 10 VA; 5P10 / 0,5

12/28/75kV 50Hz IEC 16kA(1s)

Manufacturer: ABB s.r.o., PPMV - Czech Republic

-TU1, -TU2, -TU3

Voltage Transformers

Type: TJP 4.0; $\frac{2400V}{\sqrt{3}} / \frac{100V}{\sqrt{3}} / \frac{100V}{3}$, 50 / 50 VA, cl. 0.5 / 6P

3,6/10/40kV 50Hz;

Manufacturer: ABB s.r.o., PPMV - Czech Republic



PROTECTION RELAYS



-AR1 **REF541KB118CAAA-001**
Manufacturer: ABB, Finland

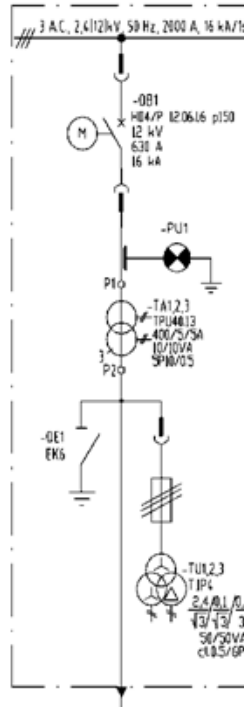
Feeder terminal REF 541 for protection, control, measurement and supervision of medium voltage networks.

Protection functions including e.g. non-directional and directional overcurrent and earth-fault protection, residual voltage, overvoltage and undervoltage protection, thermal overload protection, CBF and auto-reclosing.

Control functions including local and remote control of switching objects with synchro-check, status indication of the switching objects and interlockings on bay and station level

Measurement of phase currents, phase-to-phase and phase-to-neutral voltages, neutral current and residual voltage, frequency, power factor, active and reactive power and energy.

Advanced power quality measurement capabilities. Total harmonic distortion (THD) measurements for both currents and voltages. Measurement for short duration voltage variations like sags, swells and short interruptions.



METERING EQUIPMENT	-PU1 KUVAG PM1 NODUS Alpha
PROTECTION RELAYS	-F1 REF5418B18KAAA

*Single Line Diagram for the typical Outgoing Feeder

LOW VOLTAGE and DC PANEL with battery charger

THYROTRONIC Rectifier (Battery Charger) for stationary back up power supply, manufactured by German BENNING GmbH & Co.KG world class power solutions provider has been implemented.

The THYROTRONIC Rectifier line from BENNING is designed to address critical DC load powering and battery charging requirements in a wide range of stationary battery plant applications.

New emergency lighting, Carrier Platinum based air conditioning and new LV distribution panels were provided too.



***BENNING Rectifier series Thyrotronic**

GROUNDING SYSTEM

Enhancements of the existing Earthing were designed and implemented based on BS7430 – Code of practice for Earthing. Petrolcomet measured resistivity of the soil around the Veba Substation and the highest result was 32 Ω m. New Earthing resistance of the system **R_n = 1.29 Ω** has been achieved, outlying below the required **2 Ω** .



FIRE ALARM SUBSYSTEM

Conventional Fire Alarm Control Panel SIRIUS II manufactured by Kidde Ltd. was applied



CDX fire detectors were installed and conception to the Central Fire Station provided in addition to local annunciations.

DOWNSTREAM CABLING

Upon stringent calculations of:

- 2.4 kV Full Load Current and Ampacities
- Voltage Drop Calculations
- Short Circuit Withstand Capability
- Current and future load assessment

Dimensioning and selection of MV cables has been completed base on **IEC 60502-2** ; Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – **Part 2**: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)

NFPA 70 National Electrical Code and IEEE 241 & 399- 1990 were followed in addition to Libyan NOC General Engineering Specifications.



AEI Cables Ltd. MV cables for voltage rating 3.6/6 KV manufactured per IEC60502 standard requirements were installed. All cables used are for direct underground burial – PVC sheath (red), laid up PVC bedding SWA, 3 cores Pc tape screen with Cu conductors (STR) PCW SC/XLPE/SC insulation.

TYCO Electronics (Raychem) joints and heat shrink termination kits were applied.



EPILOGUE

Project was completed one month before scheduled completion date. Since new power supply was commissioned not a single objection on reliability has been noticed. Petrolcomet has been awarded for the new contract with Harouge Oil Operations at Ras Lanuf Tank Farm.