



Three Pronged Maintenance Strategy of Gas Processing Facilities at Bapco

BY

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Outline

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- 4) Maintenance Function & Organization in BAPCO- Upstream
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 - 5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network
 - 5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network
- 6) Conclusion

1) Introduction

Reliability of Gas processing facilities is a challenge for any company.

Safety, and Environmental issues add another dimensions to this challenge.

In Bapco, apart from above mentioned issues , we have to constantly bear in mind that supplying uninterrupted Gas supply to our valued customers is of National importance. Because all the Power generation as well as host of private industrial units solely depend upon Gas from Bapco.

The age of the Bahrain Field & its facilities and geographically distributed locations of various Gas processing facilities add more challenges to the important task of ensuring reliability & integrity of our Gas Processing facilities.

2) Presentation Purpose

This Presentation would illustrate how we ensure reliability & integrity of our Gas production and processing facilities.

We have implemented three pronged maintenance strategy, namely,

- 1. Planned & Scheduled T&Is of Gas Plants and Vessels**
- 2. Planned & Scheduled Rehabilitation of Gas Transmission Line Network**
- 3. Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network**

At the end of this presentation, the effectiveness of these maintenance strategies on the reliability & integrity of our Gas Production and Processing facilities would be explained.

3) Overview of Gas Production & Processing facilities of Bapco

-Bahrain Oil Field is located in the center and the south area of the Kingdom and it covers a wide area of harsh desert environment.

Two types of Operations are involved:-

- ▶ Oil Operations
- ▶ Gas Operations.

3.1 Overview of Gas Production & Processing



4) Maintenance Function & Organization of Bapco-Upstream

Field Maintenance Department is responsible for the entire maintenance of all field production facilities.

Two main types of maintenance are carried out:

- **Breakdown / Corrective Maintenance:**
 - Routine day to day jobs
- **Preventive Maintenance:**
 - Planned Turnaround and Inspection of Plants & Vessels
 - Planned Piping Rehabilitation Program for GTL Network
 - Planned Mechanical Integrity & Reliability checks of GDL Network
 - Mechanical and Instrument PM

5) Three Pronged Maintenance strategy:-

In order to make our Gas producing and Gas processing facilities Reliable to ensure uninterrupted gas supply to our valued customers, we have adopted following three pronged maintenance strategy:-

- Planned / Scheduled T&I of Gas Plants & Vessels**
- Planned & Scheduled Rehabilitation of Gas Transmission Line Network**
- Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network**

5.1) Planned / Scheduled T&I of Gas Plants & Vessels

5.1.1 Reasons for carrying out T&Is

We shut in the running Unit / Vessel as per T&I schedule to carry out the following:-

- a) Check the integrity of various equipment & associated components
- b) Repair/ replace / refurbish damaged items if any
- c) Carry out PM activities on various components including Electrical Instrumentation and Mechanical items.

All of above are carried out to ensure:-

- a) Smooth operation of the facility with out any In-Service Breakdown until next planned shut down
- b) Extend useful life of the facility

5.1) Planned / Scheduled T&I of Gas Plants & Vessels

5.1.2 T&I Schedule / Frequency

Number of Turnaround and Inspections carried out annually on various units and vessels are as per following schedule (frequency) & intervals (duration):

| S.N. | UNIT DESCRIPTION | TOTAL NUMBER | FRQUNECY (YEARS) | AVERAGE NUMBER PER YEAR | T&I INTERVAL (SHIFTS) |
|----------|-------------------------------------|--------------|------------------|-------------------------|-----------------------|
| 1 | <u>GAS DEHDYRATION UNITS</u> | 36 | 4 | 9 | 26 |
| 2 | <u>GAS VESSELS</u> | 12 | 4 | 3 | 12 |

5.1) Planned / Scheduled T&I of Gas Plants & Vessels

5.1.3 Basis of T&I Schedule

1. A long term (15-20 years) T&I plan by C&I based on the followings:
 - ▶ Service date of Unit / Vessel,
 - ▶ Date of Unit / Vessel's last T&I
2. An annual T&I Schedule by Field Maintenance department and approved by all concerned Sections / Departments; one year in advance.

