STUDY OF EMERGENCY MANAGEMENT PLAN IN MIDSTREAM PIPELINE OPERATIONS AT CAIRN INDIA LIMITED

Final year project report

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

Cairn India Limited is a BSE listed company with interests in oil and gas exploration, production and pipeline transportation. It has operating blocks in Andhra Pradesh, Gujarat and Rajasthan. Cairn India has just completed development of major oil and gas fields in the Barmer district of Rajasthan and commissioned world class processing facilities and a 650 km crude oil pipeline to supply the oil to refineries in Gujarat. Cairn India Limited (CIL) commissioned Environmental and Geo Spatial Solutions (EGSS), Chennai to prepare a robust Disaster Management Plan document covering its upstream assets based in Barmer district i.e. Mangala Processing Terminal, Raageshwari Gas Processing Terminal, connected well pads and cross-country pipeline between MPT and RGT. Now with the rapid development of oil and gas fields by companies such as Cairn India and setting up of cement and power plants in the district, there is a significant socio-economic changes in the lives of the people of Barmer for good and at the same time introduced a new risk of potential major industrial accidents or disasters.

Thus the EMP document reviews the midstream pipeline operation and presents a systematic emergency plan with suitable strategies for disaster preparedness and response. It also provides an operational framework and procedures for effective roll out and execution with effective engagement of the communities and the local district administration. Further the plan took into consideration the Jaipur Oil Depot fire (October 2009) incident, and related findings and recommendations of OISD. In addition the plan focuses on disaster prevention measures and proactive safety management.

ACKNOWLEDGEMENT

This two months training part of M.Tech program taught me a lot to understand the key of success in the organization. Therefore, I would like to thank all management and technical team of **CAIRN INDIA LIMITED** who helped me to achieve this result.

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It is my privilege to express my deep gratitude to **Mr.Siva Prasad (DGM Corporate HSE, Cairn India Limited)** who gave me such a great opportunity to do this project and also for his kind cooperation & help throughout the project.

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LIST OF SYMBOLS AND ABBREVIATIONS

AGI	Above Ground Installation
BLEVE	Boiling Liquid Expanding Vapour Explosion
BOPD	Barrels of Oil Per Day
BS&W	Basic Sediment & Water
CBDM	Community Based Disaster Management
CBEWS	Community Based Early Warning Systems
CBO	Community Based Organisations
CIL	Cairn India Limited
CMHO	Chief Medical Health Officer
CMP	Crisis Management Plan
CMT	Crisis Management Team
CO2	Carbon di-oxide
CRA	Commissioner for Revenue Administration
CG	Core Group
CSO	Civil Society Organisation
CSR	Corporate Social Responsibility
CWC	Central Water Commission
DCP	Dry Chemical Powder
DM	Disaster Management
DMC	District Management Committee
DMP	Disaster Management Plan
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EMP	Emergency Management Plan
EMT	Emergency Management Team
EOR	Enhanced Oil Recovery
EPPR	Emergency Prevention, Preparedness and Response
ERC	Emergency Response Centre

ERP	Emergency Response Procedures
ERT	Emergency Response Team
ESD	Emergency Shut Down
EWS	Early warning system
FCP	Forward Control Point
FRT	Forward Response Team
FERA	Fire and Explosion Risk Assessment
GIS	Geographical Information Systems
GPS	Global Positioning System
HSE	Health Safety and Environment
IAP	Incident Action Plan
IMT	Incident Management Team
ICG	Intergovernmental Coordination Group
ICC	Incident Control Centre
ICS	Incident Command System
IDRN	India Disaster Resource Network
IOC	Indian Oil Corporation
IRP	Incident Response Plan
IRT	Incident Response Team
NDMA	National Disaster Management Authority
NFPA	National Fire Protection Association
NGO	Non-governmental organisations
NIDM	National Institute for Disaster Management
NSS	National Social Service
OISD	Oil Industry Safety Directorate
OSCP	Oil Spill Contingency Plan

CHAPTER 1

1. INTRODUCTION

The comprehensive emergency management plan for midstream facility was drafted in accordance with the guidelines of the Government of Rajasthan. The disaster management plan covers natural and man-made disasters, emergency preparedness plans for on-site and off-site purposes and disaster relief and mitigation. Its prime objective is to mitigate the possible risks emanating from Cairn India Limited's (CIL's) oil field related operations.

Organizations have a responsibility to provide support to individuals who are in crisis due to loss of life, natural disasters, or other traumatic events. In emergency situations, a preplanned and organized approach is most effective in reducing psychological and social difficulties. The formation of a trained Emergency Response Team will increase the probability of preserving life, maintaining order under adverse conditions and returning the situation to a normal environment.

The potential to have hydrocarbon related/ Industrial disasters are low in frequency but are very significant in terms of loss of lives, injuries, environmental impact and property damage. Frequency and severity of hydrocarbon related disasters has increased in last few years due to rapid increase in explorations, storage, processing, transportation of petrochemical products, specifically in densely populated areas. Hydrocarbon related accidents can occur due to lack of safety measure, technical breakdown, or due to a human error. A single incident can initiate a series of uncontrolled phenomenon such as large spills, fires and explosions. These eventually target humans, environment and infrastructure/property in the area and can be in the form of immediate and residual or long term consequences. Thus, it is imperative to develop preventive measures like adoption of safer engineering practices, improved performance of safety devices and reduction of human errors by regular checks.

1.1DESCRIPTION OF CIL SITE

Origin: Cairn India Ltd., a, public Limited Company was incorporated under company's act, 1956, on 21 august, 2006 and was listed on the National stock Exchange and Bombay Stock

Exchange on 9 January, 2007. Cairn India is the largest private exploration and Production Company currently operating in India.

Operations: Cairn India operates onshore and offshore hydrocarbon fields in India. There are 40 hydrocarbon fields to date, of which 26 are in Rajasthan. Cairn India's low cost domestic production is critical to meet India's energy needs, and thus it aims to increase the nation's oil and gas production.

1.2 FACILITIES AT CAIRN

Ravva Facility: It is primarily an offshore block. The Ravva Processing Terminal consist of onshore oil & gas processing facilities connected to 8 offshore unmanned platforms located in the Bay of Bengal through subsea pipelines. The processed crude oil is transported to the Single Point Mooring (SPM) via subsea pipelines and is evacuated to the coastal refineries by marine tankers. The natural Gas is transferred to Gas Authority of India (GAIL) at the custody metering skid located within Ravva facility**.**

Suvali Facility: It is primarily an offshore block. The Suvali Processing terminal is located near Hazira within the Gujarat Industrial Development Corporation) notified industrial area. The facility processes crude oil and natural gas and is connected to (3) offshore platforms located in the Gulf of Khambat and one onshore well located in the transition zone. The crude oil is sold to the ONGC facility at Ankleshwar, Gujarat. The processed gas is transferred to the gas pipeline of Gujarat State Petroleum Corporation Limited (GSPCL) at the custody transfer metering skid within Suvali facility.

Rajasthan Facility: It consists of Mangala Processing terminal (MPT) spread over 1.6sqkm in Barmer, Rajasthan, the MPT is designed to process crude from the Mangala, Bhagyam and Aishwarya Fields- collectively known as MBA fields; and has been defined with sufficient flexibility to be later expanded to process more crude, depending on the resource potential of the block. There is Raageshwari Gas Terminal (RGT) located about 60 km south of Mangala facility**.**

The RGT caters to the fuel gas requirements for MPT as well as the requirements of the midstream projects.

1.3 SCOPE OF WORK

This report presents a review and evaluation of emergency response capabilities for CAIRN INDIA LIMITED. The purpose of this review was to provide an independent evaluation of emergency response plans, with the long-term objective of preventing accidents and improving emergency response capabilities. The evaluation also checks if the emergency response plans are followed in the site and the evaluation of mock drills.

1.4 OBJECTIVES

1. To have holistic and integrated approach to address all barriers, threats and consequences of Jaipur fire depot and delivering it in a bow tie diagram.
2. To understand the midstream pipeline operations.
3. To study the emergency management system of midstream operations with clear missions and lines of authority.
4. To ensure an orderly and timely decision-making and response process for midstream pipeline operations.

1.5 METHODOLOGY

1. Collection of various study materials and QRA reports from the corporate office
2. Learning and understanding of the bow tie software
3. Application of bow tie software for Jaipur fire 2009
4. Focusing on midstream pipeline operation, study of its emergency management plan and a few recommendations.

1.6 LITERATURE REVIEW

S.No.	Name of the Author and Year	Objective	Worker's Principle	Key Findings
1.	Cairn India Limited HSEQ Disaster Management plan of Rajasthan facility. 11 Feb 13, V. Rendall (Sr. Mgr. HSEQ)	reviews all credible disaster scenarios and presents a systematic plan with suitable strategies for disaster preparedness and response	It provides an operational framework and procedures for effective roll out and execution with effective engagement of the communities and the local district administration.	Successful handling of Process Safety risks is the responsibility of everyone, requiring the active participation at all levels within the company from senior management through to operator and maintenance personnel. It is applicable to both staff and contractors across all facets of the company activities.
2.	Kristin D. Norton, PE CFSE, Michael B. Saura, Colin R. Scholtz Risk Management Professionals, Inc. April 28 – May 1, 2013	Practical Implementation of Safety Management Systems at Unregulated Upstream Oil & Gas Facilities,	This paper is focused on providing insights and practical tips for the implementation of safety programs at upstream facilities to enhance the commitment to implementing process safety with limited resources.	1. Developing and maintaining PSI, including P&IDs, and implementing document control policies. 2. Standardizing the PHA approach, including characterizing hazards to consistently apply risk ranking, setting risk criteria to define and prioritize recommendations, and organizing facilities such that resources can be systematically applied to baseline HAZOP Studies and subsequent checklists. 3. Implementing a knowledge transfer program to develop robust Operating Procedures.
4.	Steve Lewis Risktec Solutions Limited Warrington, UK March 22-24, 2010	Lessons Learned from Real World Application of the Bow-tie Method.	This paper draws on Risk Tec's unparalleled experience in applying the bow-tie methodology and is intended to be of interest to those who are new to the technique and experienced users alike.	This paper presents the lessons learned from application of the bow-tie method across a number of business sectors. Our experience has shown that the bow-tie is ideal for structured assessment and communication of risks.
5.	Yaneira E. Saud, Kumar (Chris) Israni, and Jeremy Goddard December 2010	Bow-Tie Diagrams in upstream Hazard Identification and Risk Assessment	This article discusses the evolution of the risk-based approach in the United States.	Focus on MHEs, differentiating highly hazardous releases (e.g., loss of containment) from other workplace hazards, occupational health, or environmental aspects.

S.No.	Name of the Author and Year	Objective	Worker's Principle	Key Findings
6.	E. Shyam Sundar, Associate Vice president VIMTA Labs Limited. August 2006	Quantitative Risk Assessment and DMP for hydrocarbon development of Mangala processing Terminal	With the help of QRA the consequences of hazards are identified.	Recognises that equipment can fail and operators can make errors, therefore requires adequate layers of safety systems to reduce the chances of such malfunctions which could lead to accidents.
7.	Syed Zaiful Hamzah Principal Risk Consultant ABS Consulting – Singapore 14th Asia Pacific Confederation of Chemical Engineering Congress Singapore, 21-24 February 2012	Use Bow Tie Tool for Easy Hazard Identification.	Objectives of Hazard Identification & Assessment to ensure hazards are known understood and properly managed. Risk is reduced to As Low As Reasonably Practicable (ALARP) are utilized in the risk assessment process.	1. Assess and categorize risk factors dependability and influence. 2. Risks are prioritized using risk priority matrix. 3. Mitigation strategies are selected based on FMEA. 4. Framework was used improve risk assessment process in a chemical plant

CHAPTER 2

2. A BRIEF ABOUT BOW TIE ANALYSIS

The exact origins of the bow-tie methodology are a little hazy. In 1979, it was presented by The University of Queensland, Australian. Undoubtedly, the Royal Dutch/Shell Group was the first major company to integrate fully the total bow-tie methodology into its business practices and is credited with developing the technique which is widely in use today. The primary motivation was to seek assurance that fit-for-purpose risk controls were consistently in place throughout all operations world-wide.

In the complex world of industrial safety, a "smart bowtie" has nothing to do with dressing for dinner. Stemming as it does from risk assessment and safety case work in the 1980s by the oil and gas industry, the bowtie approach is increasingly used to understand and communicate key risk control measures at a whole range of facilities, from an offshore oil and gas platform to a mine or manufacturing plant.

