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Controlled Document

Quest CCS Project

Operation Readiness Plan

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Signatures for Revisions

Date	Role	Name	Signature or electronic reference (email)
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Operations Readiness Plan

Quest Project

(CO_2 Capture, Pipeline and Sequestration)

Contents

7 TABLES

8 FIGURES

1 INTRODUCTION

1.1 PURPOSE OF THE OPERATIONS READINESS PLAN

INTRODUCTION

This document outlines the Operations Readiness Plan for the Quest Project The purpose of this document is to set out the various steps and processes and to identify who is doing what, how and when within the overall Project team, Operations Readiness team and the CSU Team in order to successfully prepare and operate the Quest Facility. The prime objective of the Operations Readiness Team is to provide assurance that all aspects of the Ops. Readiness element of the Quest Project has been identified and defined with system & supporting documentation to achieve the Project on schedule, within budget and with due consideration for HSE.

The objective can be further broken down as follows:

- To provide input to design, and safeguard the implementation
- To develop an Operations Management System in preparation for start-up & commissioning, covering the maintenance & integrity management. System, HSE Case and Computer Aided Operations system applications and operating manuals in order to allow O & M staff to operate and maintain the QUEST facilities safely, efficiently & effectively
- To provide Operations input & coordination for the commissioning & start-up of the IOP leading to acceptance by the new QUEST asset owner.
- To develop and put in place the suite of Operations Service Contracts for QUEST in time for the handover & operations phase.
- To secure the QUEST Operating budget, QUEST manpower build-up, staff competency system, materials & logistics provision, accommodation requirements needed to operate the QUEST facility
- To secure all relevant Permits and Licenses needed to operate the facilities and create communication links with local authorities.
- To secure QUEST Procurement & Logistics requirements and interfaces with other assets and operating units (site visit, Plant data collection, Design verification and site surveys).
- To achieve the Operations Readiness objectives, the Ops. Readiness Team will comprise of personnel with extensive experience in Operations, Maintenance, and craft.

1.2 PROJECT OBJECTIVES

The objective of the Quest Project is to capture CO_2 from the Hydrogen Manufacturing (HMU) process of the Scotford Upgrader and ship it via pipeline for permanent storage underground.
In its existing facilities Shell Canada operates 3 HMU's (Hydrogen Manufacturing Units). All three units use Steam-Methane Reforming process (process license from Uhde, Germany). The reforming outlet gas passes through HT Shift Converter

followed by PSA (Pressure Swing Adsorber). The PSA feed gas stream in each HMU is relatively rich in CO_2 (~16.5%).

Quest is proposing to install a CO_2 capture facility to recover 80% of the CO_2 in the PSA feed gas. The recovered CO_2 will be compressed, dehydrated and routed to pipeline for final sequestration in a deep formation underground. The nominal design capacity target has been set at 1.2 MT/year of CO_2, to meet a commercial sequestration commitment of 1.08 Mt/year (90 % on-stream factor).

The main process areas associated with Quest include:

CO_2 Capture Section

- A CO_2 capture facility – This is an amine based absorption and regeneration system. Three absorbers will be located in the hydrogen plants (One each in Base Plant and one in Expansion 1 and a common regeneration). Each absorber will be accompanied by a wash water system The design is based on ADIP-X solvent composition of [redacted] wt% MDEA [redacted] wt% DEDA (Piperazine) and [redacted] wt% water
- A CO_2 compression facility – This is a motor driven 8 stage compression unit (integrally geared machine with approximate 145 bar discharge pressure) complete with inter-stage cooling and KO drums. A CO_2 dehydration facility – This is a standard TEG dehydration system that will be taking gas feed from the sixth stage discharge cooler of the CO_2 compressor.
- Heat Recovery and Steam generation – LP Steam will come from Base plant & Expansion 1 steam network. Existing ATCO Steam turbine will be used to let down HP Steam and generate extraction steam. HP Steam needed for TEG, will be made up from Shell Chemical Canada Ltd (SCCL) / Air Liquide network. Additional heat integration with base plant (DM Water and C.W.) has been worked out to optimise cost.

Pipeline

- Shell will build a carbon steel pipeline between the Scotford Upgraders and Sequestration Injection locations. The 1.2 million metric tonnes per annum capacity will be buried 1.5 meters underground. Approximately 64 km of 323.8 mm (NPS 12 inch) pipeline with a design pressure of 14.5 MPa from Shell Scotford to the sequestration wells. Line block valves will be located along the pipeline with a maximum of 15 km spacing (ERCB level 2 pipeline) and on either side of major crossings as required. These line block valves will automatically close to isolate a leak or rupture. Pipeline operating information will appear on a HMU panel. (Scotford Base Plant) providing information for managing and controlling CO_2 flow.

Wells

- The well sites will be located near the main trunk line, either directly adjacent to the pipeline or located off the main pipeline and connected via a four or six inch diameter lateral line.
- Currently the expectation is that we only need 3 Injector wells. Refined dynamic modelling will be used to firm up the range of wells required to achieve sustain rate of injection.

1.3 INPUT INTO EXECUTE/OPERATE PHASE

From the detailed engineering design onwards, Operations' needs will have a high profile. Operations needs have been considered during all the previous stages (identify & assess, select & define) of the QUEST. Below list of documents, plans, reports and is an extract from the QUEST Ops. Readiness Plan to be delivered by the QUEST Project team with contributions from the QUEST Operations Readiness team.

Item	Contribution by Quest Ops. Readiness Team	Delivery by Quest Project Design & Engineering Team
Opportunity Framing Report	X	X
Concept selection Report	X	X
SDP, PEP	X	X
Availability Study	X	X
Flow Assurance Process Study	X	X
Regulatory and Energy Plan	X	X
Risk & Issue Register	X	X
Environmental Plan	X	X
Contracting & Procurement Strategy	X	X
Spare Parts Requirement Plan	X	X
Local Content Plan	X	X
Project Quality Assurance Plan (audits, PER's)	X	X
Process Studies & HAZOP's	X	X
Model Reviews	X	X
VAR's	X	X
IPF's Study	X	X
HSE Case, MOPO, SIMOPS	X	X
Maintenance & Integrity Systems	X	X
Commissioning Start Up Plan	X	X
MOC	X	X
SAFOP	X	X

Table 1: Operational Readiness Participation in Project Deliverable Activities

1.4 OPERATIONS & MAINTENANCE MANAGMENT SYSTEMS

The development of Operations and Maintenance & Integrity Systems and Procedures for QUEST will be coordinated by the Operation Readiness team and members of O & M Group. The main operating systems envisaged are the Maintenance Management & Spare Parts systems (using SAP Blue print), Fiscal/Custody Transfer systems, the Activity Based cost model for OPEX, Integrated Operations Activity Planning & Programming tools, & corrosion management system.

Guidance and monitoring of above developments via the weekly Integrated Operations Review's (with Project Services) and forms part of the 9 milestones of the Operations Readiness activity plan.

All data handover requirements to Operations are defined in the IHOG (Information Handover Guide).

1.4.1 STANDARDS

ORM and OE standards are being used for project assurance reviews and "Operations Implementation including Flawless Project Delivery". ORSAT, PS 14 along with Operation Readiness Project Guides PG 14a and PG14b is the basis for Operation Readiness Plan. ORSAT is being utilized for evaluating gaps

1.4.2 MANAGEMENT SYSTEM FOR COMMISSIONING AND START-UP PHASE

The management system for the commissioning and start-up (CSU) phase shall follow the structure of the site management system (SWP, MOC, Waste management etc.), adhering to the global standards, process descriptions, specifications, procedures, tools and other supporting controlling documents.

Specific elements of the CSU management system shall describe CSU activities performed prior to first intake of raw H_2. The CSU activities will be executed in accordance with the Project requirements and shall include the Flawless Start-up Initiative (FSI) criteria. Refer to section 5.1 for more information regarding FSI.

The structure of the CSU phase management system shall be developed during Execute phase. Refer to Commissioning and Start up (CSU) Plan Document # D0414.

1.4.3 INTERFACE WITH MANAGEMENT SYSTEMS DURING PROJECT PHASE

CO_2 project execution documents clearly describe the interfaces between the project phase, CSU phase and operation phase management systems and how these will be managed.

For detailed maintenance system management plan refer Quest Maintenance and Integrity Strategy document # D0409

1.5 OPERATING MANUAL

The strategy for the provision of capture, pipeline and subsurface manuals will be a combined effort; however the development of the Quest Operating Manual will be coordinated & funded by the Quest Project team (Resident Engineering Team Manager). Target completion date of the Quest Operating Manuals is Q4, 2014

1.6 RECRUITMENT AND TRAINING

The recruitment & training coordination is carried out by ORA team. Recruitment of the required expat staff is done via MOR rounds.