The following issues are considered during the preparation of annual schedules:-

- ▶ Gas Operations T&Is are not usually planned in Summer.
- ▶ Results of In-Service UT Gauging dictate advancement
- ▶ De-bottlenecking / Up gradation projects inclusion in T&I schedule.

5.1) Planned / Scheduled T&I of Gas Plants & Vessels

5.1.4 T&I Planning

Completing T&Is – Safely , within the budget and time is critical. To achieve this proper & thorough planning is needed. We carry out following activities to achieve timely completion of the T&Is:-

- **Budgeting**
Based on proposed schedule of next year, in advance budget provisions are made to ensure fund availability.
- **Materials Management**
Based on C&I recommendations, our experience and Work lists, material procurement is initiated one year in advance to ensure receipt of the same before taking up any shutdown
- **Contract Services Management**
Ensure Contracts for required Services are available with adequate Funds.

5.1) Planned / Scheduled T&I of Gas Plants & Vessels

5.1.5 T&I Execution

The execution of T&Is is carried out under the Supervision of Bapco Shut Down Supervisor by providing him with all the required services as detailed below.

- ▶ **Supervision:- Bapco** [Focal Coordinating Point]
- ▶ **Manpower :- Contractor**
- ▶ **Equipment:- Bapco + Contractor**
- ▶ **Heavy Equipment & Rigging Services:- Contractor**
- ▶ **Scaffolding:- Contractor**
- ▶ **Insulation:- Contractor**
- ▶ **Instrumentation/ Electrical:- Bapco with Contractor support**
- ▶ **Valves etc:- Bapco**
- ▶ **Relief Valves:- Bapco**
- ▶ **Heat Exchangers overhauling :-Contractor**

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.1 Overview of G.T.L. Network

A] GTL Network consists of the following lines:-

- a) Gas Gathering lines : GDU Outlet to jump Over
- b) Gas Transmission lines:- Jump over to Gas Distribution Point

B] Total length = appxly 143 kms

C] Line Sizes and Schedules = 8" to 20", API 5 L Gr B / X52, Schedule30/40

D] Operating Pressure = 1000-1200 psig

E] Configuration = Mostly above ground but with a lot of under ground road crossings

F] Design, Fabrication & Inspection to ASME 31.8 Standard

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.2 Reasons for taking up this Rehabilitation Project

- The network is very old. Predominantly, we had been tackling only rare incidences of break down emergencies, although UT gauging was part of our Inspection group's on-going activities.
- We also used to utilize High Pressure Plidco Clamps to avoid shutting down of the line.
- In the recent past, we faced few In-service leaks at short time.
- Findings of investigation , the location of the leaks were to be in the zone of Pipe Sleeper or at the road crossings .
- Needs for inspecting pipe sleepers and supports locations of all the lines of the network & the road crossings.
- The Plan of Action was to Inspect, clean, repair if necessary & hydro test each and every segment of GTL Network to ensure its Integrity, which in turn assured of reliable & uninterrupted gas supply to our valued customers

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.2 Rehabilitation Plan :

It was very evident that this rehabilitation program is going to be voluminous.

A thorough planning will be needed to complete entire network in reasonable time frame of 3-4 years.

- The entire network was divided into 83 segments.**
- To start with, “Single” line situations were targeted.**
- Various pipes & fittings have been ordered on yearly basis in advance.**
- New piping contracts have been developed to take up these jobs.**
- Additional Supervisory staff has been approved and assigned for site supervision.**
- Fund allocation in Expense budget is ensured.**

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.3) Rehabilitation Execution:

- a. Lift the line and roll pipe sleepers from existing locations for Inspection.
- b. Inform Inspection and coordinate lifting of pipe for Inspection of bottom portion of the pipe.
- c. Daylight & expose road crossings to assess the condition of the buried line segment.
- d. UT Technician will conduct gauging at Wear locations.
- e. Inspection would review UT Gauging results & carry out visual inspection of coating & buried line to evaluate their condition.
- f. Receive entire repair package from inspection.
- g. Plan and arrange to execute the work.