In our experience, the bowtie provides a visual roadmap to more effective process safety. It can help us; for example, examine the potential causes of a toxic release from a particular vessel and how this could be prevented. It can also ensure a better focus on outcomes – for example an oil spill and how these could be mitigated. The bowtie diagram provides us with a visual representation of the safeguards required to prevent different causes of a hazardous event and the mitigation measures needed if there is an incident. The description of bow tie diagram includes:

1. Top Event (Accident Scenario)

2. Left Side (To reduce the chance of top event to occur)

- Threat
- Barrier
- Escalation factor
- Control measures
- Recommendations

3. Right Side (To reduce the consequences should the top event does occur)

- Consequences
- Recovery measures
- Escalation factor
- Control measures
- Recommendations

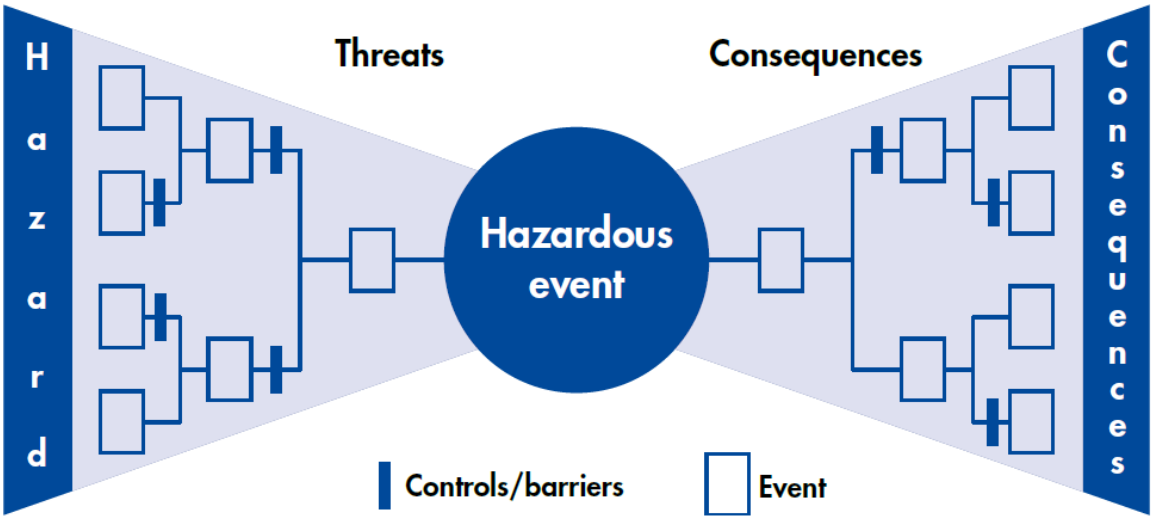

FIGURE 1 BARRIER IDENTIFICATION

2.1 VULNERABILITY ASSESSMENT OF JAIPUR FIRE 2009

A major disaster involving loud explosions from hydrocarbon storage tanks took place on October 29, 2009 at IOC Jaipur Terminals at the Sitapura industrial area. The flames due to explosion from three of the 11 tankers containing petrol and diesel spread to the nearby settlements causing several casualties. Further, the explosion also resulted in environmental degradation of the area. Black smoke formed dark clouds in a two-three kilometre radius around the depot causing respiratory distress to a large segment of the population. It is noted from the incident investigation report by Oil Industry Safety Directorate (OISD) that the IOC Jaipur Terminal incident is attributable to one or more of the following probable causes:

• Loss of containment and subsequent pool of large quantities of highly volatile flammable liquid giving rise to a massive vapour cloud explosion,
• Encroachment on to the Terminal premises by land use developments
• Plant/process engineering practices and design susceptible to human errors
• Layout congestion due to successive plant expansion with the finite land area
• Proliferation of vegetative growth within the facility premises
• Non-adherence to standard operating procedures (SOP)
• Unascertainable level of fire fighting readiness capability and training

2.2 LESSONS LEARNT FROM THE INCIDENT

Cairn has set high standard of health, safety and environmental (HSE) practices and has conducted various HSE studies to better understand the hazards and risks of the facility. In addition, the recommendations of the QRA and FERA reports are being strictly followed. Based on the lessons learned from the Jaipur incident, the following measures/steps can be considered:
• A buffer zone can be set up around the Cairn facility to prevent establishment of new settlements and businesses. This has to be promulgated by the District Authorities
• Periodic training of Cairn field personnel to improve their competency and to enable them to assess hazards and mitigate potential risks
• In addition to regular mock drills conducted by Cairn, District Authority should hold multi-stakeholder (involving community, industries concerned, district administration etc.) mock drill exercises periodically.
• When new wells are being drilled, an area of 1km radius around the facility should be considered as buffer zone. No new settlements should be allowed to reside within this zone.

2.3 BOW TIE OF JAIPUR FIRE 2009

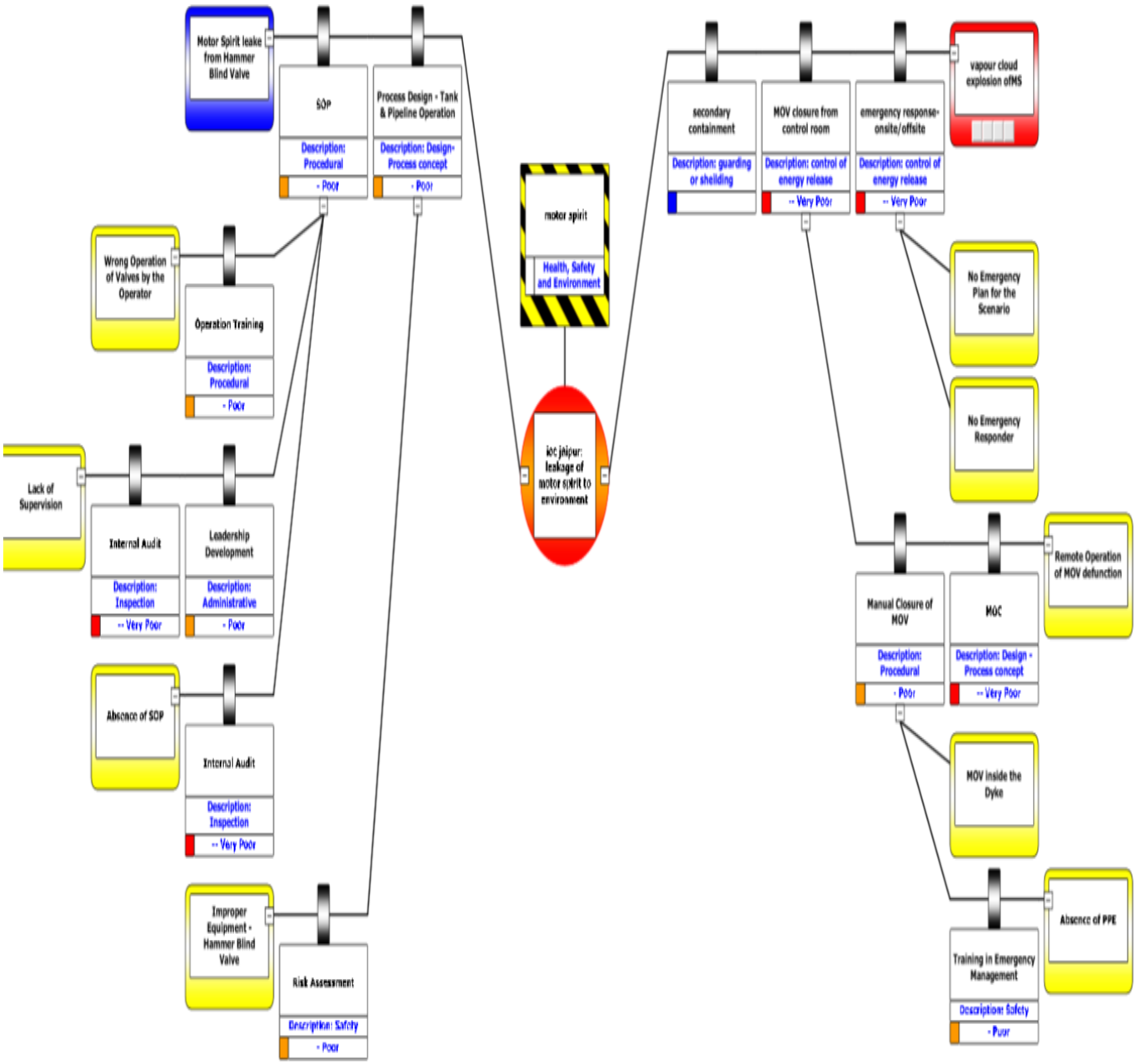

FIGURE 2 BOW TIE OF JAIPUR FIRE 2009

CHAPTER 3

3. PIPELINE OPERATIONS

In essence, the Rajasthan project is about commercialising the world class discoveries, getting the oil and gas production to market and nurturing and enhancing the resource base in the region— thus providing additional supply of energy that is vital for India's growth needs.

Production of crude oil is done from the three main fields, first Mangala, then Bhagyam and Aishwariya, followed by other fields through the development and operations of the MPT. Crude flowing through the continuously heated and insulated pipeline from the MPT at Barmer to Bhogat on the coast of Gujarat via Viramgam and Salaya. Enhancing Rajasthan's resources through technology applications in reservoir development, management, enhanced oil recovery (EOR), focused development efforts in low permeability reservoirs such as the Barmer Hill and the phased development of other fields. Further exploration in other parts of the Rajasthan block, which is spread over 3,111 km2, where the Company believes there are significant prospects. Cairn came into Rajasthan in the late 1990s, when it acquired an interest in the block RJ-ON-90/1. It soon realised that the area was rich in hydrocarbons and possessed all the key ingredients for successful commercial production. By 2003, Cairn had acquired 100% of the exploration interest and assumed the role of operator of this acreage. In 2004, the Mangala Field was discovered which is considered to be the largest onshore discovery in India in the last 25 years. This was followed by the key discoveries at Bhagyam and Aishwariya, which along with Mangala field. To date, 25 discoveries have been made in the Rajasthan block. Cairn India is the operator of the Rajasthan block with a 70% participating interest and its joint venture (JV) partner, ONGC has a 30% participating interest.

3.1 PIPELINE AND EXPORT SYSTEM

The MDP is designed to evacuate the crude oil produced from the Rajasthan assets and provide access to markets. It is the world's longest, continuously heated and insulated pipeline. Starting at the CPT, it passes through eight districts across two states, i.e. Rajasthan and Gujarat. The pipeline ends at the coastal location of Bhogat near Jamnagar on the western coast of India. The construction from Central Processing Terminal (CPT) to Salaya was completed in a record time

of 18 months. The CPT to Salaya section (~590 km) of the pipeline continues to safely deliver crude oil to Indian refiners and is operating in line with the current production profile. The balance section between Salaya to Bhogat (~80 km) has been completed and final testing is underway.

The MDP is not a conventional pipeline. Its technological ingenuity was necessitated on account of the waxy nature of crude oil. The challenge was to ensure that the crude oil remains above the Wax Appearance Temperature (WAT) of 65°C through its entire length. This required Cairn India to build a continuously heated and insulated pipeline to maintain mobility and flow through its journey over the entire length of the pipeline.

The pipeline also incorporates a Pipeline Intrusion Detection System. This provides security cum surveillance along the entire length of the pipeline, utilising a fibre optic system that generates an alarm. This is linked to a central control unit via a Distributed Control System (DCS). The pipeline is monitored at the CPT, Viramgam and Bhogat terminals for flow, temperature, pressure, and other operational parameters.

Cairn India had embarked on a project to de-bottleneck the CPT to Salaya section so that it could handle additional production. This involved:

- Adopting a proven approach, that utilises polymer additives in the pipeline which play the role of Drag Reducing Agents (DRAs) to increase the flow of waxy crude. DRAs are used in crude oil pipelines to increase flow efficiency and reduce turbulence, allowing the oil to flow under a reduced frictional drag environment.
- DRAs increase the pipeline export capacity without the need to add any booster pumping infrastructure. Capacity enhancement can be achieved within short time and no major equipment is needed under this process. Moreover, it allows for greater operational flexibility.

This project was successfully completed in 2013. It has been tested and proven to deliver higher volumes in line with Cairn India's planned production ramp up.

3.2 BHOGAT TERMINAL FACILITIES

The Bhogat terminal in the Jamnagar district, Gujarat, is a 160 hectare site located 8 km from the Arabian Sea coast. The terminal will facilitate the storage and evacuation of crude by sea. Some key elements of the Bhogat terminal are:

- Two 24" sub-sea export pipelines from the Bhogat landfall point to the Single Point Mooring (SPM) system to enable crude transfer.
- SPM system and sub-sea pipeline end manifold in deep sea to enable tanker berthing and loading.

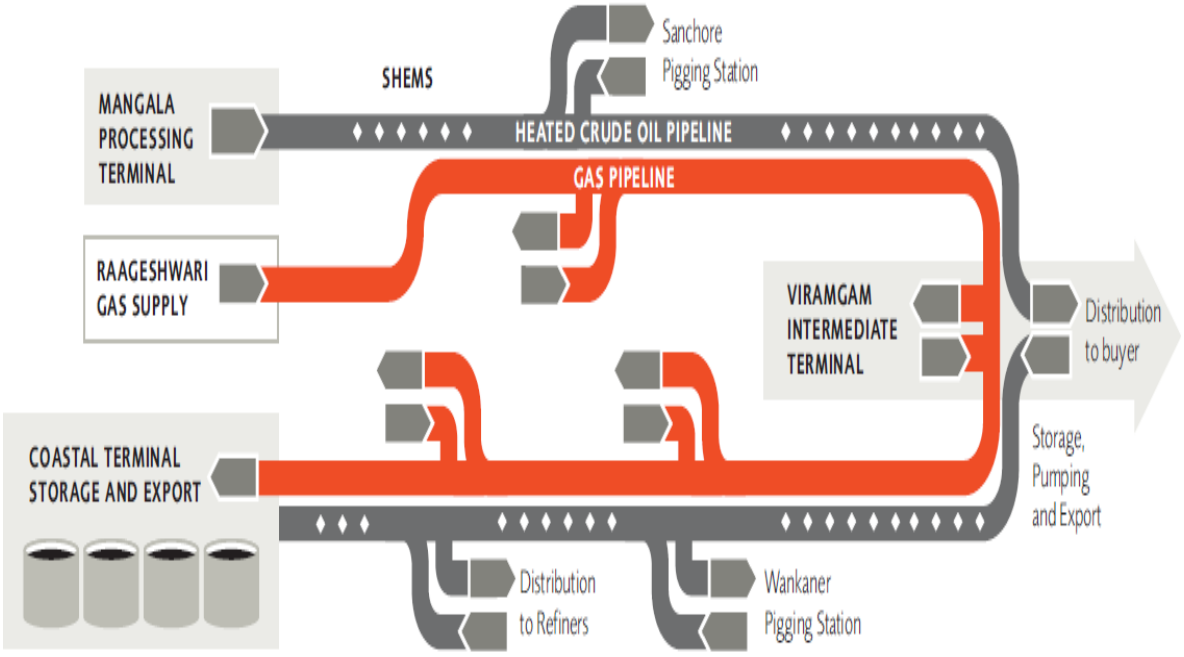

FIGURE 3 SCHEMATIC DIAGRAM OF RAJASTHAN GUJRAT PIPELINE

3.3 SKIN EFFECT HEAT MANAGEMENT SYSTEM CAIRN INDIA LIMITED

Cairn India is building the world's longest continuously heated and insulated pipeline (~700 km) to evacuate the crude from the Mangala field in Rajasthan. The export pipeline route from source at the Mangala Production Terminal to the Gujarat coast at Bhogat via Salaya passes through the states of Rajasthan and Gujarat covering eight districts and more than 250 villages. In addition,