Local staff will be recruited and trained via three different systems:

- Graduate Engineers
- Apprentices
- Experienced Technical Staff

The training plans are developed according to a competency assessment system; monthly progress meetings are taken place. Once graduate engineers and experienced technical staff are selected and recruited, any further training requirements will be provided by the Operating Readiness team using training matrix.

The training strategy is to establish a centre of training competence for hydrocarbon processes at the Scotford Upgrader. Downstream operations will create a dedicated trainer who will train the people for CCS Project. CCS Project will liaise with the base plant to maximize leverage on existing processes. *Grow your own timber* will be an objective. This trainer position is a full time but temporary. Training package must also include training for the Base Plant including simulator (Expansion 1 HMU) update.

Since the existing facility does not have any CO_2 Capture Process experience, external plants were identified to impart proper training to Operations and Maintenance; Chevrons Rangely Co. and Midlands Tx facilities were visited.

<u>CO_2 Lean and CO_2 Rich Phase of Operation for PSA</u>

It will be very important for operating staff to get trained for CO_2 rich and CO_2 lean operation. The major impacts on PSA, reformer firing, controlling and maintaining NOx and convection bank will form the basis of training. Automatic or manual switching of combustion air control during transitioning will be part of teaching

<u>CO_2 Product Properties</u>

CO_2 properties change considerably with respect to pressure and temperature, part of the process will be operated within the supercritical conditions range of CO2 and this will form part of training.

<u>Compressor and TEG</u>

In house training will be organized for compressor start up / shut down and vendor / SGSI support will be sought for developing anti-surge control scheme.

<u>Pipeline and Sequestration</u>

Pipeline and Sequestration Operation and Maintenance team will be fully trained to handle CSU, (CO_2 Properties as mentioned above and particularly depressurising pipeline). Training will be provided to the operation team for some basic fundaments of handling CO_2, pipeline layout and sequestration process

Refer to a detailed training matrix available on ORA (ITR 4 June 2011) web page (Training list.xls) and further training plan will be developed in next phase.

1.7 OPERATIONAL PROJECT RISKS

A Risk Register has been created for the project and mitigation measures are ongoing. The project risk register can be accessed using "Easy Risk" on live link at the following location:

Some of the key operational risks identified for the Projects are: Link for detailed info.

http://sww-easyrisk.shell.com/easyrisk/systems/epwcoded.html

#	Risks	Mitigations and status
1	May not achieve CO_2 capture yearly target volumes provided to government as part of EOI from Both Base Plant and Expansion 1 hydrogen plant	RAM model was developed using reliability data from Mine, pipeline and Upgraders (Both Base Plant & Expansion 1) and Quest equipment to calculate CO_2 Production. The model shows that on the basis of some reasonable assumptions the committed commercial CO_2 production target can be met
2	Disruption to Operations of Base Plant and/or SU Exp 1 may occur during the construction of CO_2 Capture facilities and visa versa (SIMOPS), SIMOPS - Construction in Operating Facility	SIMOPS Matrix has been developed along with EPC. Ranking was assigned and mitigations are developed & tracked through the risk management process.
3	Switching in or out of CO_2 recovery mode (CO_2 Rich to CO_2 Lean and Vice Versa) trips the HMU and / or PSA (i.e. Transients) or may impact to CO_2 capture process as well as Air & fuel gas system	CO_2 Bypass valve has been provided. PSA Vendor and UHDE have been contacted, control schemes have been worked out for bypass valve and louvers for fans. The plan is to run a dynamic simulation of the upset modes for the tuning of the process control, during the Detailed Engineering phase

Table 2: Capture Area Risks

Pipeline and well Risks for Operation

#	Risks	Mitigations
1	Pipeline may develop small leak or a river crossing failure	Draft emergency response plan have been created. Approved plan will become part of Upgrader's ERP
2	Control scheme may not work properly due to different back pressure for different wells	I & C along with process and operation have evaluated and will be detailed out in next phase
3	Selected location for the sequestration wells may not allow injection of required CO_2 volume	One development well drilled and two additional development wells will be drilled in 2012. Refer to well monitoring process

Table 3: Pipeline & Wells Risks

Detailed RAM analysis was also carried out to find the severity of each of the risks. A detailed risk response plan is also developed for majority of items. In addition an issue register was also prepared and an issue response plan is being developed. Risks are reviewed & updated monthly.

2 KEY RESOURCES FOR ORP DEVELOPMENT

Manpower and cost are two key component of resource development

2.1 OWNER'S COST (CAPEX)

The Owner's costs (Operation and Maintenance portion) for Quests have been developed in accordance with the Project Guide 03, identifying each of the activities and then estimating values for each of them. Area specific specialists have helped to bench mark cost and Scotford specific knowledge and experience have been utilized for estimation.

- It includes manpower cost based on WFP defining all major activities. Manpower estimate includes operation, maintenance, safety, craft team, business etc
- Chemical cleaning, first fill and steam blowing will all be done utilizing ops and maintenance team
- Power and Steam has been estimated for pre commissioning and commissioning activities and its unit values used to get raw material cost
- First fill volume includes TEG, Amine CO_2 for first fill, Anti foaming agent (Poly Glycol), Activated Carbon etc.

For detailed cost estimate and explanation refer to Quest Owner's cost Methodology. docx document.Operating cost (OPEX)

The Operating costs for Quests have been developed in accordance with the Operating Expenditure Estimating Process Guide, identifying and estimating the fixed and variable OPEX for Quest. The budget was last updated in December, 2014 in time to be included in the Scotford budget cycle for 2015/2016.

Manpower Costs

- A detailed manpower plan and cost estimate based on schedule & activities and cost breakdown is outlined
- The cost includes manpower required during start up and commissioning
- Brownfield people estimates is also included

Materials Costs

- Incremental property tax is based on the Alberta municipal budgets. Property tax factor for Scotford is 0.0042. (Source : Brian Waters)
- Turnaround cost is considered as a CAPEX factor compared to Expansion 1 and then using an additional factor of 50%, ($11.6 million C$ every 4 years) since CO_2 unit could be stopped at any time without affecting Upgrader. Unit 213 & 219 cost were compared in 2010 (Source : Harry Oates)
- Sustaining cost is determined using site CAPEX data with CAPEX factored. (e.g. $12.8 million/y for Debottlenecking D/S). Further cost were also compared for base plant Amine system
- Start up cost is included in owner's cost in CAPEX estimate.
- Cost of power is $99.0 CAD$/MWh PSV pricing and NG 4.72 CAD$/GJ PSV

(Source : Robert Murray)

OPE$T model

- OPE$T is a activity based cost calculation method and have been applied globally by Shell and other companies
- As recommended in previous ESAR, the OPE$T tool was utilized to additionally calculate and bench mark operating cost

2.2 OPERATIONS READINESS BUDGET

The funds for QUEST Operations Readiness activities are held with the common ORA Group. Total lifecycle budget for all Ops. Readiness team's members are independently maintained

Ops. Readiness Managers is responsible for their own part of the budget.

Please refer to Operation and Maintenance philosophy document for more information about resources

2.3 WORK FORCE PLAN (WFP)

A detailed work force plan was developed along with Quest CSU, operation, maintenance and safety team. ORSAT was used as a tool for detailing scope of work and subsequently hiring timetable is developed on quarterly basis.

Contractors and FTE were also identified and calculated

- Manpower cost from FID until MCC, mechanical completion and subsequently until start up and full ramp up
- Manpower estimate includes operation, maintenance, safety, craft team, business etc
- Salary includes bonus and burden for each job group. It is estimated that staff will work 40 hour /week, while hourly and craft will work more. Overtime estimate is embedded in cost
- Security, Nursing, HR, Finance, PR, Purchase, Store, Janitor etc are not considered as a part of indirect cost
- C & P, accounts, payables, Warehouse support etc. are also not considered in indirect cost
- No Project or Construction manpower is included in estimate
- Detailed breakdown of all activities (Ops and Maintenance) were carried out for each position to justify its existence and alignment with Project schedule

3 DEVELOPMENT OF CONTRACT

The development of the maintenance contracts will be coordinated by the ORA support group in accordance to Maintenance Contracting Strategy Document with an agreed implementation plan. Ownership and accountability of QUEST related MMSC & other services contracts to be transferred to QUEST Operations team

A number of asset contracts & specialist contracts may be developed to include: (Existing asset contracts will be utilized as much as possible)

- Maintenance contract for driven equipment
- Inspection contract for general plant & certified equipment
- Care of maintenance of the telecom systems
- Care of maintenance of control & safeguarding systems
- Supply of production chemicals
- Supply of laboratory services
- Catering and accommodation & office services
- Vehicle workshop services.
- Road maintenance
- Security services
- Medical services

All contracting activities associated with the CO_2 Capture Project activities will be managed by the project. The future organization shall implement the OE and Global Asset Management Excellence (GAME) Contracting and Procurement (CP) work process. High level plan created for MI Strategy, CMMS document, Availability, Reliability and Maintainability report (They are all controlled documents)

Ensure that the contract plan lists contracts for services, catalysts, materials, process materials, etc. and that it contains the following information as a minimum:

- Description of the scope of the contract;
- Contract parties involved;
- Owner of the contract; and
- When contracts need to be in place.