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.4 List of usual findings by Inspection

- a. Normal to sever external erosion at certain locations of the pipe.
- b. Missing pipe sleepers
- c. Damaged Anchor supports
- d. Damaged Pipe Supports- Fixed type
- e. Occasionally, “Below MAT” locations on the line segments
- f. Damaged to Wrapping / Coating of road crossings.
- g. No internal corrosion has been noticed.

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.5 list of Usual recommendations

- a. Fabricate & install missing pipe supports
- b. Fabricate & Install Bolted type Wear Pads at Pipe sleeper locations
- c. Repair / replace Fixed type Pipe supports
- d. Repair / replace Anchor supports
- e. Remove and install new wrappings post inspection of exposed line segment.
- f. Pipe cut-outs including replacements of Bends for defective portions.
- g. Replacement of defective Road Crossing spools

5.2) Planned & Scheduled Rehabilitation of Gas Transmission Line Network

5.2.6 Rehabilitation Achievement :-

- With sustained planning & execution, we have successfully completed rehabilitation of 37 line segments so far, in addition to 22 segments which were completed earlier.
- No In-Service leak has been experienced so far.

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

5.3.1) Overview of GDL Network

A] GDL Network starts from Distribution Points to customers

B] Total length = appxly 150 kms

C] Line Sizes and Schedules = 2" to 20", API 5 L Gr B / X52, Schedule30/40/80

D] Operating Pressure = 850 - 1000 psig

E] Configuration = Mostly under ground

F] Design, Fabrication & Inspection to ASME 31.8 Standard

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

5.3.1) Necessity for sustained Integrity & Reliability Checks program

- **Not possible for of visual Inspection or UT Gauging (under ground).**
- **Running through Industrial & partially through Residential areas.**
- **Customer's line mostly "Single", hence no Stand- By or Spare line.**
- **Entire Power Generation of the Nation depends upon our Gas Supply**
- **Main Industries [Refinery, Petrochemical, Aluminum etc] depend upon our Gas Supply**

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

Accordingly, in order to ensure uninterrupted Gas Supply to our customers, we have adopted the following Mechanical Integrity & Reliability checks on GDL Network:-

- ► Internal Cleaning of main Gas Distribution lines**
- ► Hydro-testing of ALL Gas Distribution lines**
- ► Intelligent Pigging of main Gas Distribution lines**

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

5.3.1) Internal Cleaning of Main Distribution Gas Lines

A] In order to clean the main GDL:

- Some critical lines are periodically pigged to remove condensate if any, to avoid any liquid hydrocarbon carry over to customer.
- If any line is suspected by Operations is choked with sludge, then it will be pigged.

B] Method of Pigging:

- New Lines “ In Line” pigging utilizing the service gas.
- Old lines sweet water is used to push the pigs.

C] Areas of Concerns:

- Disposal of Condensate, Sludge & Pyrophoric material.
- Control of Flaring Operation during In-Line Pigging.

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

5.3.2) Integrity check by Hydro-testing of GDL

Need for Hydro-testing

GDL Network consists of many old lines not designed for Intelligent pigging, hence although it is not the best method, we resort to hydro testing as a method of Integrity check for ALL lines of the network

Frequency of Hydro-testing

Inspection section has come up with an annual schedule based on Commissioning date of the lines. The frequency considered is once in 5 years.

Areas of Concerns

Contingency Plan is needed (ready with materials and resources) to carry out repair, in case of leak during testing.

This would involve identifying the location [as it is usually underground] by trail holes, repairing and re-hydro testing.

5.3) Periodic Mechanical Integrity & Reliability checks of Gas Distribution Line Network

5.3.3) Integrity check by Intelligent Pigging

As this is one of the best methods, we have now embarked upon an ambitious project to carry out Intelligent Pigging for 18 of our Gas Distribution lines.

Procedure and Technical Specifications have been finalized and tendered. TBA [Technical Bid Analysis] is nearing completion.

Job is expected to start in Q1/ 2010

Engineering study is in progress to modify where ever required , the existing set up to suit Intelligent pigging.