there are 4 branch lines ranging in length from 2.5 km to 21 km delivering crude to customer's enroute. Currently, 600 km section from Mangala to Salaya, along with four branch lines if fully operational. Necessity, as they say, is the mother of invention, and in the case of Cairn it was the same for this innovation of technology. The necessity of evacuating the Rajasthan crude, which is waxy in nature and needs to be maintained above 65 °C to ensure its flow, resulted in customizing existing heating technology into the Skin Effect Heat Management System (SEHMS), an innovative system by far the longest of its kind in the world today. SEHMS technology has traditionally been most often applied to shorter above ground applications. There were many innovations required to apply this technology to an underground cross country pipeline system. The crude oil pipeline is insulated with 90 mm Poly Urethane Foam (PUF) to arrest the heat loss from pipeline to the surrounding soil; this is further enclosed with a 5 mm HDPE jacket for protection and to make it water tight. Above ground heating stations with maximum 1 MW power generating units installed at every 20 km along the pipeline route supply power to SEHMS. In addition, 2 intermediary terminals and a total of 36 heating stations are installed along the pipeline route. SEHMS technology also known as the Skin Trace System (STS) or Skin Electric Current Tracing (SECT), are all dependent on the same principles of skin and proximity effect for operation. They are all established and proven electrical heating technologies used for long distance piping and pipelines. SEHMS generates heat on the inner surface of a carbon steel heat tube that is welded to the carrier pipe to be heat traced, which in our case is the 24" crude pipeline. An electrically insulated, high specification temperature-resistant conductor is installed inside the heat tube and connected to the tube at the circuit end. The tube and conductor are connected to an AC voltage source in a series connection. This method of heating is called skin-effect heating because the return path of the circuit current is pulled to the inner surface (approximately 1 mm) of the heat tube by both the skin effect and the proximity effect between the heat tube and the conductor. The outside surface of the heat tube is at ground potential, and completely safe, while the inner surface of the tube carries full current. The heating circuit impedance is mainly resistive, generating heat in the heat tube wall and, to a lesser extent, in the insulated conductor. Additional heat results from eddy currents induced in the heat tube wall by the current flow through the insulated conductor. The allowable circuit length is determined by the power output; heat tube size; conductor size; and the carrier pipe temperature. SEHMS 's advantage over other electrical trace heating systems is that extremely

long circuit lengths are possible – typically a pipeline of up to 20 km may be heated from a single electric supply point (2 circuits of 10 km each). In ideal situations the SEHMS heating system is not required on the Mangala Bhogat Pipeline as the 90 mm of PUF pipeline insulation will be good enough to keep heat losses within acceptable limits. Fuel for the gas engines producing the power for the pipeline heating system comes from an 8 inch diameter pipeline laid parallel to the main 24 inch crude pipeline. The primary gas source is from Cairn's Raageshwari field in Rajasthan. Skin Effect Heat Management System was chosen as a suitable solution due to the following advantages:

• Safe • Custom engineered • Easy to maintain • Rugged and reliable • Provides built in redundancy • Cold re-start capability • successfully used in similar conditions

The details of the Power Source and Temperature Monitoring are as follows:

• Power requirement – 40 W / m • Voltage – Approx. 4000 V • No current flow on outside skin of tube • System earthed & grounded with earth fault automatic trip • Remote emergency shut-down capability • Current flows through center conductor • Current returns through inside skin of outer tube

Since the start of pipeline operations in 2010, the SEHMS system has performed capably and contributed importantly to the pipeline, achieving world-class availability levels and has proven to be a robust and reliable technological solution to effectively solve flow assurance issues with waxy Mangala crude oil. This is the largest scale application of this technology. Mangala Development Pipeline Project is unique as it is believed to be by far the longest such continuously heated and insulated pipeline in the world. Currently, the longest pipelines using this technology are in Russia (160 km) and Indonesia (115 km).

3.4 PIPELINE INTRUSION DETECTION SYSTEM

Pipeline Intrusion Detection System (PIDS) installed by Cairn India Ltd. (CIL), using existing fiber optic cable and acoustic signature recognition, is one of the most efficient ways to mitigate external sabotage/threats to a long distance pipeline. The system is designed to sense the vibrations, earth movement, and other surface movements associated with such activities. It detects excavation/intrusion activities as the equipment approaches the sensing cable and pipe itself. It is also capable of accurately locating the source of ground vibrations. The system also

supports leak detection and pig tracking along the pipeline. By providing an early warning and precise location of an incident, Pipeline Intrusion detection system can help responders prevent costly damages/business/safety impact. Using already existing fiber optic cables along the pipeline, PIDS is the latest proven technology which provides critical information for effective response in event of any undesirable activities along pipeline.

3.5 HOW IT WORKS

A fiber optic cable is laid throughout the pipeline from Mangala until Bhogat including Spur pipelines. The fibre can be within a 10m range from pipeline and processor located at AGI's in every 40 km. the information is passed to the existing control room and hereby through mobile alert to the head office.

The following steps are:

1. Detect: highly sensitive, picks up activity quickly
2. Locate: map display, events are located to within 10m along the entire length of the fibre
3. Classify and alert: classification of activities detected and alerts on threats.

PIDS uses technique called coherent optical time domain reflectometry (C-OTDR) events in the vicinity of the fibre/pipeline which generate seismic signals are detected on the sensing fibre,

1. A pulse of light is transmitted into the fibre is reflected back from along the entire length of fibre
2. The reflection is caused by Rayleigh backscatter in the fibre
3. The information available to the user is regulated by the bandwidth available
4. The alert is generated at the processing unit is transmitted to the control unit.
5. The entire assest becomes visible from a central point.

Key factors summary

1. Sensitivity: highly sensitive early warning capability, multiple sensing
2. Accuracy: zoning capability- sound signatures database, eliminate unwanted noise, clear distinction between different activities, ongoing system calibrations

3. Applications: pipelines-monitor the assets (damage, pigging, theft, maintenance), applicable for crude and gas pipelines, pipeline mapped in GIS and Satellite images
4. Installations: only require one spare fibre, local and remote monitoring support, continuous training for operators through mock drills, HSE exercises, etc.

3.6 PIGGING

Pigging refers to maintenance practice for pipelines using 'pipeline pigs', for cleaning or inspection of pipeline without stopping operation of the pipeline. Pipeline pigs are capsule shaped objects which travel through the pipeline, cleaning the inner walls of the pipeline by brushing action. Pigs get their name from the squealing sound they make while traveling through a pipeline. Pigging usually means inspection and cleaning of the pipeline. The pig is inserted into a pig launcher, which is essentially a vessel used to for launching the pig into a pipeline using by creating a pressure differential. The pressure differential pressure between the two ends of pig launcher is created by partially closing the bypass line on the pig launcher. After launching the pig into the pipeline, pig launcher is closed and the fluid pressure is then used to push this pig through entire length of the pipeline, cleaning the inner walls all the way to the other end. On the other end of the pipeline, this pipe pig is received by a pig receiver, which has a similar structure and arrangement as the pig receiver. After receiving the pipe pig, pig receiver is closed, depressurized and then pig is removed along with the dirt and sludge. Pigging has been practiced for a long time to clean larger diameter pipelines in the oil industry. Today, however, the use of smaller diameter pigging systems is now increasing in many continuous and batch process plants as plant operators search for increased efficiencies and reduced costs.

Pipe pigging can be used for almost any section of the transfer process between, for example, blending, storage or filling systems. Pigging systems are already installed in industries handling products as diverse as lubricating oils, paints, chemicals, toiletries, cosmetics and foodstuffs.

Pipe pigs are very frequently used in oil and gas pipelines: they are used to clean the pipes but also there are "smart pigs" used to measure things like pipe thickness and corrosion along the pipeline. They usually do not interrupt production, though some product can be lost when the pig is extracted. They can also be used to separate different products in a multiproduct pipeline. Based on these factors a type of pig tool is chosen. Pipe pig types can be classified into following categories.

1. Utility Pipe Pig - These pig tools are used for cleaning and product separation. Based on the utility or the purpose of the pig tool, these are classified into 'cleaning pig tools' used for cleaning and 'sealing or separation pig tool' used for separation between two products. Based on the pig structure, utility pig tools are further classified as, 'foam pigs', 'mandrel pigs' and 'spherical pigs'. Foam pigs are capsule shaped and made out of polymer foam. Mandrel pigs are dumbbell shaped with a central tube called 'mandrel'. Different kinds of components can be attached to this mandrel to customize the pig tool to suit different operations. Spherical pig tools are either solid spheres made from polyurethane foam or inflatable spheres inflated using glycol and water.

2. Inspection Pig Tool - They are also known as 'intelligent pig tool' or 'smart pig tool'. They are used for inspection of the condition of the pipe and/or its contents. These pig tools are equipped with sensors for gathering various kinds of data, as the pig tool travels through the pipeline. The electronics and sensors on an intelligent pig tool are powered by batteries on the pig. Surface pitting, corrosion of inner walls, cracks and weld defects in pipelines are often detected using magnetic flux leakage (MFL) pigs. Other intelligent pig tools use electromagnetic acoustic transducers to detect pipe defects. Caliper pigs can measure the roundness of the pipeline to determine areas of crushing or other deformations.

3. Gel Pig Tool - Gel pigs are a series of gelled liquid systems which have been developed for use in pipeline operations, either during initial commissioning, or as a part of a continuing maintenance program. Most pipeline gels are water-based, but a range of chemicals, solvents, and even acids can be gelled. Some chemicals can be gelled as the bulk liquid and others only diluted in a carrier. Gelled diesel is commonly used as a carrier of corrosion inhibitor in gas lines. As a liquid, although highly viscous, the gel can be pumped through any line which will accept liquids. Gel pigs can be used alone (in liquid lines), in place of batching pigs, or in conjunction with various types of conventional pigs. When used with conventional pigs, gelled pigs can improve overall performance while almost eliminating the risk of sticking a pig. Gel pigs do not wear out in service like conventional pigs. They can, however, be susceptible to dilution and gas cutting. Care must be taken, therefore, when designing a pig train that incorporates gel pigs to minimize fluid bypass of the pigs, and to place a conventional pig at the back of the train when displacing with gas.

3.7 PIGGING AT CAIRN INDIA LIMITED

As the crude oil has high wax content, pigging of the crude oil pipeline and Radhanpur/Reliance/Essar spur line is frequently performed in order to minimize the wax depositions. The pipeline is split into three sections for pigging operations of pipelines

- Section 01 - Mangala terminal to Sanchor intermediate pigging station
- Section 02 – Sanchor intermediate pigging station to Pigging Station AGI-13A
- Section 03 - Pigging Station AGI-13A to Viramgam terminal
- Section 04 - Pigging Station AGI-13A to Radhanpur terminal
- Section 05 – Viramgam Terminal to Wankaner Intermediate Pigging Station
- Section 06 – Wankaner Intermediate Pigging station to Salaya Pigging Station
- Section 07 – AGI 32A to Reliance Pig Receiving Station
- Section 08 – Salaya to Essar Pig Receiving Station

600 MM CRUDE OIL PIPELINE	
Parameter	**Value**
Pipeline Diameter	600 mm (24 inch NPS)
Material of Construction	Carbon Steel API 5L X65
Pipeline Wall Thickness	10.6 mm
Corrosion Allowance	1.2 mm
Pipeline Length – Mangala to Salaya	Approximately 594 km
Pressure at Mangala Terminal	7100 kPag
Pipeline Design Pressure	9500 kPag / FV
Temperature at Mangala Terminal	90°C
Maximum Design Temperature	93°C for heated pipeline
Minimum Design Temperature	15°C for buried pipeline

Heating	By SEHMS
Insulation	90 mm thick Polyurethane Foam (PUF), in an outer jacket of high density polyethylene (HDPE) of 5 mm thickness
Cathodic Protection	Not required
Maximum Crude Oil Flow Rate	150,000 bopd (23,848 m^3/d)
Minimum Crude Oil Flow Rate	30,000 bopd (4770 m^3/d)

Crude Oil Pig Launcher/Receiver	
Parameter	**Value**
Tag No. (Pig Launcher)	2012-PF-201 (Mangala launcher) 2024-PF-203 (Sanchor launcher) 2055-PF-002 (AGI-13A launcher) 2055-PF-003 (AGI-13A spur line launcher) 2014-PF-205 (Viramgam launcher) 2041-PF-207(Wankaner) 2056-PF-001(AGI 32A Reliance Spurline) 2015-PF-210(Salaya to Essar Spurline)
Tag No. (Pig Receiver)	2055-PF-001 (AGI-13A receiver) 2024-PF-202 (Sanchor receiver) 2014-PF-204 (Viramgam receiver) 1712-PF-001 (Radhanpur receiver) 2041-PF-206 (Wankaner) 2015-PF-208 (Salaya) 1800-PF-001(Reliance Spurline) 1400-PF-001(Essar Spurline)
Material of Construction	SA 516 Gr 70
Corrosion Allowance	3.0 mm
Size	600 mm x 700 mm (24 inch x 28 inch)
Design Pressure	9500 kPag
Max. / Min. Design Temperature	93°C / -2°C
Heating	Electrical tracing
Insulation	100 mm PUF
Design / Construction Code	ASME B31.4 / ASME VIII Div

3.8 HAZARDS AND RISKS INVOLVED IN PIGGING OPERATION

The following hazards and risks have are typically linked to pigging operations:

- Exposure to high pressure hydrocarbon gas or condensate
- Physical exertion required to operate manual process valves or handling pig
- Potential loss of containment of hydrocarbons through leaking flanges or opened valves
- Risk of igniting released hydrocarbon gas or condensate

FIGURE 4 PIG OPERATION

3.9 PRECAUTIONS TO BE TAKEN DURING PIGGING OPERATIONS

- Wear standard Personal Protective Equipment (PPE).
- All personnel should minimize their exposure to the open launcher barrel.
- Never assume that a launcher barrel is depressurized, as pressure can accumulate over time.
- Never attempt to open the barrel unless it is certain that it is at atmospheric pressure.
- Always check that the launcher barrel is completely depressurized before draining to the drain vessel.
- Use a trolley to assist on the insertion or removal of the pig where possible.
- Follow manual handling requirement to avoid injuries.

CHAPTER 4

4. EMERGENCY MANAGEMENT PHILOSOPHY

Cairn India's Emergency Response Philosophy it to provide "reasonable assurance that adequate protective measures can and will be taken in the event of an incident or emergency." This document sets forth emergency planning standards and defines the responsibilities of the organizations involved in emergency response. Emergency planning has been adopted as an added conservatism to the Emergency Response philosophy. Briefly stated, this philosophy

1. Requires high quality in the design, construction and operation of the facilities to reduce the likelihood of malfunctions;
2. Recognizes that equipment can fail and operators can make errors, therefore requiring safety systems to reduce the chances that malfunctions will lead to accidents;
3. Recognizes that, in spite of these precautions, accidents may happen, therefore requiring containment structures and other safety features to prevent escalation; and
4. Has in place organizations capable of responding to incident's and emergency situations that may occur involving any of the Cairn India facilities or supporting operations, to preserve life.