It has been agreed that Scotford Operation will manage CO_2 Capture Portion, CO_2 piping and wells. Detailed monitoring will be carried out by Calgary EP team and will communicate to Scotford for any changes.

Anti foaming system, make up of Amine and TEG may require further contracting activities

3.1 THIRD PARTY ASSISTANCE AND AGREEMENTS

- Operation readiness team will decide during execute phase the need to get support during start up from SGSI for Amine system Initial discussion has occurred with Roger Rangy regarding chemical cleaning and tray test

- TEG drying potential vendor assistance
- CO_2 Compressor initial run test (CO_2 or N_2) / surge test and start up may require vendor assistance. Unit rate have been obtained for support and basic need conveyed to Fluor.
- PSA and other vendor support will be better defined in the Execute phase
- Uhde’s support may also be needed
- Chemical cleaning contract for Amine loop

4 ORGANISATIONAL READINESS

4.1 LICENSE TO OPERATE

Application for approval

Since this is an environmental project, Application for environment permit has been submitted. However as a part of “CO_2 removal”, heating value of fuel gas gets increased considerably. Higher heating value of fuel gas along with absence of cooling gas like CO_2 causes marginal increase in NO_x quantity. Environment board is being consulted. A NO_x mitigation plan and decision note is in place and accordingly flue gas recycle will be installed along with changing burners to Low NO_x burners.

4.2 OE & GAME IMPLEMENTATION

OE, Operation excellence will form the overall umbrella under which GAME will function. CO_2 Capture Project will be Global Asset Management Excellence compliant at project “Ready for Start Up” (RFSU). A key requirement for GAME implementation for the CO_2 Capture Project is that the relevant components must support not only Operational Excellence but also commissioning and (flawless) start-up. The GAME IT projects will be implemented in such a manner that each respective IT tool will be available for use during the commissioning and start-up phases.

The Scotford site is currently implementing the following GAME work processes:

- Ensure Safe Production (ESP);
- Equipment Integrity (EI);
- Operational Integrity (OI);
- Instrumented Protective Functions (IPF);
- Maintenance Execution (ME);
- Reliability Centered Maintenance (RCM); and
- Turnaround (TA).

At the time of writing the ORP, Strategy and Asset Information Management (SAIM) GAME work processes were not being implemented at Scotford. This remaining work process will be fully implemented by Scotford before the CO_2 Capture Project RFSU.

Progress of GAME implementation at Scotford shall be monitored by CSU Manager and Integration Manager to ensure (by Q4 2014) that the existing site is GAME compliant at CO_2 Capture Project RFSU.

At the time of writing these documents an additional GAME work process; Mitigate Threats (MT) is being developed. A lesson learned workshop was organized for GAME (mainly ESP). If other new GAME work processes are developed during the Quest Project Implementation, they will be addressed in the same manner.

A basic ESP model has been developed and sent to Quest project team. It includes basic requirements, templates and examples. An “EPC GAME information session” was also organized to clearly understand scope. Individual Scotford champions (e.g.

RCM, ME etc) were also contacted for clarity of deliverable within define phase. This work process will follow the expectations of Scotford Operations management.

4.2.1 OPERATING MODES AND P & I REVIEWS

A detailed PFD and P & I review and coarse HAZOP were carried out. Necessary operation and construction participation ensured operability and maintainability of Quest

A list of operating modes was developed based on existing plan processes. A preliminary review of different modes was also covered during coarse HAZOP.

Please refer to Ops Modes folder (In Quest live link "06 Operations Angus MacQuarrie") for more information

4.2.2 AVAILABILITY AND RAM MODELING

To properly assess the amount of CO_2 that can be produced from Base Plant and Expansion 1, a RAM model was developed. "Mine production rates", "failure rates of critical equipments of Quest" and "Dow gas availability" were used to develop the model. SGSI produced an "availability factor" for Quest equipment and RAM analysis of Upgrader was merged with it. Dow gas quantity also was predicted and thereby H_2 production was developed. Subsequently using material balance CO_2 production profile was developed.

4.3 TURNAROUND PLANNING & MAINTENANCE

4.3.1 TIE INS

In order to correctly understand and optimize scope of work for turnaround a detailed work list was created including followings

- Unit based mechanical tie ins required for Quest operation was created
- Electrical supply and necessary connection were identified
- Instrument work was identified necessary within base plant and expansion 1

Numerous site visits and meetings with key site folks helped to develop a very comprehensive strategy and activity based scope definition for all tie in scope. Tie in packages (Mechanical) have been issued (IFC) for all tie ins, detailed operating procedure writing is completed.

4.3.2 TURNAROUND

The turnaround strategy to be adopted for the Scotford facilities will provide the availability target, legal obligations and company HSE directives. The strategies will include:

- Optimal turnaround preparation
- Appropriate planning and scheduling
- Contractor selection
- Scope challenges
- Effective and efficient turnaround execution structures

Dedicated staff in the operation organization (CSU Manager, OC, OE and

Maintenance Supervisor) in CO_2 Capture Project will ensure a flawless process of scope definition and preparation (by Q3 2015). Turnarounds will be managed and executed using the GAME Turnaround methodology, and with support and guidance by the site TA team, shared service department.

Activity based timelines

Timelines have been developed in order to ensure integrity and cost effectiveness of turnaround. Turnaround timelines have further been aligned with Debottlenecking project and operation readiness team is leading that activity of framing turnaround time in consultation with site

A procedure will be developed along with proper control scheme to ensure that CO_2 Capture Project can be stopped without affecting any of the running units and without losing H_2 production. Base plant operation team will coordinate planning activity and will also execute all shutdown related work. The Absorber located in Expansion 1 and its related equipment will be taken care of by Expansion 1 HMU team.

Proper communication will also be established with piping and sequestration team for coordinating any turn around schedule.

Independent operation

CO_2 Capture Project will be designed such that it can be shut down without affecting any of the hydrogen plant operation. Tight shut off valves will be provided for isolating C1, C2 and C3 columns. Any maintenance on them can be carried out independently. However due to shortage of Amine storage affected columns may have to be emptied in to some of the running columns.

Any maintenance on the Stripprer column will require complete shutdown of the CO_2 Capture facility.

The GAME TA work process will be used to develop a long-term schedule for the turnarounds, which will be updated periodically. CO_2 turnaround can be mechanically done independent of base plant and or Expansion 1. As far as possible and practical the schedule will be adjusted with neighboring industries in order to avoid parallel resource demands and thus resource crunch.

4.4 ORGANISATION

Organization and staffing, including the resource plan, addresses:

- The hiring strategy
- Resource loading of pre-commissioning, and commissioning and start-up activities
- Brown Field organization
- Work culture as well as Work / Life Balance
- The workforce plan to staff the organization until steady-state operation
- Competency assurance, including Competency profiling and assessment
- Training for the commissioning and start-up team, and operations, maintenance and technical teams
- Defining learning interventions

4.4.1 GENERAL

Preliminary organization has been defined for CO_2 Capture Project and is shown in Annexure 1. The CO_2 Core Team reporting to the Scotford Interface Manager (After FID) will provide operations input in support of the CO_2 project for the Execute phase. The team will consist of CSU manger, CO_2 Operations Coordinator & or Operations Engineer (OC/OE), HFE and U&O support. Contract services might be used to secure subject matter experts if required to supplement the team.

CO_2 Capture project (including compressor) will have one additional field operator in each shift for a steady state operation. For Start up, an additional panel operator will operate the Quest kit. After operability is demonstrated, the existing HMU panel operator will take the additional load of CO_2 Capture portion.

The existing HMU panel operator will run the CO_2 Capture portion of unit. One more instrument tech and part time pipefitter as well as electrician will make up the tech team. The rest of the support will come from the existing Scotford and Expansion 1 organization.