6) Effect of Maintenance Strategies on Reliability of our Gas Processing Units

In conclusion, due to adopting the three pronged maintenance strategy , we have now managed to achieve our objective of making our Gas Production & Processing Facilities reliable , resulting in the following:-

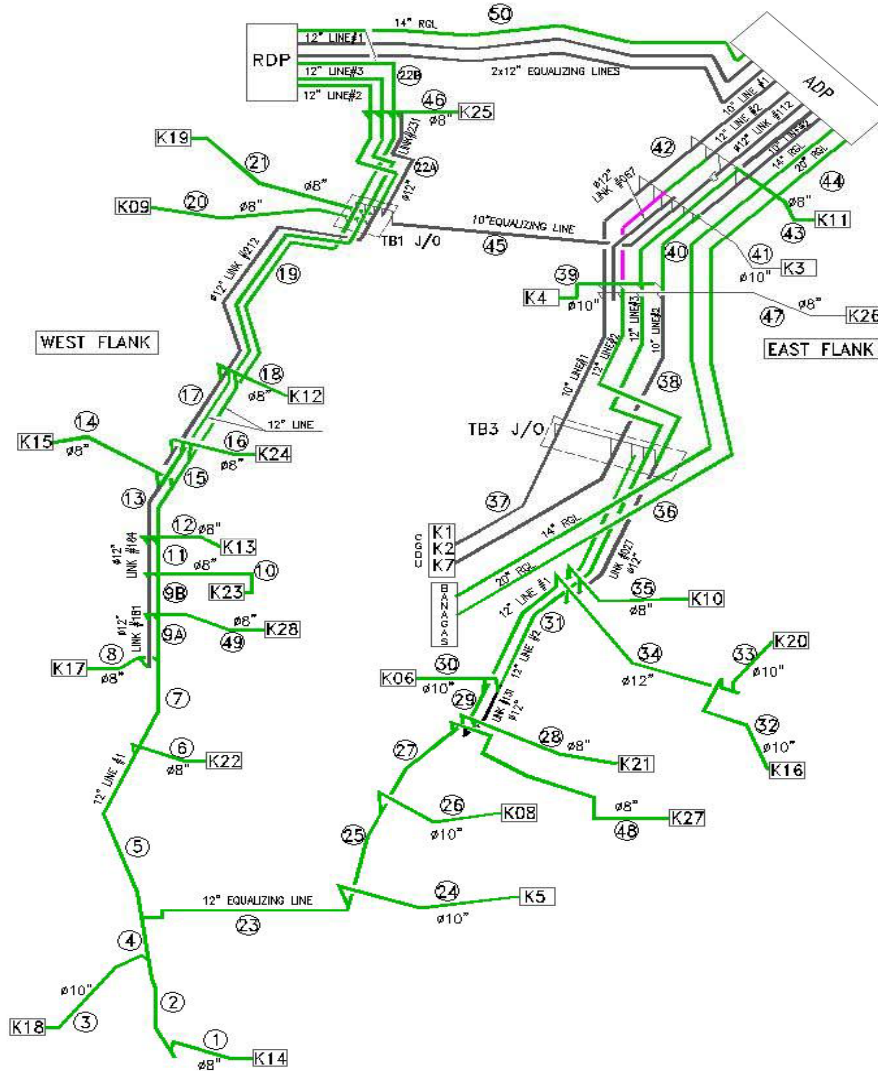
- Maximum availability of equipment / vessels between two T&Is.**
- Un-interrupted operation of Gas Transmission line Network**
- Un-interrupted operation of Gas Distribution line Network**
- No Condensate carry over to Customer**

Thank You

And Ready for Q&A

| KHUFF UNIT | WELL NO. | FREQUENCY | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|------------|----------|-----------|----------|------|------|------|------|------|------|------|------|------|
| K1 | 254 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K2 | 255 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K3 | 264 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K4 | 265 | 4 Years | Schedule | T&I | | | | T&I | | | | T&I |
| | | | Actual | | | | | | | | | |
| K5 | 288 | 4 Years | Schedule | | | T&I | | | | T&I | | |
| | | | Actual | | | | | | | | | |
| K6 | 279 | 4 Years | Schedule | T&I | | | | T&I | | | | T&I |
| | | | Actual | | | | | | | | | |
| K7 | 299 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K8 | 300 | 4 Years | Schedule | T&I | | | | T&I | | | | T&I |
| | | | Actual | | | | | | | | | |
| K9 | 312 | 4 Years | Schedule | | T&I | | | | T&I | | | |
| | | | Actual | | | | | | | | | |
| K10 | 311 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K11 | 359 | 4 Years | Schedule | T&I | | | | T&I | | | | T&I |
| | | | Actual | | | | | | | | | |
| K12 | 358 | 4 Years | Schedule | | | | T&I | | | | T&I | |
| | | | Actual | | | | | | | | | |
| K13 | 360 | 4 Years | Schedule | | | T&I | | | | T&I | | |