The added feature of emergency planning philosophy provides that, even in the unlikely event of an incident or release to the environment, there is reasonable assurance that actions can be taken to preserve life, injury to people damage to plant or the environment Cairn India Limited's (CIL) responsibility is to properly manage any emergency or crisis situation so as to minimize the impact it may have on all personnel associated with its activities, the environment, the community, the Company's financial position and reputation. To respond effectively to emergencies and incidents an agreed and approved Incident Response Plan (IRP) shall be in place supported by a pre-established organization, on-call and capable of mobilizing and responding effectively to different levels of incidents that may occur. This organization must be staffed with competent individuals, organized into teams, with allocated and clearly defined roles and responsibilities and practiced in their roles. This IRP must be documented and identify the various levels of the Cairn emergency organizations and emphasizes the links and interrelationships between these levels. The IRP must define the organization and predetermined actions that are in place in order to respond effectively to incidents and must also define the

procedures to be followed by the Incident Response Teams (IRT's) and Emergency Response Team (ERT) to ensure a prompt and efficient response to emergency situations wherever they occur within the Balmer Salaya Pipeline as well as AGI's. The IRP shall include scenarios of incident types associated with Major Accident Hazards and the IRP will therefore require to be updated as new equipment is commissioned and brought on line.

In a bow tie diagram we know there are preventive measures on the left and the recovery measures on the right as a part of my project work I will be concentrating on the emergency management plan which is one of the recovery measure as shown in the bow tie.

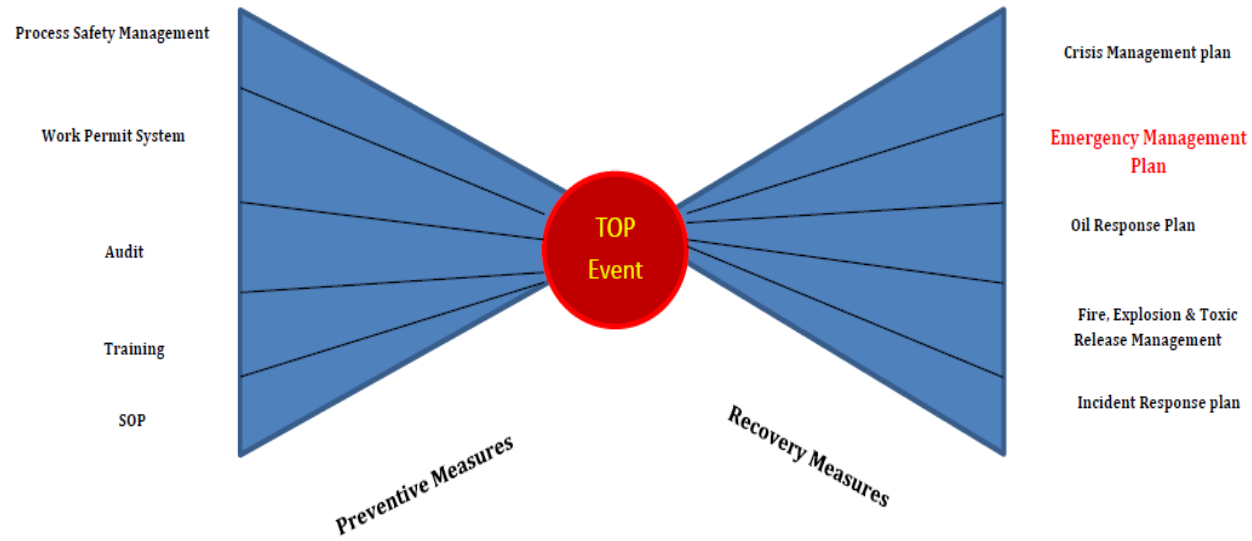

FIGURE 5 BOW TIE ANALYSIS

4.1 DOCUMENT CONTROL AND DISTRIBUTION

This Mangala Development Pipeline including AGI's (Above ground installations) Incident Response Plan is issued on the authority of the Head of Operations. It is the responsibility of the Midstream Operations Field General Manager to ensure that the document reflects the latest emergency response information and for ensuring that the whole document is reviewed at regular intervals not exceeding two years or when there is a change in the operating asset structure that has an impact on the contents. It is the responsibility of all Holders of this Incident Response Plan that they ensure that they are using the most up to date version of the Document. The person managing the location to which the Emergency Response Plan is issued is responsible for

ensuring the manual is the current version and is maintained up to date with any revisions incorporated. When any location is de-mobilized then it is the responsibility of the person managing that location to return the manual to the Document Control Centre, Gurgaon. Any changes to this document must comply with the Management of Change (MOC) procedure and be submitted in writing to, and approved by, the Midstream Operations Field General Manager. Controlled copies of this document will be issued to everyone in the distribution list. The original electronic version is also available in documentum. Those with specific duties for dealing with an incident or emergency must ensure that they are aware of their responsibilities and duties as contained in this manual, and the manner in which these procedures interface with the other support groups and organizations.

4.2 PURPOSE

The primary purpose of this IRP is to ensure that personnel based at Various Terminals, and who are appointed to an Incident Response Team (IRT) or an Emergency Response Team (ERT) are aware of their roles and responsibilities and the incident response procedures. The IRP details the procedures to be followed by members of the IRT and ERT to ensure a prompt and efficient response, should an incident or emergency situation occur within the field area in which they are based. This IRP contains Incident Management Guides (IMG's) based on the most significant risks that may occur in the pipelines as well as AGI's; these IMG's are provided as an aid for those involved with managing incidents or emergency situations. The IMG's can be used as an aid for the purpose of emergency response training and exercises. Incident Response Teams (IRT's) for each of the various field areas will be formed from managers, supervisors and personnel based in the field who will be on call at all times while on location**.** Personnel who form an IRT will be informed of their responsibilities and trained in their role. If an incident or emergency situation develops the IRT will be mobilised, and as the situation develops, depending on circumstances at the time, other suitably trained personnel may be called to provide assistance. Similarly each member of the ERT will also be trained and practiced in their role.

4.3 EMERGENCY CLASSIFICATION

An emergency is any unplanned event which changes the operational state of the site or location and requires an IMMEDIATE RESPONSE to deal with it. CIL defines emergency situations in

three tiers of severity, related to the scale of the incident and the capability of the organization to respond effectively.

Emergency Level	Category	Response	Health & Safety	Environment	Security
Tier 3	Crisis situation appears likely. Duty CMT leader's decision to call out CMT members. Duty CMT leader must notify the Chief Executive Officer.	Crisis Management Team	▪ Incident leading to loss of facility ▪ Incident leading to significant financial loss ▪ Kidnap or extortion / threat ▪ Incident leading to multiple injuries or a fatality ▪ Total loss of marine vessel ▪ Incident which could lead to international media interest ▪ Major traffic incident with multiple casualties	▪ Major pollution - Oil spill > 1000T (7000bbls) ▪ Effluent discharge / flaring beyond acceptable limits ▪ Flood or Cyclone warning - Yellow alert - within 12 hours ▪ Major Earthquake	▪ Terrorist activities / bomb threat ▪ Kidnap or extortion / threat ▪ Major civil unrest
Tier 2	Substantial incident. Duty EMT leader's decision to call out EMT members. Duty EMT leader must notify duty CMT leader.	Emergency Management Team	▪ Fire & or explosion ▪ Injury or illness requiring evacuation ▪ Traffic accident requiring external assistance ▪ Marine incident like vessel collision ▪ Flood or Cyclone warning - Blue alert - within 48 hours	▪ Oil spill from > 100T but < 1000T (700 – 7000bbls) ▪ Offsite environmental exposure contained with outside help ▪ Earthquake ▪ Flood or Cyclone warning - Blue alert - within 48 hours	▪ Civil unrest or security breach ▪ Major Criminal activity
Tier 1	A minor incident where site/location requires no external assistance and can control the incident with location resources. Incident Controller must notify leader of the ERT or EMT of the situation.	Incident and Emergency Response Teams	▪ Minor medical or injury case requiring no external support ▪ Equipment damage without loss of production ▪ Minor fire without injury or plant damage ▪ Rescue of trapped and injured personnel	▪ Minor oil spill < 100T (700bbls) ▪ Onsite environmental exposure contained with internal effort e.g. chemical spill ▪ Notification of cyclone within 72 hours	▪ Notification of cyclone within 72 hours

TMDAYT

FIGURE 6 THE DETAILS OF THE TIER LEVELS AND IS BASED ON THE CAIRN RISK EVALUATION GUIDELINES

4.3.1 Tier 1

- Emergency or incident can be effectively and safely managed, and contained within
- the site, location or facility by operations staff
- Emergency or incident has no impact outside the site, location or facility
- There is unlikely to be danger to life, the environment or to company assets or reputation.

4.3.2 Tier 2

- The incident cannot be effectively and safely managed or contained at the site, location or facility by operational staff and additional support is required.
- The incident is having, or has the potential to have an effect beyond the site; location or facility and external support may be involved.
- There is likely to be danger to life, to the environment, to company assets or reputation.

4.3.3 Tier 3

- The incident has escalated to a level where it has, or has the potential to; adversely affect the public, the Company's operations or reputation.
- The incident will have technical, media, public affairs and personnel implications, which require immediate action.

4.4 CIL INCIDENT AND EMERGENCY MANAGEMENT ORGANISATIONS

The Company's emergency management procedure uses a three-tiered emergency management organisation. These are:

1. At the first level there is the **Incident Response Teams** (IRT's) based in the incident control centres at located at Radhanpur, and Viramgam & and in future Bhogat Terminal. The Emergency Response Team (ERT) is located at Viramgam Terminal for entire Midstream. There are Incident Response Teams based at all manned remote locations, sites or facilities that are responsible for:

- Management and control of localised incidents and emergencies
- Notifying and liaising with the duty Emergency Management Team Leader
- Notifying the ERT Leader

Note for the unmanned stations there will be a **Forward Controller** responsible for the response for a designated number of above ground facilities and pipeline section .The Emergency Response Teams role is to provide support to the entire field IRT's and act as the main link to the EMT. In the initial stages of operation, especially early gas, support for the most northern sections of the pipeline will be sourced from Rageshwari Gas Terminal (RGT) and Mangala Processing Terminal (MPT).

2. An **Emergency Management Team** (EMT) based in the Company head office in Gurgaon, responsible for:

- Providing support, advice and off-location assistance to the remote location where a major incident is in progress
- Notifying next-of-kin, authorities, employees, contractors, national JVs etc Notifying and liaison with Crisis Management Team
- Providing and co-ordinating specialist support
- Co-ordinating recovery from incident
- Obtaining clearances for and issuing release to national media

3. A **Crisis Management Team** (CMT) based in the Company head office in Gurgaon, responsible for:

- Providing strategic response assistance, support and advice to the EMT
- Notifying international authorities, shareholders, JV partners, and financial institutions
- Co-ordinating and approving all media releases, issuing international media releases
- Authorising extraordinary expenditure
- Deciding on the course of action in the event of civil unrest or war
- Co-ordinating response to kidnap and extortion demands
- Providing legal advice and response

Each remote location, site or facility is having in place an incident Response Plan and an Incident Response Team trained to manage incident and emergency situations at their location, site or facility and to assist at other nearby CIL locations, sites or facilities.

The Incident response plan details the incident response team's individual roles and responsibilities and provides guidance on how they should provide assistance to others in emergency or incident situations and address the issues arising out of such situations e.g. personnel,environment,legal and financial.

4.5 CIL INCIDENT AND EMERGENCY MANAGEMENT ORGANISATION RELATIONSHIP

The Cairn India Limited management of incidents and emergencies is handled through a three tiered structure with organisations in place to cover each level. The Midstream pipeline project development consists of various facilities which need to be supported by a trained and competent emergency organisation. The size and capabilities of the organisations is dependent on the facility and its location. All the terminal is having an incident response team and is supported by the midstream field or emergency response team.

4.5.1 Incident Response team- operational response

Each Incident Response Team comprise a:

- Incident Control Team, responsible for management and control of the incident
- Forward Response Team responsible for all the scene response

Terminals and pipeline teams on location in Midstream pipelines is having clearly identified IRT's and before any operations are undertaken they need to demonstrate that each member of the IRT is competent in their emergency role. All IRT's operating in the Midstream Operations Field will need to comply with the structure and management guidelines of the Incident Response Plan. The IRT has responsibility for dealing with all incidents and emergency situations which may occur at or within their area of operation. Where additional support in the way of resources and advice is required by the IRT this will be requested through and provided by the Emergency Response Team (ERT).Technical support will be supplied from the Gurgaon

office through the Emergency Management Team (EMT). Each sites Incident Response Team will be responsible for responding to and managing incidents or emergencies at their location, this may include inter-field pipelines and sections of the oil export pipeline, the gas pipeline and any associated pipeline facilities and Terminals. For Terminals facilities the leader of the Incident Control Team is the site Terminal/Production Manager or their nominated deputy and the Forward Response Team will be led by the designated site senior supervisor who will be trained and assessed prior to being authorized for the role.

4.5.2 Emergency Response Team (ERT) – Field or Regional Operational Support

Cairn Energy India Limited at Viramgam has an organisation in place to provide day-to-day support to the field operations teams. Members of this organisation will be utilised to provide support to the site teams in the event of an incident or emergency, and will form the core of the Emergency Response Team (ERT). The General Manager - Field Operations, or his delegate, will manage the ERT and offer support in the form of Medical, Logistics, Security, CSR and IT. Any requested technical support is provided from the EMT based in Cairn India's Gurgaon office.

Delegation of Authority: It is the responsibility of General Manager - Field Operations to ensure he/she has a delegated alternate within their group and that their ERT Leader duty is delegated when they are unavailable for whatever reason e.g. sickness, or at a location from which it will take more than 1 hour to arrive at the Emergency Control Centre (ECC). They must ensure their alternate is suitably briefed of what is required of them. When authority is delegated, the person taking up the ERT Leader role must send a mail to the duty EMT Leader and Gurgaon Radio Operator advising them of the change. The ERT are responsible for initiating and co-ordinating responses to road transport accidents, searches for missing vehicles and people, providing security and logistics support, organising and co-ordinating all evacuations (medical, injury, fatality, weather or other threat) for the whole of Terminal and liaising with the Emergency Management Team (EMT) based in Gurgaon. In the event of a kidnap or extortion threat within the area, the ERT is responsible for co-ordinating the Gurgaon Emergency Management Team response to the threat.