4.4.1.1 PIPELINE AND SEQUESTRATION

Scotford Operation organisation will be responsible for entire Quest Project Facilities. The critical information from CO_2 pipeline and sequestration will appear on HMU panel (Base Plant) providing necessary tool for managing and controlling CO_2 flow at Battery Limits.

A separate document was generated to define operating philosophy for CO_2 Capture, pipeline and sequestration. The decision with this respect has been made to have one Operation Readiness & Implementation organization managed from Scotford including start up and commissioning

4.4.2 CSU

4.4.3 OWNER'S TEAM

In line with the CSU strategy, the owner organization will start up the facility.

The preliminary commissioning and start-up organizations structures have been developed and attached at Appendix A. As per chart, OC for CO_2 Capture Project has been hired. CSU manager, Maintenance Supervisor and HSE Coordinator are on board. All of the panel and field operators are hired. Existing HMU Trainer with additional support have taken up training function.

Matrix of Facilities and Responsibilities

A matrix of responsibilities has been developed during execute phase showing the persons responsible for the commissioning and start-up

4.4.3.1 COMPLETION TEAM

The completion team will enable the implementation of the FSI program. Completion team along with construction manager will also facilitate system handover to owner's organization. The organization of the completions teams will be described in Execute phase.

4.4.3.2 BROWN FIELD

There will be a considerable work force required to carry out the Brownfield work. CO_2 Capture will have approximately 50 interconnections with the Scotford base plant, Expansion 1 and Shell Chemicals. Due to shear distance to different locations of tie in points, it will be quite a challenging task. A dedicated team of Brownfield staff will support this activity including isolation, purging and issuing permits. Expansion 1 model will be used to follow the process. Preliminary definition of brown field and green field permit plan is completed along with construction team

4.4.4 START-UP ORGANIZATION

The start-up organization chart has been developed and included at Appendix A

Tentative schedule	2011			2012				2013				2014				2015			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Total for Quest (Capture, ppl and seq.)	4	5	5	9.9	10.9	11.4	11.9	14.3	16	25.3	43.3	50.5	64.5	62.5	51	49.5	9.5	9.5	9.5	9.5
Ops. manager (Marc untill FID and then Tim W)				0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5			
CSU Manager (Angus MacQuarrie)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
HSE Coordinator (Kelly Chanski)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Safety Inspector													1	1	1	1				
OC (John Asselman)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Process/Ops Eng				1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
Field Operators					1	1	1	1	1	1	6	6	6	6	6	6	6	6	6	6
Panel Operators								1	1	1	4	4	4	4	4	4	0	0	0	0
Temporary (Contract) Operators							*	*	*	1	6	6	6	6	0	0	0	0	0	0
Area Trainer				0.5	0.5	0.5	0.5	1	1	1	1	1	1	1	0	0	0	0	0	0
Rotating Engineer				0.3	0.3	0.3	0.3	0.5	0.5	0.5	1	1	1	1	0	0	0	0	0	0
Maint. and Eng. Manager (John Losty)		1	1	1	1	1	1	1	1	1	1	1	1	1	0.5	0.5				
Maintenance team lead							0.5	0.5	0.5	0.5	1	1	1	1	1	1	0	0	0	0
Pipe Fitters										2	2	4	10	10	10	10	0	0	0	0
Millwright										2	2	2	2	2	2	2	0	0	0	0
Instrument Tech.				1	1	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1
CTM Instrumentation										2	2	4	10	10	10	10				
Maintenance specialist											2	2	2	2	1	1				
Elect Tech.				0.3	0.3	0.3	0.3	0.3	1	1	1	2	2	1	1	0.5	0.5	0.5	0.5	0.5
Electrical CTM										1	1	1	2	2	2	2				
Flawless Coordinator				0.5	0.5	1	1	1	1	1	1	1	1							
Maint. Supervisor (Aaron Balaban)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
I & C Eng.				0.3	0.3	0.3	0.3	1	1	1	1	1	1	1	1	1	0	0	0	0
Inspector									1	1	1	1	1	1	0	0	0	0	0	0
Lab Tech.										0.3	0.3	0.5	0.5	0.5	0.5	0.5	0	0	0	0
CSU Planner					0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5	1	1	1	1				
Maintanance Planner										0.2	0.2	0.2	0.5	0.5	0.5	0.5				
Business Advisor							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3				
Regulatory and Government Interface Adviser							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3				
Total CO2 Capture	4	5	5	9.4	10.7	11.2	12.3	14.7	16.6	25.1	42.1	47.3	62.1	60.1	48.6	48.1	8	7.5	7.5	7.5
Pipeline and Sequstration staff																				
Subsurface team (covered under separate budget)																				
Pipeline / well Operator				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Pipeline and Well temporary (contract) operators											1	2	2	2	2	1				
Pipeline and well maintenance craftman										0.5	0.5	1	1	1	1	1	1	1	1	1
Pipeline and well temporary (contract) maintenance craftman										0.5	0.5	1	1	1	1	1				
Total pipeline and well	0	0	0	1	1	1	1	1	1	2	3	5	5	5	5	4	2	2	2	2
Total for Quest	4	5	5	10.4	11.7	12.2	13.3	15.7	17.6	27.1	45.1	52.3	67.1	65.1	53.6	52.1	10	9.5	9.5	9.5

Figure 1: Startup Organization Chart

4.4.5 COMMISSIONING AND START-UP RESPONSIBILITIES

During the execute phase of the project the owner and the Capture and Pipeline Engineering Contractors shall work together in integrated, asset-based teams.

The Project Manager will be responsible for the management of these integrated teams throughout engineering, procurement, construction and commissioning, that is, up to the CO_2 Capture Project "Ready For Start Up" (RFSU). Integrated commissioning and start-up (CSU) teams will be formed. Prior to system handover construction manager and the Main Engineering Contractor's site Manager lead the team. After system hand over the owner's CSU Manager leads. Please refer Project to Asset Transfer Plan (P2A) document # D- 0412

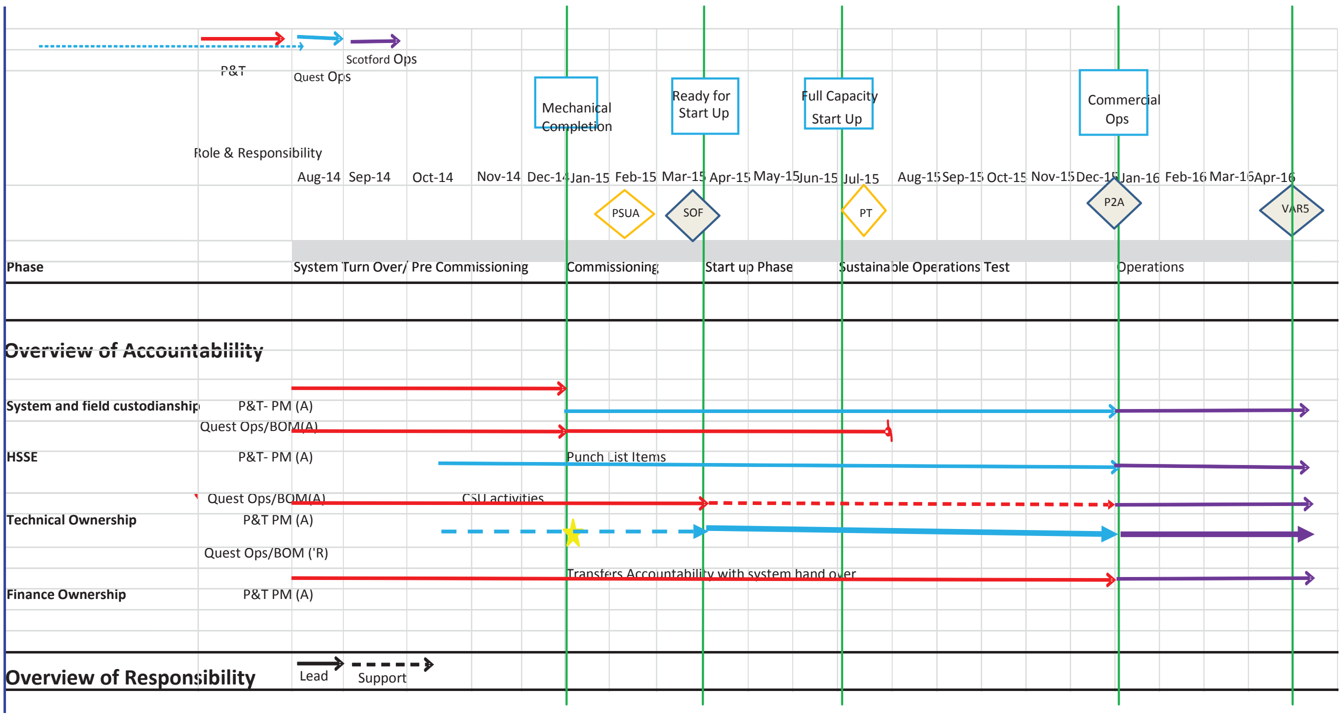


Figure 2: Overview of Accountability

4.4.5.1 RESPONSIBILITIES DURING COMMISSIONING

The CSU Manager will be responsible for the completion of commissioning activities. During this phase the owner CSU team will lead activities. The contractor is responsible for handing over clean, tight, operable, safe, functional and complete systems, in accordance with the Flawless Start-up Initiative (FSI) criteria.