GTL & RGL NETWORK-REPAIR STATUS ON 24-08-09



NOTES:

LEGEND

- REPAIR COMPLETED
- REPAIR IN PROGRESS
- REPAIR PACKAGE ISSUED
- TO BE INSPECTED
- UNDER INSPECTION

REFERENCE DRAWINGS

DRG NUMBER

| REV. | DATE | DESCRIPTION | DRAWN | CHECK | ENGR. | PROJ. | OWN | SER. | C. | OTHERS |
|------|----------|--|-------|-------|-------|-------|-----|------|----|--------|
| 17 | 24.08.09 | 12" GTL LINE#2 K-03 J/O TO K-04 REPAIR COMPLETED | HMK | DEV | DEV | | | | | |
| 16 | 07.08.09 | 12" LINE#3 K-03 J/O; K-11, 12" LINE#2, 8" BETWEEN K-09 TB#01 J/O, K-10 J/O TO TB#03 REPAIR COMP. | HMK | DEV | DEV | | | | | |
| 15 | 27.04.09 | 12" GTL LINE#2 K-03 J/O TO K-11 REPAIR COMPLETED. 12" GTL LINE#2 K-11 J/O INSPECTION STARTED | HMK | DEV | DEV | | | | | |
| 14 | 14.02.09 | 8" GTL BETWEEN K-09 TO TB#01 J/O & 12" GTL LINE#2 K-03 J/O TO K-11 J/O REPAIR IN PROGRESS | HMK | DEV | DEV | | | | | |
| 13 | 15.02.09 | UPDATED AS REQUESTED BY ENGINEER | HMK | DEV | DEV | | | | | |
| 12 | 27.01.09 | UPDATED AS REQUESTED BY ENGINEER | HMK | DEV | DEV | | | | | |

شركة نفط البحرين (بورس) ب.س.ج. (مستقل)
THE BAHRAIN PETROLEUM COMPANY B.S.C. (C) (L) (P) (S)
 P.O. BOX 25555 AWALI, KINGDOM OF BAHRAIN



PROJECT TITLE
GAS TRANSMISSION NETWORK

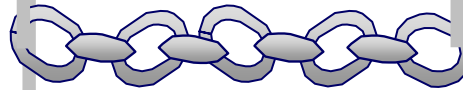
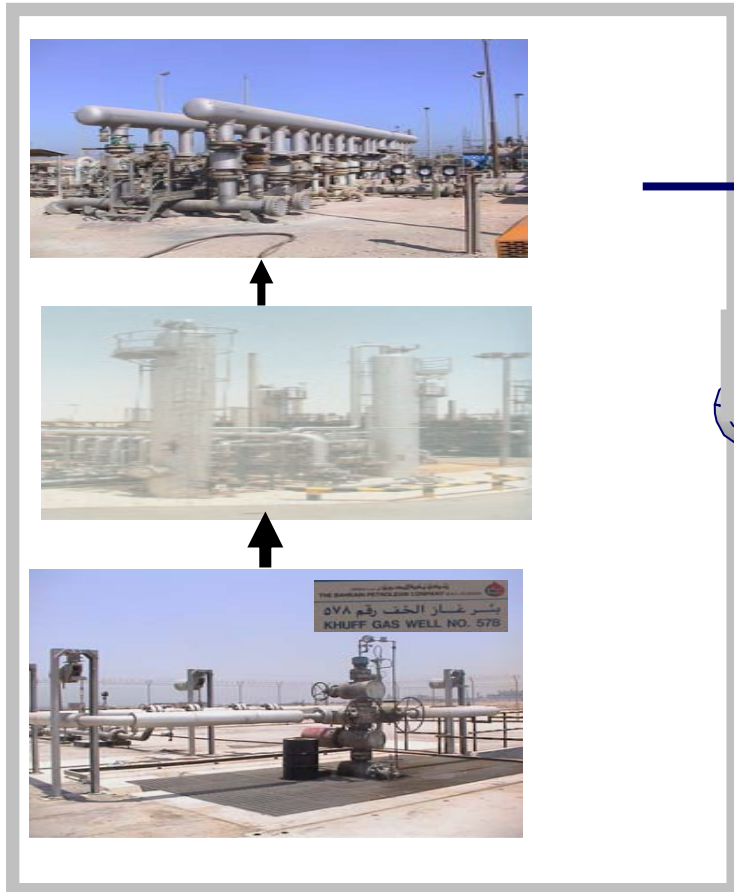
DRAWING TITLE
GTL & RGL NETWORK REPAIR STATUS