4.5.3 Emergency Management Team (EMT) – Tactical Response

Based in the CIL Gurgaon Office, the Emergency Management Team (EMT) is responsible for providing tactical response, support, assistance and advice to all incident and emergency situations occurring in any of the Cairn India areas, fields, sites or plants and for providing operational response to any incident or emergency which may occur in or affect CIL Gurgaon Office. The document “Cairn India Emergency Response Manual” describes how the EMT will handle both the "technical" crises e.g. fire, explosion, oil spill, and "social" crises e.g. illness, injury, kidnap, extortion, civil unrest.

4.5.4 Crisis Management Team (CMT) - Strategic Response

The Crisis Management Team is the CIL corporate body located in the Corporate Office in Gurgaon with the responsibility for defining response strategy for major incidents involving any of the company’s operations. A crisis is defined as a situation arising from a single or multiple incidents or emergencies that escalate to a point beyond where significant damage to the Company’s business could result, including commercial and reputation damage, significant financial loss, shareholder loss of confidence and damages resulting from litigation. When a potential crisis situation appears likely the CMT will be mobilized to manage issues pertaining to the reputation and the continued commercial wellbeing of the Company.

4.6 Emergency Management Organisation Structure and Linkages

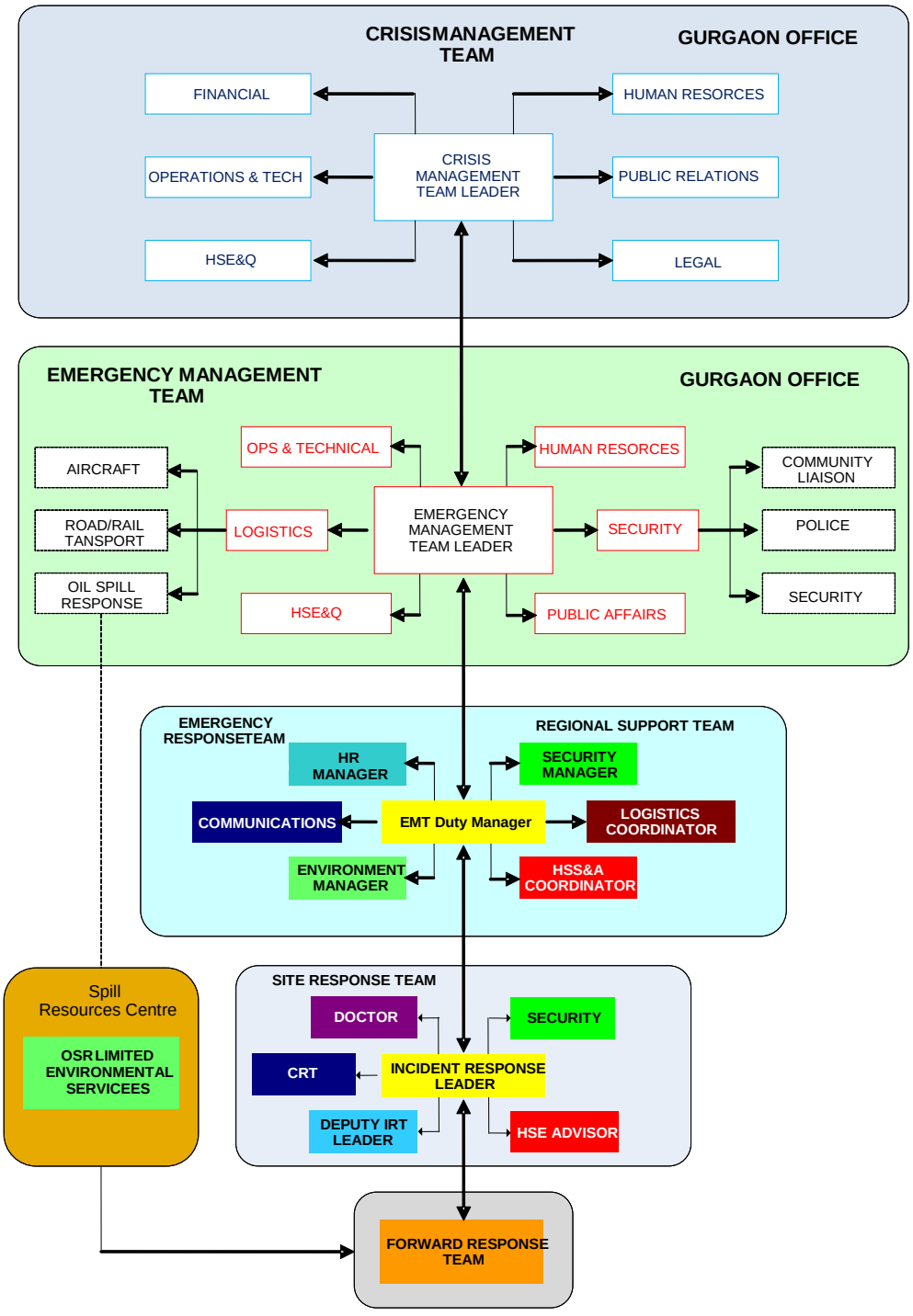

FIGURE 7 EMERGENCY MANAGEMENT ORGANISATION STRUCTURE AND LINKAGES

CHAPTER 5

5. MIDSTREAM PIPELINES INCIDENT RESPONSE ORGANISATION

The Cairn India incident response strategy requires that there will be rapid response to any incident or emergency at any of its sites. To fulfil this strategy each site in Midstream Pipelines where Cairn is operating or managing operations, including permanently or temporarily manned sites, must identify and develop a core Incident Response Team that can be immediately mobilised. The IRT must be competent to manage all identified incidents or emergency situations which may occur at any time. Some field locations may be occupied by transient teams they too must have their own Incident Response Team, which adhere to Cairn India's emergency response strategy

5.1 PIPELINE REGIONAL ERT

The figure 7 illustrates the typical incident/emergency response organisation required to manage the Production, Drilling, Seismic and Construction sites incident and emergency situations. With the regional based ERT, the Technical support required by the fields in emergency situations is provided from Gurgaon.

5.2 INCIDENT CONTROL AND EMERGENCY RESPONSE CENTRES

Each site emergency organisation is headed by the Incident Controller (or appointed deputy), who has overall responsibility for the safety of all personnel on the site. The Incident Controller will also be responsible for co-ordination of response covering incidents affecting the site accommodation and administration

5.2.1 Incident Control Centre (ICC)

Every manned remote Field, Plant or Site will identify an "Incident Control Centre" (ICC) location to be used by the Incident Controller and his/her team. Each ICC will be permanently equipped with communications equipment, an information management system, a copy of this IRP document and Incident Management Guides (IMG's), maps, location drawings, technical

and reference documents, procedures and contact lists and any other equipment and documentation which will be required by the Incident Controller and team to manage an incident or emergency situation. Incident Control Centres are based at:

- Radhanpur Terminal
- Viramgam Terminal
- Bhogat Terminal (in future)

The Incident Controllers for Midstream Operations will have a clearly identified Incident Control Centre within their base or camps. Where practical each site should identify a facility which can be used as an alternative control centre in the event of the primary location not being available. In the event of an incident or emergency the Incident Controller and his/her team shall man the ICC and manage the situation from there.

5.2.2 Emergency Response Centre (ERC)

The Field Emergency Response Centre currently based at Cairn India's regional office in Viramgam and provides support to the existing operations, and construction activities in Midstream Operations in Rajasthan and Gujarat. The Emergency Response Centre will have a designated Control Centre. The ERC will be manned by the Emergency Response Team Leader and his/her team during any incident in Midstream Pipelines operations.

5.3 THE INCIDENT CONTROL AND RESPONSE TEAMS

The Midstream pipeline Operations and Construction groups must operate within the structure outlined in this document. Each Incident Response Team must comprise:

- Incident Control Team
- Forward Response Team

Incident Control Teams comprise of
Operations
• Terminal Manager / Production Manager • HSE Coordinator • Radio Officer • Medical Officer • Muster Controller • Scribe

Forward Response Teams comprise of
Operations
• Forward Controller Fire/Rescue Team

FIGURE 8 ICT/FRT OPERATIONS

The field HSE engineer will provide support to the Incident Controller and each site will appoint a scribe to maintain a record of events. Each site has a dedicated ICC from which the Incident Control Team will operate.

5.4 THE MIDSTREAM PIPELINES OPERATIONS

The Incident Controller and his Team will be located at the Incident Control Centre (ICC) situated in the building identified for management and control. The team comprises:

· Incident Controller

· Doctor/Medic

· HSE

· Radio Operator

· Operations Support

· Scribe

For small remote sites it is recognised that in some circumstances one person may cover more than one role, however the person must be trained and deemed competent to carry out their designated role(s). Each site must identify and have in place a trained and competent Deputy Incident Controller. If the person with the delegated responsibility of Deputy Incident Controller works a rotational shift pattern this needs to be taking into account to ensure the role is always covered. The site Fire Team will muster in a pre-defined location along with any members of the site personnel who are trained and deemed competent in fire fighting. The site must identify a person to act as a link between the Incident Control Team and the Forward Response team(s) who will keep the Incident Controller informed of the situation by providing verbal and were practical a pictorial status of incident and response team(s). The Forward Controller and Forward Response Team will muster in their designated area of the site while the Medical Response Team will muster in the medical facilities. Muster Checkers will be located at their designated muster points. The Site Support Team and Technical Support Personnel will be formed on an "as need basis" and will comprise personnel from the Field Muster Points. Technical Support Personnel will be directed, when needed, to locations on production site or remotes sites to assist the Forward Controller or perform actions necessary to ensure the safety of site personnel. The site Incident Controller will be responsible for managing or controlling any incident or emergency associated with the site.

5.5 FIRE FIGHTING AND RESCUE (REMOTE SITES)

The Incident Response team will be trained in the use of all available equipment and will operate under the instructions of the Incident Controller and guidance and control of the Forward Controller. In cases where abnormal operations are being carried out such as containment is broken, or gas inventory is vented via temporary facilities for maintenance purposes, suitable fire fighting provisions will be provided on site. The extent of these provisions will be determined via risk assessment. These fire fighting provisions will be monitored for effectiveness by the HSE Manager.

CHAPTER 6

6. MANAGEMENT AND CONTROL OF EMERGENCIES

The nominated **Incident Controller** shall assume command and control of any emergency occurring within the area of Cairn India's Terminal as well as AGI's operations Viramgam ICC will be responsible for controlling incidents on the pipelines from Midstream pipelines form Mangala and Raageshwari terminals to Viramgam. To assist this following **Forward Controllers** and mutual aid from the associated upstream facilities will be as described:-

The **Forward Controller** acts on behalf of the Incident Controller as the person in charge of the incident location and coordinates the front line response as directed by the **Incident Controller** and also reports the status of the incident/emergency to Incident Control Centre, organise fire fighting response and the rescue of trapped or injured personnel. The treatment of emergencies will be different to the control and organisation of routine operations and maintenance work. To provide effective response times and resources then mutual aid will be sourced from nearby terminals. Therefore the AGIs and pipeline sections covered from a pipeline focal area in an emergency will differ to those cover under normal operation. The **mutual aid** will come from

· Mangala Processing Terminal

· Raageshwari Gas Terminal

· Radhanpur Terminal

· Viramgam Terminal

In general Due to the geographic constraints and the availability of incident response resources at MPT and RGT, both these terminals will provide mutual aid to the pipeline section to AGI 7. The midstream pipeline facilities within Mangala Processing Terminal (MPT) are covered by the incident response team at MPT utilising Barmer pipeline personnel as operational/technical support. A Forward Controller is to be nominated from the MPT Incident Control Team for AGIs 1 and 2 and associated pipeline sections, from MPT to the upstream flange of AGI 3. Mangala Processing Terminal will provide mutual aid in terms of resources and manpower if an incident occurs at either AGI 1 or 2.

- In an incident from AGI 1 to AGI 2, the MPT Incident Response Team will take primacy of incident control including forward control and Viramgam Incident Control Centre will provide operational and technical support.
- The midstream pipeline facilities within Raageshwari Gas Terminal (RGT) are covered by the incident response team at RGT utilising midstream personnel at Barmer and Sanchor as operational/technical support. A Forward Controller is to be nominated from the MPT Incident Control Team for AGIs 7 to 11 and associated pipeline sections, from the upstream flange of AGI 3 to the downstream flange of AGI 7. Raageshwari Gas Terminal will provide mutual aid in terms of resources and manpower if an incident occurs at from AGI 3 to AGI 7.
- In an incident from AGI 3 to AGI 7, the RGT Incident Response Team will take primacy of incident control including forward control and Viramgam Incident Control Centre will provide operational and technical support. The control of incidents between AGI 1 and 7 is detailed in the bridging document for incident response plans of midstream operations and Raageshwari Gas Terminal RJON-EGS-HSS-PLN-0002.
- As stated in the point above a Forward Controller is nominated from the Sanchor pipeline personnel for AGIs 8 to 11 and associated pipeline sections that are the downstream flange of AGI 7 and the upstream flange of AGI 12. These pipeline personnel will manage and organise resources and manpower if an incident occurs at from AGI 8 to AGI 11.
- Radhanpur Terminal has an associated Incident Control Centre and Forward Controller. The Forward Controller is nominated from the Radhanpur Terminal personnel for AGIs 12 to 14 and associated pipeline sections that are the upstream flange of AGI 12 to the upstream flange of AGI 14. Radhanpur Terminal will provide mutual aid in terms of resources and manpower if an incident occurs at from AGI 12 to AGI 14.
- AGIs 14 to 24 and associated pipeline sections a Forward Controller is nominated from Viramgam Terminal personnel.
- AGI 25 to 29 and associated pipeline section a Forward controller is from Rajkot office and AGI 30 to 33 and associated pipeline section a Forward controller is from Jamnagar pipeline offices.

Detailed procedures advising personnel of their roles and responsibilities during emergency situations are detailed below and all personnel based or visiting a site are to be briefed on the emergency procedures and advised of their responsibilities.

Mitigation measures are employed at all sites to protect personnel, equipment and property at any of the sites from the effects of fire and explosion. Due to the differences in the nature of the Midstream Pipelines Operations sites and operations carried out the type and range of protection provided varies. Additionally, wherever possible, hazardous areas have been segregated by distance which provides mitigation against escalation from one location to another.