The term "responsible" embraces all Health, Safety, Security and Environment (HSSE), Sustainable Development (SD), schedule, cost and quality aspects of the work. Clear definitions of clean, tight, operable, safe and functional were included in the implementation phase contracts along with the performance standards expected, as part of the FSI project specification. The Main Engineering Contractor (Fluor) shall be responsible for quality assurance throughout project implementation until System hand over.

CO_2 Capture shall have pre-commissioning and commissioning phases. Detailed roles and responsibilities have been defined in EXECUTE by Quest Integration

Manager.

4.4.5.2 RESPONSIBILITIES DURING START-UP

The CSU manager shall be responsible for the start-up through to sustained operation post Government performance tests of the CO_2 Capture facilities as well as pipeline, wells, and MMV program. See detailed roles and responsibilities for Wells and MMV in a separate document (Operational and Maintenance Philosophy, 07-0-OA-5522-0001). The contractors will provide adequate timely assistance during start-up for the rectification of defects. A dedicated crew who are not involved in ongoing construction or commissioning activities should perform this work.

4.4.6 POST START UP SCOTFORD ORGANIZATION

After start-up and after attaining sustained stable operation of the CO_2 Capture facility (Refer: Performance Testing), it will be integrated into the Scotford Upgrader and Expansion 1 as part of one organizational concept. Proper data communication and controls will be established between Base Plant, Expansion 1 and SCCL due to utility and process integration

4.5 SYSTEMIZATION / CLEANING MATRIX

Basic system definition was completed and P & ID's marked up. A priority list is also made for identifying which system should be available first (In blocks) in order to reduce start up time (Refer: Systemization and Cleaning folder in ORA live link "ITR 4 June 2011"). First alignment session also completed with construction and CSU team. A detailed cleaning matrix has been generated for all systems. It highlights which system will be cleaned using which method. It also indicates method of drying / preservation. Refer to detailed cleaning matrix for more information
It is envisaged that all mechanical works for Expansion 1 along with common systems will be completed early followed by base plant. Amine regeneration / TEG and CO_2 Compressor will be started early followed by lining of each Amine absorber associated with each HMU in series depending on completion of work in each unit. The lesson learned of each Absorber will be used for further line up

4.6 MODULARIZATION

Refer to detailed Modularization feasibility report (Third Generation Modularization Risk Assessment.docx in ORA live link "ITR 4 June 2011") for complete review.

4.7 ORA AND CSU SCHEDULE

A level 3 ORA Activity based scheduled was prepared. ORSAT was utilized to come up with key ORA activities. It is then integrated in to overall schedule.

Following major components were used to develop ORA schedule

- OR&A Management
- Flawless Project Delivery
- Operations Management Systems
- SD and HSSE / SP
- Cost Modeling

- Operations Organization (incl. Venture Set-Up)
- Commissioning and Start-up (CSU)
- Project to Asset Transfer

Individual activities were linked using predecessor and successor along with duration

A level 3 CSU schedule was developed in consultation with pipeline and well team. Considerable efforts have been made to align overall schedule along with CSU activities. Critical milestones have been identified and forms part of overall integrated schedule. For detail list of ORA activities and milestone please refer to ORA part of integrated schedule. Please also refer to CSU schedule (Capture 2014 CSU Schedule.xlsx at ORA live link) for duration and activity planning during CSU. The strategy is to start all the utilities and common system first. Compressor pre commissioning and surge test will be completed in advance. Amine circulation will be established followed by lining up of Absorbers. It is envisaged that Expansion 1 absorber (HMU 3) will be started first followed by Base Plant units. (Pipeline and wells will be made ready in advance to receive CO_2 from capture unit.) The start up of the wells will commence once the surface facilities have completed the pre start up checks; pipeline has been hydro tested, pigged and is ready for commissioning and the wells telemetry system is working to record real time injection pressures, temperatures and rates. The wells commissioning will commence after the pipeline is full of CO_2 and the system pressure is high enough to commence injection. Systems are already marked up on P & ID's. Preliminary definition of predecessor and successor of system based schedule is also ongoing. The strategy will be to turn over the system to the operations as per the project schedule agreed on (According to system priority).

a) The bulk of the process equipment will be tested prior to commissioning as in utilities, TEG, compressor to prove the integrity and operability.
b) Amine system storage will be build up prior to commissioning activities.
c) On completion of the above the systems will be turned over on a system-by-system basis based on a priority matrix.

<u>CSU Schedule Alignment</u>

The ORM process recognizes and ensures operations input from the early select phase and throughout all subsequent project phases. The staffing of the CO_2 Capture operations team, as a part of Growth Team, is scheduled to meet this requirement. Operations will ultimately be responsible for accepting operating systems from the Capture and Pipeline contractors upon mechanical completion.

Following mechanical completion and hand-over, operations is the leading party in commissioning and start-up, under the guidance and direction of the commissioning and start-up team, and with specific vendor support, wherever required. The project team will correct possible misfits or design non-compliances that are discovered in this phase. Raw H2 is introduced, a production ramp-up to meet design capacity is planned to take place within two weeks. Between one and three months after the introduction of Raw H2, performance guarantees test runs for the CO2 Capture is planned to assess compliance to the design. Non-compliance will be addressed and corrected under the design-assurance clause of the EPC contractor and know how supplier.

Following three performance tests are included in schedule to achieve successful commercial operation

- **Test A – Capture Unit Capacity** – 24 consecutive hours in which Quest capture unit processes a minimum of 2,960 tonnes of CO_2 (1.08 MTpa over 24 hours) from the HMU facilities.
- **Test B – Capture Unit Efficiency** – 20 consecutive days in which the Quest capture unit processes a minimum of 75% of the total CO_2 produced by the Upgrader base and expansion HMU facilities during those 20 days, while running at an average of at least 50% and a minimum of at least 30% of design rates.
- **Test C – Integrated Project Reliability** – 30 consecutive days in which the Quest project maintains operation whereby the capture, transportation and subsurface facilities operate continuously without shutting down, while running at an average of at least 30% of design rates.

It is very important to align the start up and commissioning schedule along with Turnaround schedule of Base Plant and Expansion 1. This schedule will include not only project, engineering & construction activities but should also include pre commissioning / commissioning time until on spec CO_2 is produced.

Refer CSU strategy document for more information

4.8 PRODUCTION PLANNING AND LOGISTICS

CO_2 Capture Project facility is widely spread among base plant and Expansion 1. Absorber, wash water system, anti foaming skid and any other possible NOx abatement system for each HMU will be operated from corresponding DCS. That means system associated with HMU 1 and 2 will be operated from Base Plant DCS (Foxboro), while the one within HMU 3 will be operated from Expansion 1 (Honeywell). All common system associated with Amine regeneration, CO_2 Compressor and Drying unit will be operated and managed from Base Plant control room.

SIS and safeguarding system will also follow similar pattern as mentioned above. However there will be a constant flow of information between base plant and Expansion 1 for critical loops

Pipeline monitoring, information will come to DCS at Scotford through SCADA. This information will come to Calgary using PI server for monitoring wells.

CO_2 product will meet or exceed the **quality specs** (Included in BDEP). Lab result will be confirmed before sending CO_2 to pipelines. Until such time, off spec CO_2 will be sent to CO_2 stack. On spec CO_2 will end up in one of the sequestration sites. Presently EP is handling piping and sequestration and proper communication will be established with them. The CO_2 will be delivered at B.L. at a required pressure so as to send it to the bottom of well. It is expected that well pressure, flows and other parameters will be communicated to Scotford control room for monitoring as well as control.