DRAWN: AH DATE: 11.04.2005 SCALE: NTS

ER No. PD20 AREA GASDIS DRG No. BN-A2-9990 REV. 17



Importance of Bapco Gas Production & Supply



- POWER GENERATION



- ALUMINUM



- PETROCHEMICAL

- IRON PELLETS

- OTHER INDUSTRIES

- REFINERY



LOCATION MAP

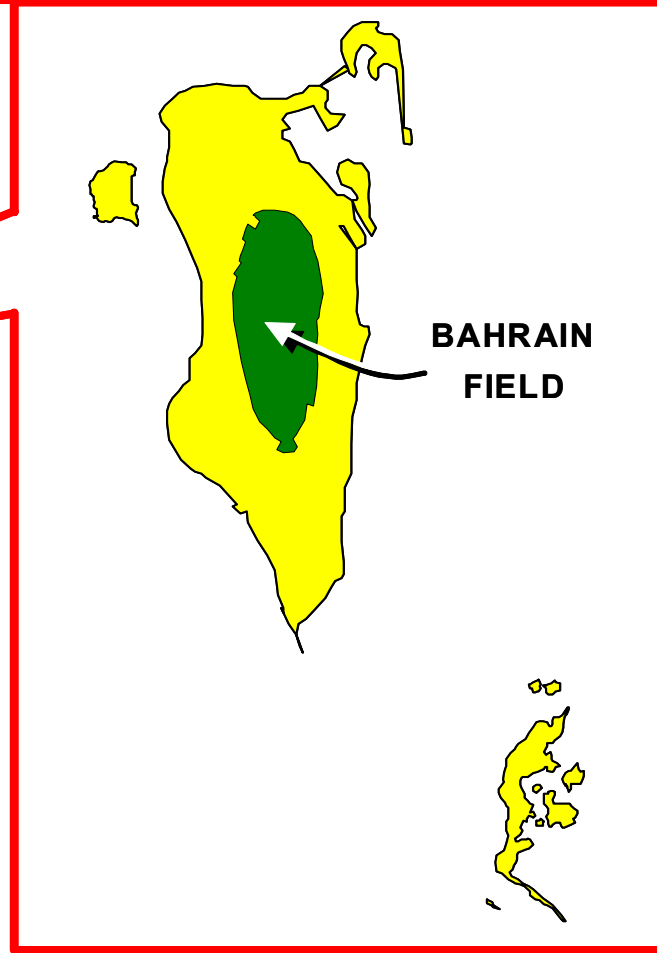
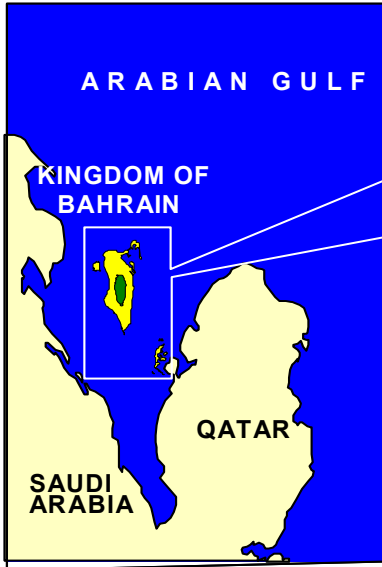
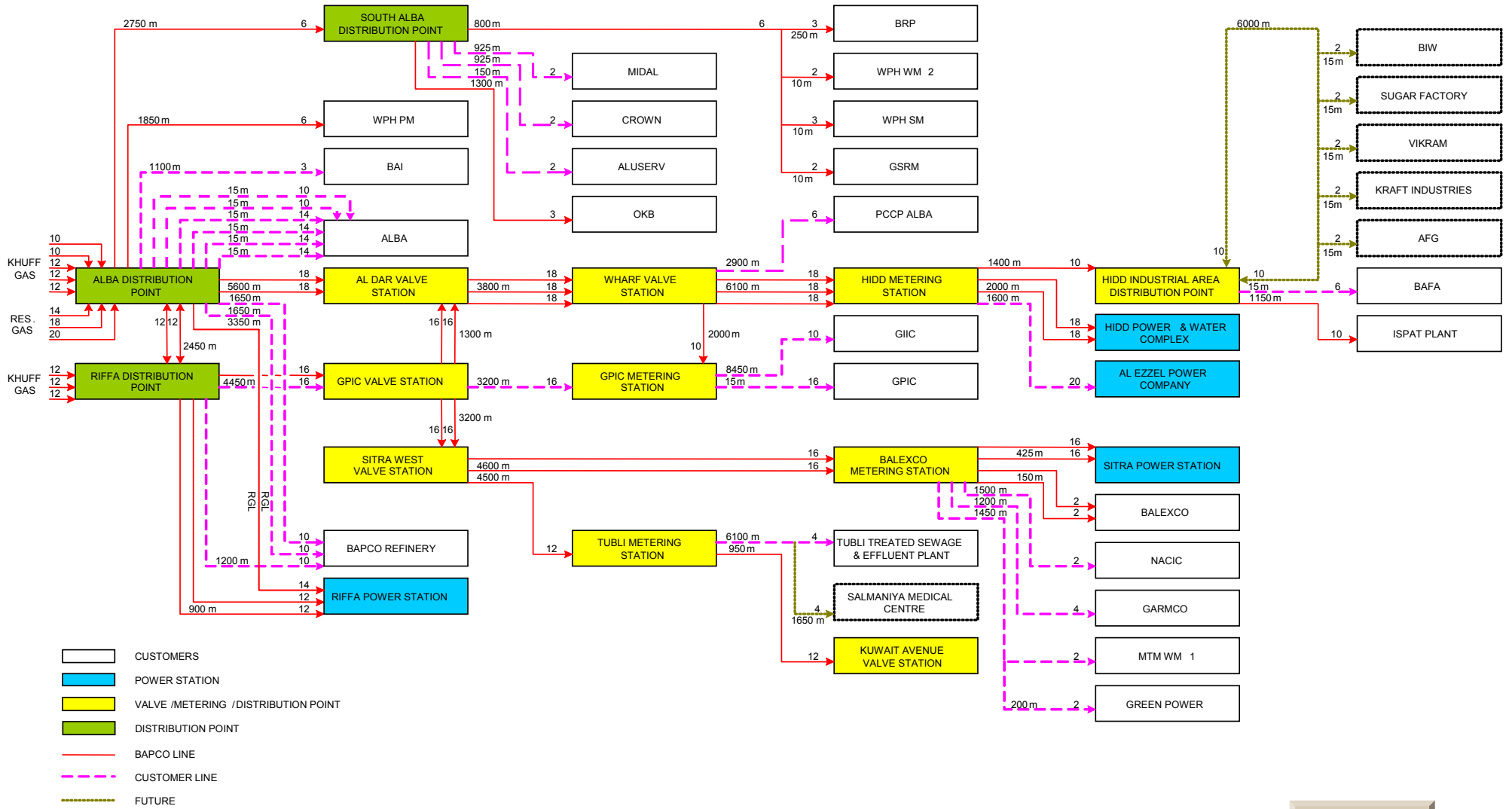