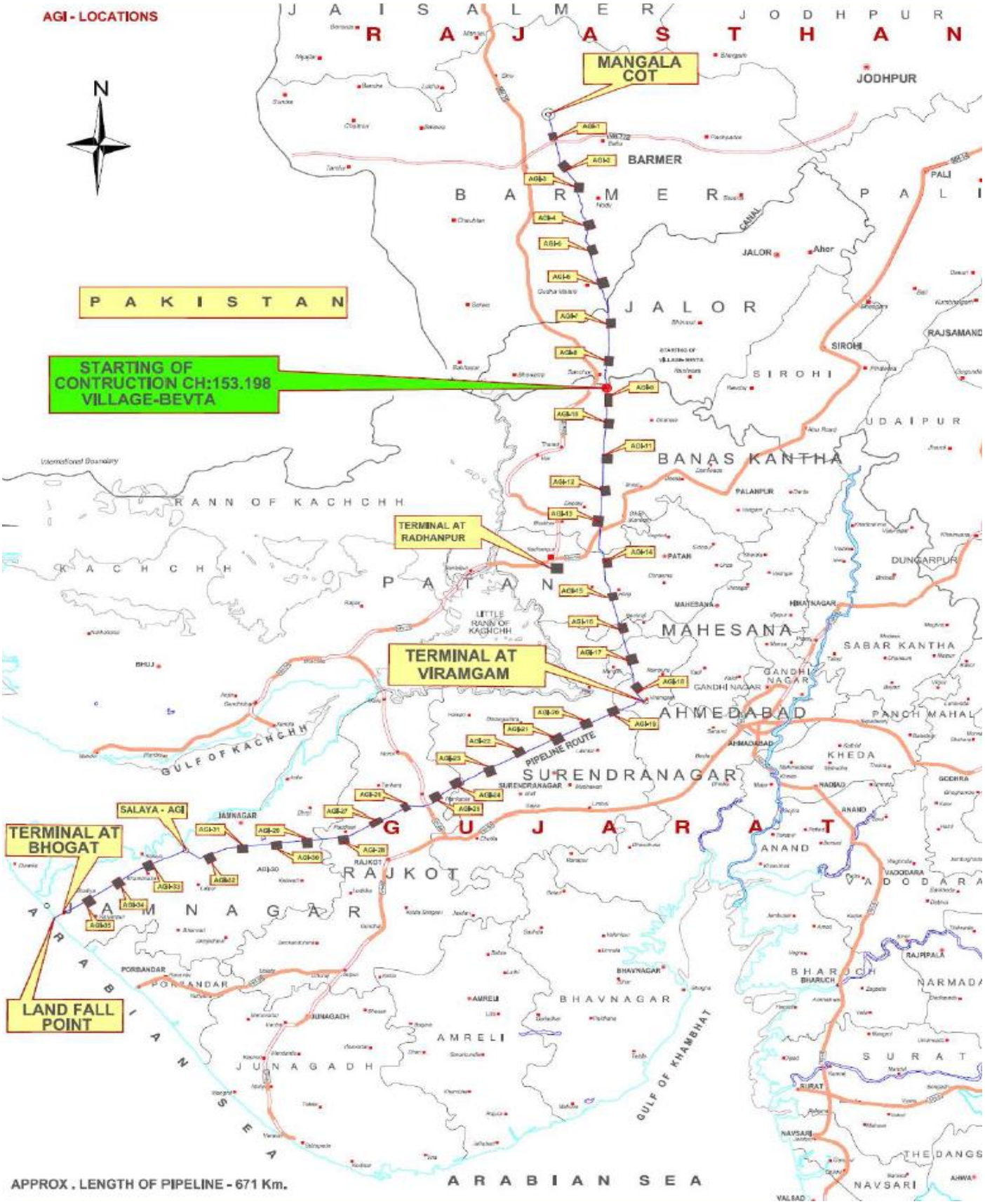

Figure 9 LOCATION OF AGI's AT DIFFERENT PLACES

6.1 CONTROL

Control measures employed to limit or prevent the escalation of accidents, incidents and hazards include, but are not limited to:

- Remotely operated equipment such as ESD and blow-down systems, specific to the area.
- Deployment of the Forward Response Team, if it is safe to do so, to proceed to the incident and manually operate equipment, e.g. isolation valves.
- Remote operation of equipment and co-ordination of the Forward Response Team is performed by personnel located in the Incident Control Centre.

Performance standards of control equipment must be defined and verification of performance covered in maintenance and testing routines. The manning of the Incident and Emergency Control Centres and duties of the respective personnel are described in the Organisation and Competency section.

6.2 EVACUATION, ESCAPE AND MUSTER

Cairn India is committed to providing adequate arrangements, facilities, resources and training to facilitate the safe mustering, evacuation and escape of personnel from the sites in the event of any life threatening emergency and or the integrity of the facility. Muster Points or temporary safety areas must be clearly identified and personnel must muster at these areas when the emergency alarm or signal is activated. Muster Points are detailed in the sites emergency locations plans Muster Points must protect personnel either physically or by distance from the effects of the incident or emergency. Muster Points must also be located at areas where communications cannot be interrupted between the Muster Checkers and Incident Control Centre (ICC). In the event of an incident in any area of the site where entrapment is possible, local escape and evacuation facilities will be in place to allow personnel to move away from that area.

6.3 EMERGENCY SIGNALS AND ALARMS

Every site, plant or field location will have recognisable and identifiable emergency signals and alarms to notify all personnel on that site, plant or field location that an incident or emergency situation has occurred and for when the emergency situation is over. Where applicable, alarm tones and the duration will comply with the requirements of OISD – STD – **116**. There must be a clear set of actions to be followed, including how to raise the alarm, by the person or persons

becoming involved in or discovering an incident or emergency situation. The actions must include a clear instruction on how to report an incident or emergency to the Incident Controller.

6.4 MEDICAL FACILITIES AND SUPPORT

To ensure prompt response and minimise delays in the treatment and transportation of patients needing hospital care, medical facilities such as clinics or first response units such as mobile clinics or ambulances is available at Midstream Pipelines operating sites. For all 24 hour operations the Terminal or Site Manager needs to ensure sufficient medical support available to cover the period of the operation. The Operations base at Mangala, Viramgam and Bhogat Terminal is provided with a medical clinic manned 24 hours by a doctor /medical assistants. Mobile medical/clinic facilities and personnel are provided at remote sites. The Operations based clinic will contain equipment and medication necessary to deal with all envisaged medical emergencies associated with the on-going operations similarly the mobile facilities will have sufficient equipment for dealing with site medical needs. Ambulances are provided which are of sufficient quality to accommodate a patient and allow good access to administer all necessary treatment during the journey.

6.5 EMERGENCY COMMUNICATIONS

In case of emergency in gas pipeline in which it is required to reduce the flow of gas in pipeline or required to shut the flow completely then communication needs to be given to Rageshwari control room immediately for taking necessary steps. Moreover in case of emergency in crude oil pipeline in which it is required to reduce / stop the flow of crude then communication needs to be given to Control room at Barmer immediately for taking necessary steps. All the above communication needs to be routed through Viramgam Control room. Communications facilities in Midstream Pipelines Operations available at the primary control centre include the following:

- Hot line phone with direct access to the Mangala pipeline control room can dial up any AGI.
- Analogue telephone system at AGIs utilising the OFC that can contact predefined areas of the pipeline stations.

- UHF radio linking the personnel via handheld units to others working within vicinity and also to other pipeline stations via the OFC.
- HF radio link which links Viramgam with Mangala Terminals and communicates with
- Telephone Network, there are ePABX at Mangala Terminals; the Mangala Control Room can gain access via the upstream ePABX. Note the pipeline AGIs cannot gain access to public telephone network.
- Mobile phones (individual communication outside of AGIs/Terminal areas / operations sites).

All communication systems, which may have to be used during an emergency, must be designed to, so far as reasonably practicable; remain available for, as long as they could be required. Details of emergency numbers and contacts available in the incident response plan.

6.6 DETECTION OF INCIDENTS

Incidents and potential incidents are detected primarily by either:

- Fire and Gas Detection System
- Automatic detection of process deviations or leaks
- Personnel at site

Automatic detection systems are described in the site safety booklet. For personnel who come upon or suspect an incident or potential incident or are charged specifically to guard against an incident occurring (e.g. vessel entry watch or fire watch), specific advice must be given in the site Safety Induction training, in Procedures and in Permit to Work precautions. Personnel must be trained about manually raising alarms - e.g. manual alarm call points, by telephoning or calling by radio the site Incident Control Centre (ICC). Personnel at remote sites who detect operational anomalies, for example deviations in vessel or pipeline pressure must be aware of how and to raise the alarm. Procedures for these sites must include that the control point is informed immediately.

6.7 EXTERNAL SUPPORT

The Emergency Management Team based at Gurgaon provides support in the event of an emergency at any of the Midstream Operation pipeline sites. The corporate Cairn Energy India Crisis Management Plan provides details of the Cairn India Crisis Management Team’s activities

in support of the field response teams in such aspects as the involvement of external emergency services i.e. Police, public and media enquires etc.

6.8 LOCATION SPECIFIC INFORMATION AND EMERGENCY EQUIPMENT

It is the responsibility of the Terminal manager / Incident Controller to ensure that information and equipment required for managing and dealing with any incident is immediately available at all times. It is also the responsibility of the Terminal manager / Incident Controller to ensure that an Incident Control Centre (ICC) is clearly identified and available for use at all time. The ICC must be fitted out with the appropriate equipment, information and information management systems which will allow the Incident Controller and his/her team to manage any incident or emergency at any time when it may occur. This ICC does not have to be dedicated for incident or emergency management alone, it may well be any permanently manned control centre, radio room or office provided that communications can be easily established with the responding teams, incident site, transport and the Emergency Response Team Leader. The Terminal Manager / Incident Controller must ensure that the team responsible for controlling an incident are trained and competent in the use of the information, equipment and management systems that are provided in the ICC. A list of essential information and incident management systems and tools that should be available in the Incident Control Centre is contained in the **incident response plan.**

6.9 INCIDENT REPORTING

This procedure defines the minimum HSE arrangements to ensure that the following are reported and appropriately investigated to prevent recurrence and improve risk control:

- Incidents /Accidents
- Occupational related illnesses
- Near misses
- Potential incidents (hazards)

An initial Incident Notification Report must be compiled and submitted by the concerned Line Manager to the relevant management levels within 12 hours of the incident occurring. This document also lays down the responsibilities of the Facilities Manager to conduct an investigation and report the findings.

6.10 ROLES AND RESPONSIBILITIES

The composition and mobilisation of the IRT and ERT will vary depending upon the nature of the incident or emergency. The duty ERT Leader will decide on any additional support required. A situation may arise where the ERT Leader or team members may require mobilising additional CIL staff to assist them in responding to an incident or emergency situation. All IRT and ERT members are required to read and familiarise themselves with this document, and be familiar with their roles and responsibilities as indicated in the Section for Emergency Personnel Roles and Responsibilities. Checklists have been developed in order to assist members in fulfilling their roles. Incident Controller and Emergency Response Team Leader must ensure that they have access to this document at all times.

Duty IRT and ERT members will be identified on a duty rota which will be issued once for the ERT and IRT members. New list will be issued as and when changes in the list / telephone numbers take place.

On the activation of the ERT, all the members, as they are called in, should immediately proceed to the Emergency Control Centre. The first to arrive may have to assume the role and duties of the ERT leader until the duty ERT Leader arrives. The initial actions for the first person(s) to arrive in the Emergency Control Centre are to initiate the actions contained within First to Arrive Check List and to ensure that:

- Telephones and communications systems are set up and functioning
- Establish and maintain communications with the incident or emergency location
- Identify the facts of the emergency and ensure that they are written up on the status boards
- Continue with actions as laid down in the arrival check list

CHAPTER 7

7. DISCUSSIONS AT CAIRN INDIA LIMITED

7.1 EMERGENCY MANAGEMENT TEAM ROOM

The EMT is located in the Company's head office in Gurgaon and is responsible for providing support and the tactical response to any incident or emergency situation to all the Company's fields, sites and locations and for managing any incident or emergency which may affect the Gurgaon office. At any time the EMT leader may decide to mobilize the EMT and take overall command of any incident or emergency situation.

The EMT core organization is comprised of the following roles and responsibilities:

EMT Leader: Is overall in-charge. Responsible for company tactical response for all emergency situations.

Human Resources & Services Coordinator: Responsible for providing HR and Services advice and support.

Logistics coordinator: Responsible for providing transport and logistics support as required.

Operation and Technical Coordinator: Responsible for providing operational and technical support and advice.

Public Affairs Coordinator: Responsible for providing public affairs and inputs to Company's media response.

HSE Coordinator: Responsible for providing health, safety, environmental support and response.

Recorder: Responsible for maintaining a timed log of key events and actions.

Security Coordinator: Responsible for providing security support advice and assisting others as required by EMT Leader.

Receptionist: Responsible to the HR and Services Co-coordinator for managing the level 3 reception area Call Centre, or providing additional support to the EMT members and regular Call Centre resource.

Telecommunication Co-coordinator: Responsible for providing the EMT with technical support associated with the communications hardware and software.

Occupational Health Advisor: Responsible for providing advice and assistance on health and medical issues.

Legal Advisor: Responsible for providing advice and assistance on legal matters.

Contractors representatives: who may be called in to give assistance to the EMT should the incident involve members of their organization.