Amine loading and filling for startup is a key component of logistic plan. Refer a detailed logistic plan for more information

The newly merged logistics dept. at Scotford will coordinate the logistics & procurement requirements of Quest once equipment and installations are handed over. The purchase of “Other items” (Trucks, safety items, hoses, fittings, first fill etc are mentioned in owner’s cost) have been specified and a register will be maintained for procurement prior to CSU period.

The estimated values of purchasing the different items are mentioned in owner’s cost document

Procurement of movables such as office desks, workshop equipment etc will be provided by the Quest Operation readiness team.

Computers and LAN facilities will be coordinated by the current IT services group at Scotford. Spare parts and materials for commissioning and first year operations will be provided by the Quest Project team.

Funds for first year’s operations spares are included in the owner’s cost. Movables, such as hand tools will be provided by the Maintenance Service Contractor.

4.9 DOCUMENT, INFORMATION AND DATA REQUIREMENTS

Shell IT will provide the project with access to the necessary office and communication tools to execute the Execute phase of the project. This includes but not limited to:

- Shell network at the EPCM office (using approved service providers).
- A key learning from the Scotford expansion 1 site is that a “Data Center” trailer purchased early in the project is very desirable. This trailer will provide a suitable location to start hosting all services needed at the construction site. A cost effective solution including, HVAC, raised floor, cable tray, etc, will be preinstalled and requires little retrofit at the site. This trailer will be included in the CMT complex but can be purchased and deployed to site as soon as ground clearing has completed. The “Data Center” trailer will serve as the fiber optic hub for the construction network.
- Shell GID office desktops and laptops
- Printing environment
- Suite of office applications and specific engineering, project management and project control applications.
- Office communication tools including email, calendar, Microsoft Office Communicator (internal and with EPCM), Live meeting, calendar sharing with EPCM.
- Shell Livelink technical library and project work space
- Shell IICE document transfer tool (for document validation and transfer between the EPCM and Shell)
- Shell Livelink technical library and project work space
- Wireless device for remote access to the Shell network via MOB.
- Access to Shell Livelink and other applications when required.

For more information refer to IT delivery plan 07-0-AA-5806-0002

PI Process book was utilized to collect average H_2 production, availability figures and NIL production days. Data collected were also validated by site. All modifications carried out within PSA were detailed to vendors for evaluating PSA performance. For Expansion1 design data were provided for all necessary evaluation.

4.10 INFORMATION TECHNOLOGY

4.10.1 INFORMATION MANAGEMENT

Information management (IM) is critical to the success of a project, from early scouting through commissioning and start-up, and into steady operation. Information flow diagrams have been developed showing information flows between all project partners.

The project internal stakeholders are:

- The CO2 Capture Project team
- Joint Venture Partners' team
- EPC Contractors
- Owners' operations teams, specifically the commissioning and start-up, operations, technical and maintenance teams

The information flow diagrams will contain relevant details about individuals having key roles in the information exchange process. For more information please refer to IM delivery document 07-0-AA-5806-0001

4.10.2 QUALITY MANAGEMENT

Quality management of both data and information, and the systems and infrastructure used for this purpose, is vital. Providing complete documentation on a timely basis is a key project deliverable. Timely availability of information is especially important if this information is required for training purposes.

5 FLAWLESS PROJECT DELIVERY

5.1 FLAW LIST (LESSONS LEARNED)

Lessons learned from base operation and projects were compiled. Dedicated operations personnel are part of ORA team supporting the project bringing extensive knowledge from the operational, maintenance and projects that will be implemented into these projects. Lessons will continue to be collected from D/S and other groups as in SGSI to ensure minimal deficiencies.

Flawless list has been prepared for majority of Quality Qs. Core team for each Quality Q e.g. “Operability and Maintainability Q” have been identified and action party has been assigned for many of flaws.

Please refer to individual flawless area for more information (ORA web page) and also to Flawless Executive Phase Plan document # 07-0-OA-5876-0001

5.2 QUALITY AREAS

The following Quality Areas have been selected for now but during execute phase further development will be made on flawless start up. (Also refer additional list)

Quality area	KPI	Target
Tightness	# of leaks causing more than 4 hours delay during commissioning # of High Pressure CO2 Leaks causing delay during commissioning	2
Cleanliness	# of "foreign bodies incidents" causing more than 8 hours delay in Schedule (‘Foreign Bodies’ in Systems, Equipment or Components) including downstream to injection site	1
Mechanical Integrity (Static)	# of re-opening of static process equipment due to required rework during commissioning	1
Mechanical Integrity (Rotating)	At time of Compressor Start up the # of days lost due to an unsuccessful anti surge test At time of Start up the # of days lost due to an unsuccessful start of a Major piece of Rotating Equipment	2
Instrumentation integrity	# of caused upset conditions to Scotford operations during the commissioning	0
	# of caused delays (longer than 8hrs) due to failure of instrumentation (All systems and field instruments)	1
Electrical integrity	# of electrical connections requiring rework during commissioning Start compressor with no impact on Scotford Electrical Distribution System (measure # of days delay against target)	5 0
Operability & Maintainability	# of accepted punch items causing rework related to HFE items -	2
	# of unplanned delay due to operability or maintainability causing start up delays of more than 1 day	0
Novelty & Complexity	# of unplanned interventions on novel or complex systems causing start up delays of more than 1 day # of new Prototypes emerged during Commissioning to Start-Up causing more than 8hr delay	1 0
Testing	# of days delay in performance Testing (Measuring quality, quantity	0

Quality area	KPI	Target
	including government performance criteria) beyond 3 months of start up # of Incidents of overall NOX release levels higher than stipulated environmental limit	0
Competence and Experience	Key Operations Personal (Tech Staff, Operators, Maintenance, etc) positions filled with competent personnel prior to commissioning and start-up activities (Threshold = Go/No Go position) # of days causing delays (longer than 8hrs) due to lack of experience or competency prior for start up	0 2
Coinciding events (incl. schedule)	Project meets their Turnaround deliverables supporting turnarounds activities (ie, missed deliverables) # of lost construction days due to conflicting events with Scotford planned activities	0 0
Information	# of delays (longer than 8hrs) caused by documents or data packages not being available or inadequate prior to commissioning # of delays (longer than 8hrs) caused by documents or data packages not being loaded into Operations Systems (GAME) prior to commissioning	1 0

Table 4: Quality Key Performance Indicators (KPI's)

5.3 QUALITY ROUNDS

Quality rounds will be included in the job descriptions for the Operational personnel working within the CSU organization. These are also considered key activities for the construction contractors and will be included in the contracts so as to ensure compliance. Q rounds will be included in the pre-commissioning and commissioning phases so as to ensure consistency in the quality work pattern throughout the project. These rounds will need to be incorporated into the Intelatrac system in order to keep with the GAME ESP, M&CC standards.

5.4 Q ASSURANCE PLANS

ORM guidelines from ORSAT is being used for developing operational assurance plan and it will be carried out during each phases of the project. (Please refer BDEP for more information). ORA schedule is now integrated with overall schedule and all milestones have been identified.

5.5 HSSE REQUIREMENTS

The HSSE requirements for the project will be provided in the PEP and HSSE design case. Action for the next phase is to identify all HSE deliverables as per PS1 and DCAF, some of these may be operation teams. HSE person in project team will pull the plan with input from a HSE focal point from operation team.

Operation will need to provide input into the HSE plan for the next phase.

5.5.1 HEALTH, SAFETY AND ENVIRONMENT ORGANIZATION

The main area's of HSE work are:

- Development of the QUEST HSE Design Case

- Enhancement of the Permit To Work system and permit development for brown field and green field
- Development of QUEST emergency response procedures, linked to corporate HSE-MS and HSE competency training/assessment of QUEST staff
- Development of Oil Spill Response Plans
- Development of QUEST HSE and risk procedures
- HFE and HRA
- Waste management
- Operational environmental/sanitary monitoring
- Post construction carry-over management of site rehabilitation
- HSE/Compliance organization model
- Cold weather work/travel plan
- Mandatory HSE training requirements for staff & visitors
- Alcohol, drugs & smoking policy
- MMV Plan

The development of the Operations HSE design cases is described in a detail HSE document 07-0-HX-7506-0001

MOPO (manual of permitted operations) will form part of the QUEST HSE Case as it is the case with SIMPOPS (simultaneous permitted operations). The QUEST HSE & emergency response procedures will evolve from those developed previously.

5.5.1.1 CONSTRUCTION PHASE (SIMPOS)

The owners' project team and the engineering, procurement and construction (EPC) contractors are responsible for managing HSSE-SD in the construction zone, under the Scotford systems of compliance, until the first system is turned over. Pipeline HSE management will use the Onshore Projects HSSE system while the wells will use the Well Delivery HSSE management system.