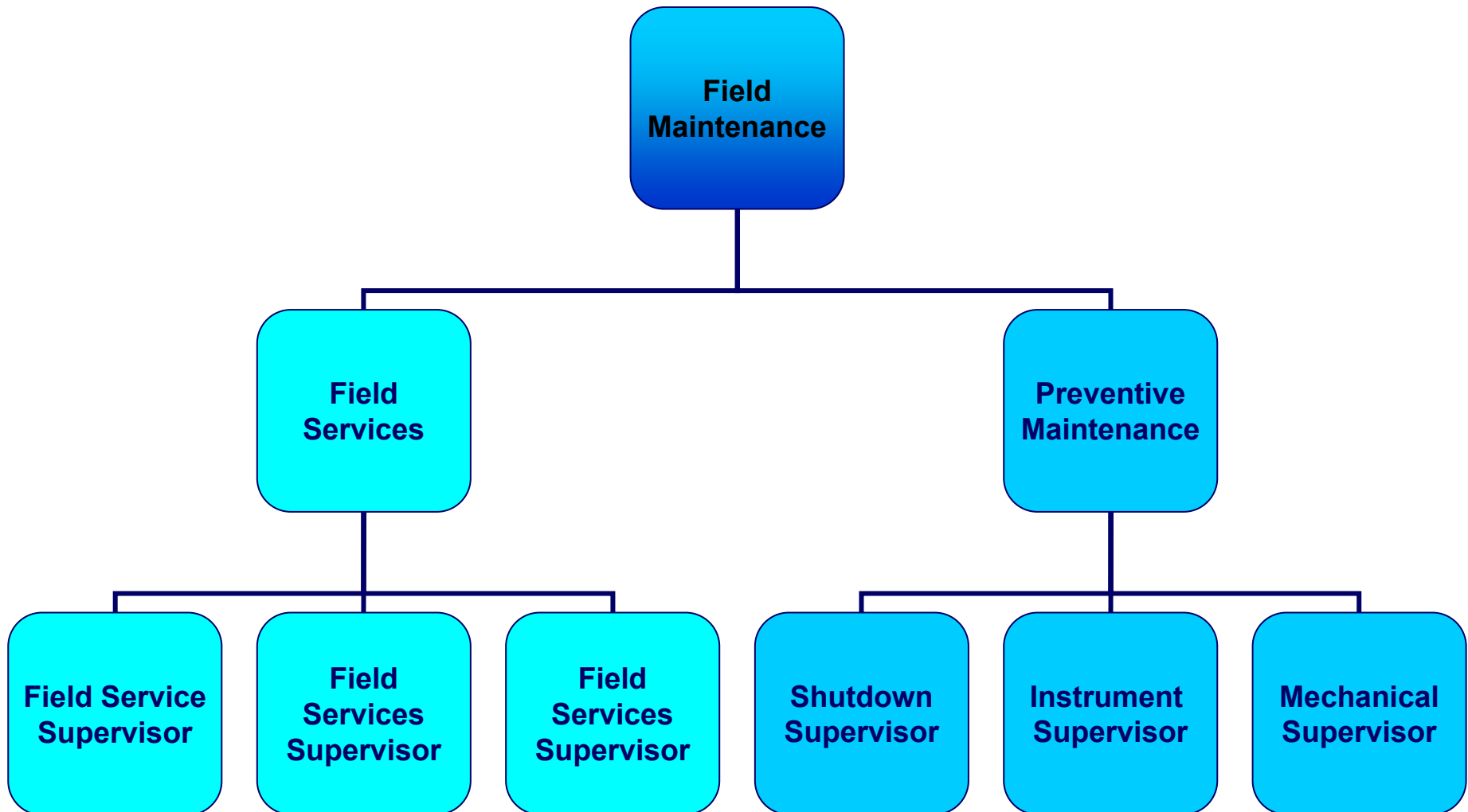
Figure : 1 – Bahrain Field Location Map



Gas Distribution Network



4) Maintenance Function & Organization of Bapco-Upstream (Cont'd):



2009 GAS OPERATIONS T&I SCHEDULE








Task **Milestone**
Split **Summary** **External Tasks**
Progress **Project Summary** **External Milestone**
Deadline **Deadline**

Rev: 0
Date: 20 DEC 2009

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