EMT room Facilities at the new building:

Hardware:

- Content Display on projector along with audio for four Laptops.
- Polycom VC Display on four 46" Display (two for VC& Content) (one for dish TV). Fourth for VPMS/CCTV feed from plant connected to small desktop.
- Room Scheduling.
- Audio through ceiling speakers & Mikes.
- Lighting control
- AV Rack
- DTH
- 8 Nos. Alcatel Audio phones
- Polycom IP Phone
-

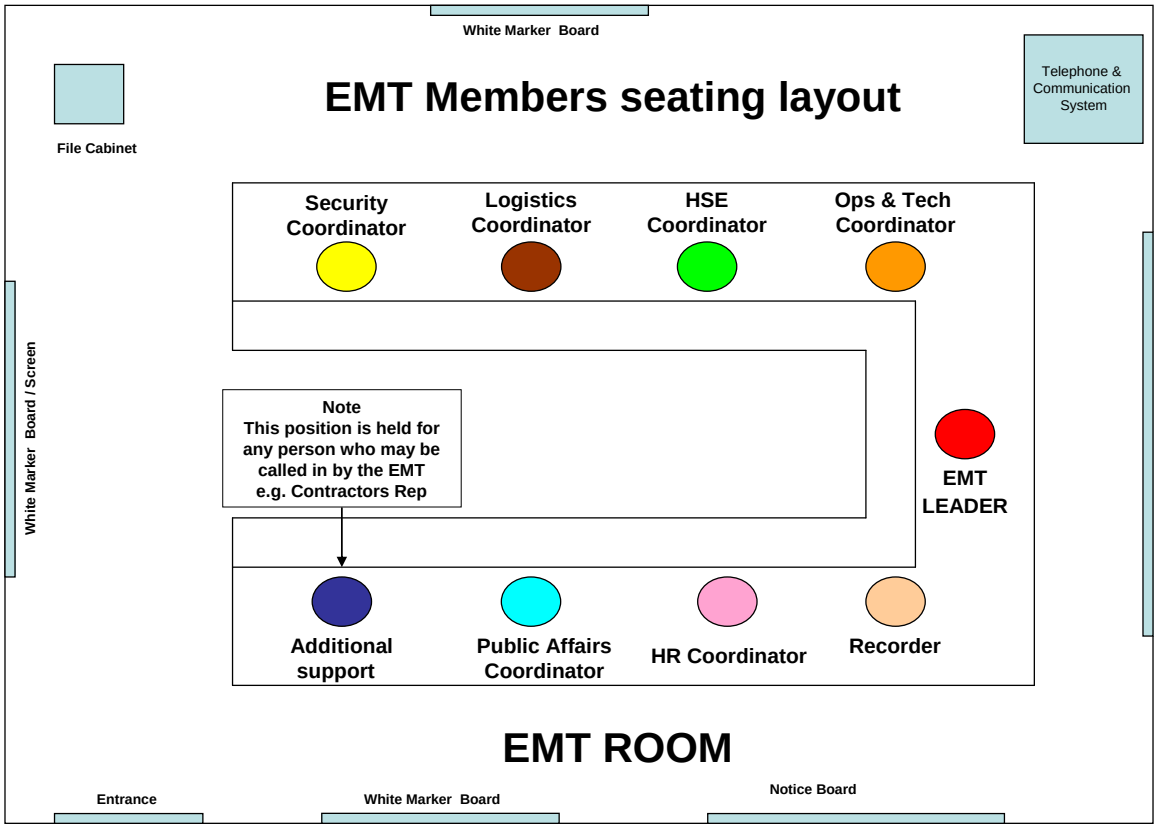

FIGURE 10: EMT ROOM LAYOUT

Functionality:

- Local presentation should come on all four displays along with Projector. Incase required Two output should be provisioned such as one Laptop Display output to all Four TV & Second Connected to Projector Only.

- Multi input Source selection to display and / or projector should be selectable via Touch Control Panel.

- During the VC, only two screens should display VC along with content.

- During the EMT, two screens should be applicable to VC along Content/ Two Screen should be connected to laptop, one screen should play the role of DTH & one screen should play the role of apple PC & One Projector should connect to the laptop.

- The system should be capable of being used as good quality meeting/presentation rooms with the capability of all the participants allowed to share their desktops along with their computer audio effortlessly on the table.

- The display should be operated through touch control panel.

- Video conferencing facility integrated with ceiling hung mikes and speakers.

- The participants should be able to connect computer/laptops along the LAN and audio cable 24*7.

- The system should be capable to provide power for the LAN without any power adaptor for people who are travelling from anywhere in the world.

7.2 VISIT TO VIRAMGAM TERMINAL

As part of our training program we were sent for a visit to Viramgam Terminal in Ahmedabad to further enhance are Exposure to Oil and Gas Exposure and add practical Experience to our knowledge about Cairn India Ltd.

FIGURE 11 VIRANGAM TERMINAL

7.3 SYSTEM OVERVIEW

The Viramgam Terminal consists of the following facilities:

- Crude Oil Buffer Storage Tanks & Closed Drains
- Crude Oil Export
- Inlet Metering Inc. Crude Oil Pipeline Pumps
- Export Metering
- Fuel Gas System
- Electrical Power Generation & Distribution
- UPS System
- Control Systems
- ESD / PSD System
- Fire and Gas Detection System
- Telecommunications
- Instrument & Compressed Air System
- Water Systems
- Foam and Firewater System

- Sewage and Effluent Systems
- Steam Generation
- Steam Distribution
- Diesel Storage
- HVAC Systems

Crude oil is transported to the Viramgam crude oil storage tanks by a 24 inch, 328 km long heated pipeline from the Mangala Processing Terminal (MPT) on the Barmer to Salaya Pipeline (BSPL). The battery limit pressure for the Viramgam Terminal is 80 barg for a flow of 30,000 bopd and 25 barg for a flow of 150,000 bopd. The terminal has the facility for diverting the crude oil for despatch by road tankers or to the pipeline.

7.3.1 Crude Oil Pipeline Pumps

Crude Oil Pipeline Pumps 116-PU-001A/B/C (two units on 'Duty' with one unit on 'Standby') are located downstream of the inlet metering skid at Viramgam Terminal. Their purpose is to boost the crude oil pressure (when required) to allow crude oil delivery to the Salaya Terminal. Crude oil arriving at Viramgam with a flow rate of less than 110,000 bopd, and pressure more than 50 barg can be transported to the downstream Salaya Terminal by pump station bypass without any additional pressure boosting. Crude oil arriving at Viramgam with flow rate more than 110,000 bopd and pressure less than 50 barg is enhanced by variable frequency drive mainline pumps before delivery to Salaya Terminal.

7.3.2 Crude Oil Storage and Closed Drains

The crude oil is stored in three Crude Oil Buffer Storage Tanks of 3,330 m3 each. The crude oil buffer storage tank operating pressure is approx 3 kPag at 80°C and design pressure is 6 kPag at 120°C. The crude oil is routed from the inlet header and delivered to the storage tanks, after reducing the pressure to 15 bar by pressure valve 1112-PV-003 and to approximately 2 bar by restriction orifice. Separate level, pressure and temperature indicators are provided on each tank for monitoring the respective parameters by the Distributed Control System (DCS) and Emergency Shutdown (ESD) systems. Safety relief valves PVRVs and ERVs are provided on each tank to protect the tank from overpressure. The crude oil temperature is maintained at 65°C by heating from low pressure steam at 2 to 3 bar. The steam flow is regulated automatically by temperature control valves 1166-TV-0005 / 0007 / 0009 located at the inlet of the steam line to

the crude oil storage tank and controlled by an average temperature controller located in the tank. The condensate is recovered in a recovery system and recycled back to the boiler as boiler feed water. The buffer tank shell and roof is insulated by mineral wool to minimise heat loss. A water siphon line is provided for each tank to remove water accumulated at tank bottom. A closed drain line is provided for drainage of the tank to closed drain tank. In the event of overpressure, over temperature and/or high level in the tank, the inlet motorised valve to the tank closes.

7.3.3. Crude Oil Export

The crude oil from Crude Oil Buffer Storage Tanks 1112-TK-001 / 002 / 003 is pumped by three 50% duty Export Booster Pumps 1114-PU-002A/B/C (two in service, one in standby). The pumps are of a vertical barrel type and supply crude oil to the road tanker loading facility and to export pump suction. The export booster pumps suction and discharge pressure is monitored by the instrumentation on each pump. The high-high and low-low pressure sensed by the pressure switch indicating transmitters (PSIT) automatically trips the associated pump.

7.3.4 UPS System

The electrical distribution system of Viramgam Terminal is provided with a dual redundant Uninterruptible Power Supply (UPS) to provide maintained alternating current (AC) supplies and a single battery backed-up supply system to provide maintained direct current (DC) supplies. Both systems provide supplies that are maintained for a given duration during power outages and emergency shutdowns.

The AC UPS system provides a maintained 240 VAC single-phase supply to the AC distribution boards located in the UPS room of the control building, the NMS room and the console room.

The UPS system is provided with the following:

- 2 x three-phase supply transformers
- 2 x AC / DC rectifiers
- 2 x DC battery banks
- 2 x DC / AC inverters
- 2 x static switch assemblies
- x single-phase bypass line transformer

- 1 x 240 VAC single-phase distribution board

7.3.5 ESD / PSD System

Control of the process plant is automated under the control of the two primary plant control systems. The systems interact to cover the primary control logic of the plant. The systems are designated as follows:

- ESD System
- PCS System
- DCS System
- SCADA System

The Viramgam Terminal is provided with an ESD and F&G detection system as safeguarding systems. They interface with the terminal's DCS to provide complete status, alarm overview, and operational overrides in 'Single Windows' concepts for terminal operations. The terminal DCS interfaces with the SCADA system through a fibre optic communication network to monitor the terminal parameters.

7.3.6 Fire & Gas Detection System

Viramgam Terminal has standalone ESD and F&G detection as safeguarding systems. They interface with the terminal DCS to provide complete status, alarm overview, and operational overrides in 'Single Window' concepts for terminal operations.

The function of the F&G detection system is to provide early warning to personnel of potentially dangerous situations in terms of flammable and toxic atmospheres and/or fires. These potentially dangerous situations are monitored by means of dedicated sensors.

The F&G detection system enables automatic or manual initiations of actions to avoid / minimise escalation of events. This is performed by activation of audible and visual alarms, creation of signals to initiate automatic fire fighting systems, start firewater pumps and activate deluge valves. The system has the capability to initiate automatic shutdowns via the ESD system. There are various extinguishing equipments available which include foam trolleys, fire extinguishers of

various sizes, SCABA, oil spill response kit and inergen system are at place during the time of an emergency.

FIGURE 12 FIRE FIGHTING EQUIPMENTS AT VGT

7.3.7 Telecommunications System

The main communication system for the operation of the pipeline is a fibre optic cable (FOC), which is installed along the pipeline from Mangala to Bhogat. Direct buried FOC is installed within the same trench as the pipeline. The FOC for the main backbone of the pipeline communication system has sufficient cores for normal operation, standby operation and to enable future expansion.

The lengths of the fibre optic cables are as follows:

- Along the pipeline – 675 km
- Within the main facilities (Mangala, Viramgam, & Bhogat) – 12 km
- Within all remote stations – 20 km
- Total length of fibre optic is approximately 707 kilometres

Provision has been made in the design of the main fibre optic communication system for easy integration with a future backup communication system for future upgrading.

In the future, additional telecommunication systems such as microwave radio or Very Small Aperture Transmission (VSAT) Satellite System may be required to act as a telecommunication backup backbone in the event of a failure of Fibre Optic Transmission Equipment (FOTE)

7.3.8 Water Systems

The Viramgam Terminal water is supplied from a local water supply or by tanker. It is treated and supplied to various services as required. The raw water flow rate requirement is approximately up to 220 m^3/h. Adequate storage is provided for 24 hours. The raw water is treated in the raw water treatment unit where solid particles are removed. Plant water is then stored in the plant water tank.

Plant water is provided to the system from the plant water tank which has a capacity of two hours consumption. Two 100% plant water pumps supply the system users.

Plant water is supplied at a rate of 45 m^3/day to the treated water treatment unit. Here the water is further filtered and treated by reverse osmosis making it suitable for drinking.

The raw water treatment system consists of the following equipment:

- 1163-TK-013 Raw Water Storage Pond
- 1163-PU-013A/B Raw Water Pumps
- 1163-VE-501 Mesh Filter
- 1163-TK-501 Coagulant Dosing Tank
- 1163-TK-502 Multigrade Filter
- 1163-TK-008 Plant Water Tank
- 1163-VE-503 Buffer Vessel

7.3.9 Foam & Firewater System

The entire terminal is protected with appropriately placed fire hydrants and monitors. Hydrants and monitors are located to give the most effective fire protection whilst considering the fire hazards at different locations of the facility to be protected.

In the event of a fire signal detected from the tank area, the fire detection system installed on the control room panel automatically operates the fixed foam system to the tank on fire. For spill fires around a tank, self-inducting foam monitors are provided and can be operated manually.

The major areas of potential hazard at the Viramgam Terminal are the buffer storage tanks, the pump raft and diesel storage tanks. The firewater ring main encircles the buffer storage tanks and pump raft, with spur lines where necessary to extend to other areas, and incorporates hydrants and monitors at appropriate locations.

The buffer storage tanks are fixed roof crude oil storage tanks. These are provided with top foam pourers to inject foam into the tank supplied via a central foam preparation unit, located behind a fire wall.

In addition to the above, suitable portable and hand-held fire extinguishing equipment including mobile foam apparatus and fire extinguisher units are provided as necessary. These units being located at appropriate key positions around the site.

Both fixed and mobile equipment complies with the requirements of Oil Industry Safety Directorate OISD Code 117.

The site layout incorporates suitable road access to all areas to enable fire tender vehicles to provide full back-up to the facilities if necessary.

Fire alarm call points are provided as necessary. As a minimum they are installed in all buildings, gantries and shelters, around tank bund areas and at key positions in site operational areas.

The firewater system is designed in line with OISD standards to include the following equipment:

- Two firewater tanks with a capacity of 1600 m^3 each

- Three firewater pumps – two on duty and one on standby, with a design flow of 400 m^3/h each
- Two jockey pumps – one on duty and one on standby with a design flow of 25 m^3/h each
- One foam concentrate tank with a capacity of 4 m^3
- Hydrant and monitor ring main

FIGURE 13 WATER TANKS AT VGT

7.3.10 HVAC Systems

The HVAC systems provide ventilation, air conditioning and pressurisation as required, to all living areas, equipment rooms requiring a controlled environment for comfort or optimum operating conditions for equipment and overall safety of the facilities.

- The HVAC systems are designed to meet the following objectives:
- Positively pressurise enclosed areas to achieve a non-hazardous classification and to prevent the entry of flammable gases
- Maintain essential ventilation to all equipment areas that are required to be operational during an emergency when the main source of power is unavailable
- Provide conditioned air to manned areas to ensure a comfortable and healthy working and living environment
- Maintain breathable conditioned / ventilation air to the Temporary Refuge (TR) during emergency response, when powered by the emergency generator
- Provide satisfactory conditions in enclosed areas for the safe and economic operation of equipment

Reliability of the HVAC systems and equipment to perform continuously in the tropical environment is essential.

Equipment and system components are designed and constructed for a 25 year operating life span.