During construction, the construction organization will be accountable for HSSE management. Incidents will be reported and addressed. An emergency response team will be defined and staffed from within the construction organization. If an HSSE incident cannot be handled by the construction organization, the Base plant and or Expansion 1 will be contacted for support.

The EPC will be responsible for providing security services to secure the site. The RDS Security standard will be the minimum standard of performance.

A detailed **SIMOPS** matrix was developed along with operation and EPC contractor to list external and internal factors that can affect personnel safety, environment or material during construction phase. Further ranking and colour coding will be assigned to them to highlight risk involved. Mitigation plan for each of them will be linked to the matrix in next phase

5.5.1.2 SAFETY IN TRANSITION

The Safety in Transition Plan (SIT) has been developed jointly between the Project

(P&T, HSE Advisor) and QUEST CS&U Ops (HSSE Coordinator). It is patterned after the SUEX-1 SIT plan as the plan was successful during the Scotford Upgrader Expansion-1 project.

5.5.1.3 TURNOVER AND START-UP

After the first system has been turned over, HSSE-SD responsibility will start to shift from the owners' project team and the EPC contractors to the operations and commissioning and start-up team (for Brownfield – it will be during Construction in existing facilities). An HSSE Transition Plan will be in effect throughout the turnover process. Risk assessments will be used to determine whether special restrictions will be needed for areas adjacent to live systems.

The commissioning and start-up team will include HSSE coordinators and inspectors for auditing during construction. After hand-over, the HSSE accountability will be transferred to the commissioning and start-up team and, after start-up, to the permanent Scotford organization. At the moment after M/C (Mechanical Completion), the Shell permit to work will come into effect in associated areas of the construction site. (The Permit to work system may be in effect for live Operating Units during the Construction phase prior to system turnover). The introduction of Raw H_2, Amine or charging system will be carefully planned to balance HSSE compliance with contractor resource efficiency at the end of construction.

5.5.2 HSSE COMMISSIONING AND START-UP PLAN

The commissioning and start-up team will prepare a detailed commissioning and start-up HSSE plan for each unit, which will include:

- Classifying all commissioning and start-up activities as hazardous and non-hazardous. Job safety analyses will be done for all hazardous activities.
- Establishing geographical boundaries suitable for separating live units and non-hazardous work
- Utilizing existing permit-to-work procedure, including training requirements and a list of authorized signatories. E & P field operating sites permit to work procedures will also be reviewed.
- Permit Guidelines for the Upgrader to be utilized for maximum number of permits of various types that can be handled safely by operations.
- Providing a list of HSSE, safeguarding and utility systems that must be operational before commissioning starts. This also applies to all required procedural safety systems, such as meetings and control rounds.
- Assigning responsibility and preparedness of emergency response services, such as the emergency response team, medical responders and safety advisors, security services during the various project phases
- Determining the availability of, and alignment with, external response organizations, such as hospitals, police, ambulance and the fire department, STARS
- Identifying HSSE risks unique to the project
- Preparing a pre-start-up HSSE checklist

- Identifying the requirements for training, workshops and toolbox meetings to ensure that all plant personnel are aware of the commissioning and start-up hazards
- Preparing a plan for obtaining assistance from the site emergency response team, and the readiness of the fire protection systems during emergencies
- Preparing a procedure for overriding safeguards or changes to alarm and trip settings during commissioning and start-up. Will follow the existing SWP for IPF and Impairment systems.
- Establishing a plan to reduce additional HSSE risks for operations
- Communicating the detailed roles and responsibilities of the various parties (commissioning and start-up team, HSSE department and EPC contractors) during the transition phase from one safety regime to another
- Establishing a sound communication protocol for all contractors workers on the previously mentioned issues

Clear descriptions of the changes to the HSSE rules and procedures, as the project moves through construction to start-up, will be in the HSSE Transition Plan. Two HSSE management systems will be in place, and the procedures will address both sides of the interface:

- One for the project organization (covering the period of construction, commissioning and start-up)
- One for the permanent organization (starting as soon as start-up begins)

6 APPENDICES

Appendix A: Standard Document Checklist (To be agreed upon with Project)

Document	Clarification note	N.A.	Document to be prepared by		Remark
			CSU team	Project team	
Safety documents					
External safety report	e.g. Pre Start-up Safety Report	☐	☐	X	
Hazard Control Sheets		☐	☐	X	
Hazard and Operability (HAZOP) studies		☐	☐	X	
Occupational Health Instructions		X	☐	☐	
HSE memorandum		X	☐	☐	
Noise maps		☐	☐	X	
Area classification		☐	☐	X	
Material Safety Data Sheet		☐	☐	X	
Waste handling instructions		☐	☐	X	
Operation documents					
Operating Manual		☐	☐	X	
Alarm & trip setting lists		☐	☐	X	
Operating limits	Ensure Safe Production	☐	X	☐	
Cause & Effect Diagrams		☐	☐	X	
Process Safeguarding Memorandum	i.e. scenario for RV	☐	☐	X	
Safeguarding Narratives	e.g. IPF narrative	☐	☐	X	
Control System Manual		☐	☐	X	
Process Control Narratives		☐	☐	X	
Feedstock/product specifications		☐	☐	X	
Work instructions	e.g. instructions for taking out a vessel and changing absorbent…	☐	X	☐	
Operational lists	e.g. permanent spade lists, Relief Valve checklist…	☐	X	☐	
Job aid	e.g. Power failure, Cooling water failure…		X		
Graphics for DCS		☐	X	X	
Pictorials for Process Information system		☐	☐	X	
Start-up / shut-down documents					
Start-up procedures		☐	X	☐	
Shut-down procedures		☐	X	☐	
Emergency procedures	e.g. trip & trip recovery instructions	☐	X	☐	
Restart procedure after trip		☐	X	☐	

Document	Clarification note	N.A.	Document to be prepared by		Remark
			CSU team	Project team	
Commissioning plan		☐	X	☐	
Commissioning procedures		☐	X	☐	
Pre-commissioning plan		☐	X	☐	
Pre-commissioning procedure		☐	X	☐	
Maintenance documents					
Maintenance procedures	e.g. Instructions for maintenance of flow meters	X	☐	☐	
Equipment specific maintenance instructions	e.g. instructions for maintenance of chiller units	X	☐	☐	
RCM / RBI baseline data		X	☐	☐	
Flange Management Protocols		X	☐	☐	
Technology documents					
Mass and heat balance		☐	☐	X	
Utilities balance		☐	☐	X	
Laboratory documents					
Analytical test methods		☐	☐	X	
Key Project documents					
Archive Feasibility report		☐	☐	X	
Archive Basis of Design		☐	☐	X	
Archive BDEP		☐	☐	X	
Archive Design book		☐	☐	X	
Performance test run report		☐	X	X	
Process Flow Scheme		☐	☐	X	
Process Engineering Flow Scheme		☐	☐	X	
Process Safeguarding Flow Scheme		☐	☐	X	
Utility Flow Scheme		☐	☐	X	
Plot Plan		☐	☐	X	
Other documents					
Training documents		☐	X	X	

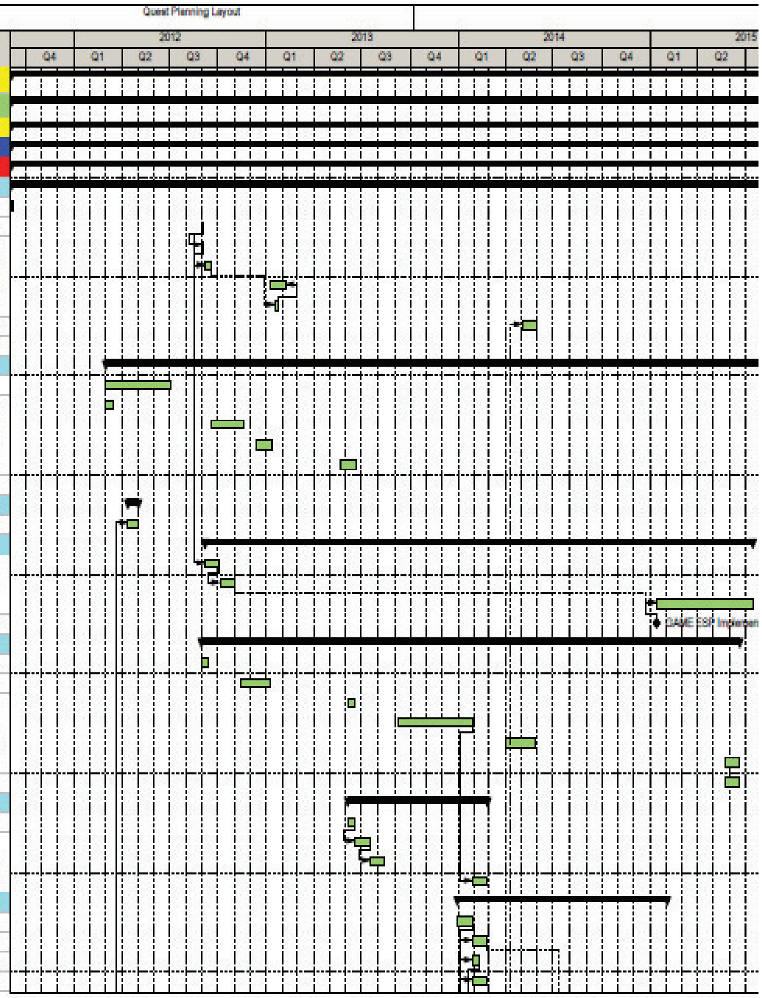
Appendix B: Minimum Requirements per Quality Area (Capture)