7.4 INCIDENT RESPONSE TEAM

Forward Response Team
• Forward Controller (Onsite Response and control) • Fire/ Rescue Team (Fire Rescue and control)

The Incident Controller and his Team will be located at the Incident Control Centre (ICC) situated in the building identified for management and control. The team comprises:

· Incident Controller

Muster & Security Control Team
• Muster checkers (Muster Count and Control)

· HSE

· Radio Operator

· Operations Support

· Scribe

Incident Control Team	
• Installation Manager	(Incident Controller)
• Production Manager	(Deputy IC/ Operations support)
• Maintenance Manager	(Technical Support)
• Am HSE	(HSE Support)
• Radio Officer	(Communications)
• Security Officer	(Security and support)
• Medical Officer	(Medical Response)
• Scribe	(Records Keeping)

For small remote sites it is recognised that in some circumstances one person may cover more than one role, however the person must be trained and deemed competent to carry out their designated role(s). Each site must identify and have in place a trained and competent Deputy Incident Controller. If the person with the delegated responsibility of Deputy Incident Controller works a rotational shift pattern this needs to be taking into account to ensure the role is always covered. The site Fire Team will muster in a pre-defined location along with any members of the site personnel who are trained and deemed competent in fire fighting. The site must identify a person to act as a link between the Incident Control Team and the Forward Response team(s) who will keep the Incident Controller informed of the situation by providing verbal and were practical a pictorial status of incident and response team(s). The Forward Controller and Forward Response Team will muster in their designated area of the site while the Medical Response Team will muster in the medical facilities. Muster Checkers will be located at their designated muster points. The Site Support Team and Technical Support Personnel will be formed on an “as need basis” and will comprise personnel from the Field Muster Points. Technical Support Personnel will be directed, when needed, to locations on production site or remotes sites to assist the Forward Controller or perform actions necessary to ensure the safety of site personnel. The site Incident Controller will be responsible for managing or controlling any incident or emergency associated with the site.

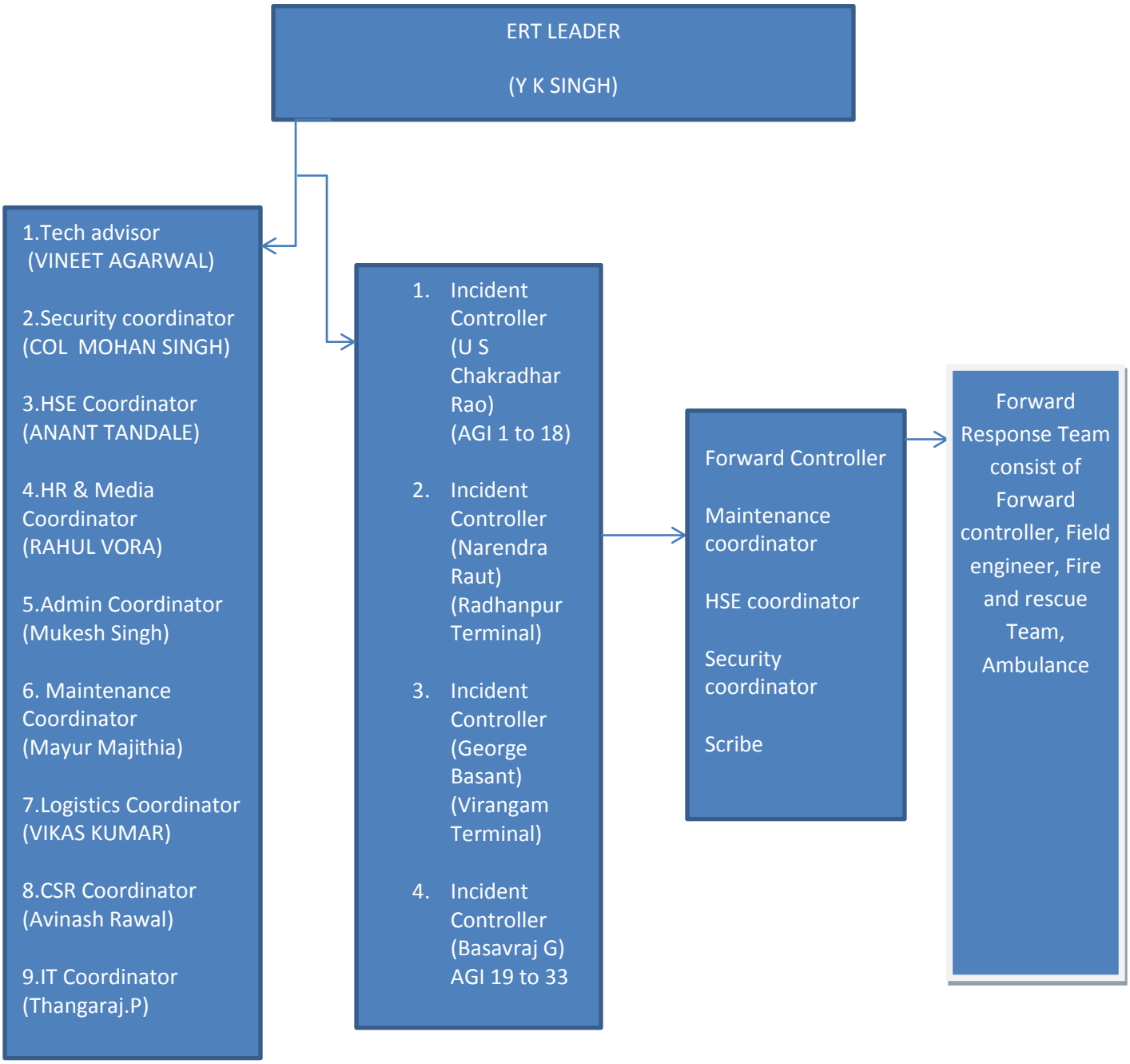

FIGURE 14 HIERARCHY AT VGT

7.4.1 Emergency Siren working philosophy:

1. **Fire:** For fire situation, the siren shall be wailing sound for 2 minutes.
2. **Disaster:** for disaster situation, the siren shall be wailing sound for 2 minutes repeated thrice with a gap of 10 seconds.
3. **All Clear:** for all clear situations, the siren shall be straight run sound for 2 minutes.
4. **Test Siren:** for testing, the siren shall be straight run sound for 2 minutes.

7.5 PSM INTERNAL AUDIT CLOSING MEETING

During field visit to VGT we had attended a process safety internal audit closing meeting with Mr. Vincent Rendall (Team Leader), Mr. Arun Negi (HSE Representative) and Mr. Manoj Kumar (Engg. Process safety) and following points were discussed about process safety at VGT:

1. SOP: There was no corporate guidance procedure manual for process equipment's.
2. PHA: No corporate procedure for PHA at VGT. There was no Bow tie analysis at VGT.
3. Training:
4. Contractors: Emergency action plan but there was no PSM plan with the contractors.
    i. HSE Violation notices.
    ii. No documents for contractor's orientation to know the potential hazards.
    iii. HSE induction process for all contractors employees.
5. Non Routine work authorization (Permit to Work System):
    i. Some hazards are not identified in the preliminary checklist in the permit.
    ii. JSA and work methodology not available on PTW audited at site.
6. Incident Investigation:
7. Emergency Planning &Response.
    i. Compliance audit: No provision in GAT to record management action plan after an audit recommendation.
    ii. Email notifications to action partly through CIMS/ GAT.

- **JSA Review:**

✓ Task is divided into small activities and are analyzed and assessed to identify the hazards associated with them.

✓ JSA is done for all the critical activities.

- **JSA at VGT:**

✓ In VGT JSA is performed for every permit

✓ In JSA the task is divided in to small activities and hazards and control measures of all activities are identified.

✓ The corrections in the JSA are discussed over there.

✓ The following authorities are present in the meeting

a. HSE engineer
b. Sr.Electric engineer
c. Maintenance superintendent
d. Production superintendent
e. Mechanical engineer

- **Work Permit System Review:**

✓ Work Permit System for HOT work, COLD work, SPARK potential.

✓ Familiarization with PTW system documents.

✓ The following are the roles of different authorities.

Role	Title
1. **Person requiring the job to be done**	**Permit Originator (Applicant)**
2. **Person authorising or approving the permit**	**Permit Authority**
3. **Person in control of the location where work is to be carried out**	**Area Authority**
4. **Person issuing the permit**	**Issuing Authority**
5. **Person working under the terms of the permit**	**Performing Authority**

Table 1 role and title

7.6 OBSERVATIONS AT VGT:

1. Status & Condition of firefighting pumps:

S. No.	Pumps	Auto	Manual	Testing	Hours	Fuel	Condition of valve	Daily Cleaning	Volts	W/T
1.	Diesel pump A	✓			69	95%	Open	Done	28	24
2.	Diesel pump B		✓		181	95%	Open	Done	27	24
3.	Diesel pump C	✓		✓	203	95%	Open	Done	26	49
4.	Jockey pump A		✓				Open	Done		
5.	Jockey pump B	✓					Open	Done		

Table 2 Status & Condition of firefighting pumps

2. Status of fire water storage tanks:

Tank No. 005			Tank No. 006		
1.	Mm	8792.7mm	1.	Mm	8787.7mm
	%	76.449%		%	76.421%
2.	Mm	8805.8mm	2.	Mm	8836.6mm
	%	76.594%		%	76.831%

Table 3 Status of fire water storage tanks

3. Status of Fire Tender:

1.	Water Level	Full
2.	Foam Level	750 liter's
3.	Fuel Level	60%
4.	Running (Km)	2173
5.	Static Testing	✓
6.	Condition of Pump	✓

Table 4 status of fire tender

S.No	Title	Observation	Recommendations
1	Scenario	All scenarios which are globally relevant oil & gas sector which are relevant to VGT are present in the VGT	NIL
2	Mock drill	The mock drill are conducted regularly	NIL
3	Emergency response plan	The emergency response plan are in place	NIL
4	Organizational structure	The ERP has a well organizational structure	NIL
5	Water storage tanks	The water tanks were not completely filled with water	Regular checking of water level in the tanks
6	Emergency facilities	All the emergency facilities are present in the VGT as per standards	NIL
8	Bridging documents	The bridging documents of VGT for emergency management are present	NIL
9	Fire extinguisher	The fire extinguisher are maintained properly and monthly inspection are performed	NIL
10	Scaba	The compressed air in the cylinder was partially filled when checked	Checking of the cylinders at regular intervals

Table 5 observation and recommendation

7.7 Mock Drill Report

(A)Location of Emergency: -AGI-31

(B) Date & Time:-19th March 2015 at15:15 Hrs.

(C) Brief description of the scenario:-

• Crude oil Leak from PT flange

(D) Action Taken:-

• Security Guards who observed the Crude oil Leakage informed to Viramgam control room and Security Control Room.

• VGT control room called to FC and IC.

• FC rushed to the site.

• FC informed the I.C and later IC informed to ERT leader at VGT.

• All energy sources have been isolated at AGI.

Sr no	Time	From	To	Description
1	15:15	Security Guard	VGT Control	Crude oil leak observed by Security Guard from PT flange. Informed about the incident and location.
2	15:16 .	VGT Control Room	FC & IC	Informed about the incident and location.
3	15:17 .	Security Guard	Security Control Room	Informed about the incident and location
4	15:17	VGT Control Room	IC	Informed about the incident and location; discussed about action to be taken and rushed to the site
5	15:18 .	IC	ERT	Informed about the incident and location; discussed about action to be taken
6	15:19	FC	MPT Control room	
7	15:19			Isolation done remotely from MPT
8	15:20	FC	IC	FC with team mobilised for site / location
9	15:22 .	VGT Control Room	HSE Coord.	Informed about the incident and location, valve closing action taken from MPT CR and FC is on the way to incident site

10	15:30 .	FC	HSE Coord.	Informed about the incident and location, actiontaken
11	15:30	EOL	IC	Updated on the situation.
12	15:38			FRT with 2 nos. technicians reached at site
13	15:40			FRT called FC and updated the situations.
14	15:40.			AM Sec, reached at site with additional 2 security guards
15	15:42			Additional security guard 1+2+ 2 reached andCordoned the area.
16	15:44			Leak checked and LEL monitored.
17	15:45	FRT	FC	Section kept under observation.
18	15:46	FRT	FC	Updated on the situation.
19	15:46			FC reached the site
20	15:55	FC	VGT Control Room	Informed that situation is normal, No leakage At site now.
21	15:56	FC	IC	Informed that situation is normal, No leakage at site now. so that maintenance activity(Flange gasket replacement) can be undertaken
22	16:00	IC	ERT	Informed that gas leak is arrested fully. Situation is normal. Maintenance activity needs to be planned.
23	16:05.			All Clear given from VGT and drill called off

Table 6 event log sheet

Actions during emergency –

On getting the information of emergency location and situation, immediately following action have been carried out.

•Immediately Forward Controller and Security Coordinator of Rajkot base was asked to rush to the incident site.

• IRC / IRT members were intimated and initiated the action as per the IRP.

• After taking clearance from FC & VGT control room, emergency was declared over.

• All the persons including whose roles are not directly defined in IRP, assembled at the assembly (muster) point as given below-

Place of Assembly point	**Assembly point coordinator**	**No. of persons present prior to emergency situation**	**No of persons assembled after declaring emergency**	**Remark**
01	Security guard	04	04	

Table 7 final report

7.8 CONCLUSION

- In this report the **Emergency Management Plan** for midstream operation is discussed and fire protection facilities are as per OISD 116.
- **Pipeline Intrusion Detection System** provides security cum surveillance along the entire length of the pipeline, utilising a fibre optic system that generates an alarm. The pipeline is monitored at the CPT, Viramgam and Bhogat terminals for flow, temperature, pressure, and other operational parameters.
- **SEHMS** technology also known as the Skin Trace System (STS) or Skin Electric Current Tracing (SECT), are all dependent on the principles of skin and proximity effect for operation which helps to maintain above 65 °C to ensure its flow.
- **Intelligent Pig** tools are equipped with sensors for gathering various kinds of data, as the pig tool travels through the pipeline. Surface pitting, corrosion of inner walls, cracks and weld defects in pipelines are often detected using magnetic flux leakage (MFL) pigs.
- **Strong Safety Culture** at VGT plant and Strict Implementation of **HSE** guidelines at workplace.
- In case of an emergency at VGT terminal **ambulance** with spark arrestor and **fire tender** are ready to serve.

FIGURE 15 FIRE TENDER AT VGT

FIGURE 16 AMBULANCE WITH SPARK ARRESTE

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