Quality area	Minimum requirements
Tightness	• Torque all joints • Identify any bolt tensioning required • Induction required for all construction team • Identify any critical valves and request witness pressure test at vendors or workshop
Cleanliness	• Identify cleaning requirements / flushing and resources required • Ensure pipe work is delivered capped • Identify lay down areas for material • Carry out Quality rounds weekly to check criteria being met • Final inspection of all vessels required prior to box up
Process Integrity	• Ensure all feed, product & consumables specifications are complete and agreed • Ensure potential fouling / foaming due to process reason is identified and addressed • Ensure key process variables, their targets and target limits are defined and hardware is available for monitoring • Ensure all operating modes are defined in the FEED phase • Ensure loading of adsorbent / catalyst as per agreed scheme(s) • Ensure (process) stream sampling requirements are defined
Mechanical Static Integrity	• Inspect all vessels/columns/reactor internals against drawings
Mechanical Rotating Integrity	• Perform static and dynamic functional tests
Instrumentation Integrity	• Perform static and dynamic functional tests
Electrical Integrity	• Perform static and dynamic functional tests
Civil integrity	• Review installation procedures and competency of work force
Operability & Maintainability	• Review operability & maintainability during PEFS & 3D model reviews (if applicable) • PEFS check by operations team to check spade positions. • Commissioning / start-up shutdown and emergency procedures to be written and reviewed with operations • Utility supply agreed with focal points. Pressure verified. Can it be supplied? • All tie in points agreed with owning process unit, site visited and valves tested
HSE in transition	• Agree permitry responsibilities for all phases: tie-ins, construction, commissioning, etc… • Highlight any high risk areas for the project such as working in H2S areas or any live line requirements
Novelty & Complexity	• List novel and complex items and get agreement from process unit and team. Put in place mitigation. I.e. extra testing or time for commissioning. Novel items should be minimised!
Testing	• Integrated project plan for inspection and testing (static and dynamic) for process units, systems and individual components. • Issue testing and inspection templates
Competence and Experience	• Agree operational resources and competences with release dates for: design, construction, commissioning and normal running • Identify who requires training, how, length, who gives it and when
Coinciding events (incl. schedule)	• Coordination of actions between Q areas • Identify potential conflicts (e.g. concurrent activities, resources for Flawless, etc…) by brainstorm and put in place mitigation • Discuss start-up and commissioning plan with schedulers/programmers and identify any utility or hydrocarbon requirements

Appendix C: ORA Activities and Schedule

Shell Quest CCS Project Execution Phase Schedule 7 Sep 11 | Quest Planning Layout

Activity ID	Activity Name	Original Duration	Start	Finish
Shell Quest CCS Project Execution Phase S		1527.0d	05-Sep-11	09-Nov-15
Execute Phase		1527.0d	05-Sep-11	09-Nov-15
Venture		1527.0d	05-Sep-11	09-Nov-15
Project Assurance		1527.0d	05-Sep-11	09-Nov-15
Operations Readiness and Assurance		1527.0d	05-Sep-11	09-Nov-15
OR&A Management		1527.0d	05-Sep-11	09-Nov-15
OPSEE1330	Update OR&A Plan and agree post acceptar	5.0d	05-Sep-11	09-Sep-11
OPSEE1180	Mobilise competent Senior OR&A Manager f	5.0d	30-Aug-12	05-Sep-12
OPSEE1190	Mobilise additional OR&A team personnel for	5.0d	30-Aug-12	05-Sep-12
OPSEE1290	Identify competency shortfalls and initiate trai	10.0d	06-Sep-12	19-Sep-12
OPSEE1305	Finalize Operations Readiness Plan	22.0d	09-Jan-13	07-Feb-13
OPSEE1300	Perform formal Operations Readiness Revie	5.0d	18-Jan-13	24-Jan-13
OPSEE1310	Co-ordinate & conduct Pre-Start-Up Audit (P	20.0d	02-May-14	29-May-14
OPSEE1320	Co-ordinate & conduct Final Acceptance Au	5.0d	03-Nov-15	09-Nov-15
Flawless Project Delivery		1310.0d	02-Mar-12	02-Oct-15
OPSEE1350	Roll out FPD compressor & major equipment	88.0d	02-Mar-12	03-Jul-12
OPSEE1340	Initiate FPD with core team (incl. Primary cor	10.0d	02-Mar-12	15-Mar-12
OPSEE1355	Roll out FPD to field construction contractor	44.0d	20-Sep-12	20-Nov-12
OPSEE1365	Roll out FPD to 3rd gen module contractor	22.0d	13-Dec-12	11-Jan-13
OPSEE1360	Roll out FPD to pipelines contractor	22.0d	22-May-13	21-Jun-13
OPSEE1370	Identify flaws and lessons during Start-Up, R	10.0d	21-Sep-15	02-Oct-15
Plans, Philosophies and Strategies		21.0d	13-Apr-12	03-May-12
OPSEE1380	Contribute to update of the Asset Reference	15.0d	13-Apr-12	03-May-12
Operations Management Systems		1043.0d	06-Sep-12	15-Jul-15
OPSEE1390	Develop support systems for OMS	20.0d	06-Sep-12	03-Oct-12
OPSEE1400	Prepare OMS for handover to Asset team	20.0d	04-Oct-12	31-Oct-12
OPSEE1415	Implement OMS	132.0d	13-Jan-15	15-Jul-15
OPSEE1410	GAME ESP Implementation	0.0d		13-Jan-15*
Production Operations		1024.0d	30-Aug-12	19-Jun-15
OPSEE1430	Develop Hydrocarbon Allocation (HCA) Manu	10.0d	30-Aug-12	12-Sep-12
OPSEE1450	Develop MOPO and SIMOPS procedures	40.0d	14-Nov-12	08-Jan-13
OPSEE1480	Conduct WRM minimum standard assessment	10.0d	05-Jun-13	18-Jun-13
OPSEE1440	Develop Detailed Operating Procedures	100.0d	10-Sep-13	27-Jan-14
OPSEE1420	Transfer ownership of Asset from Project tea	40.0d	01-Apr-14	28-May-14
OPSEE1460	Implement WRM Field Surveillance Plan	20.0d	25-May-15	19-Jun-15
OPSEE1470	Implement Metering and Allocation methodolo	20.0d	25-May-15	19-Jun-15
Production Chemistry		265.0d	05-Jun-13	24-Feb-14
OPSEE1490	Finalise Production Chemicals Performance	10.0d	05-Jun-13	18-Jun-13
OPSEE1510	Develop Production Chemistry Management	20.0d	19-Jun-13	16-Jul-13
OPSEE1520	Deploy and populate Production Chemistry s	20.0d	17-Jul-13	13-Aug-13
OPSEE1500	Review Commissioning and Start-Up proced	20.0d	28-Jan-14	24-Feb-14
Maintenance and Integrity		399.0d	31-Dec-13	02-Feb-15
OPSEE1530	Finalise M&I plan	20.0d	31-Dec-13	27-Jan-14
OPSEE1550	Develop M&I Management Systems and Doc	20.0d	28-Jan-14	24-Feb-14
OPSEE1570	Deploy M&I Asset Team personnel during E)	10.0d	28-Jan-14	10-Feb-14
OPSEE1580	Deploy and populate M&I applications (e.g. tx	20.0d	28-Jan-14	24-Feb-14



Actual Work | Critical Remaining Work | Summary
Remaining Work | Milestone

Page 1 of 3

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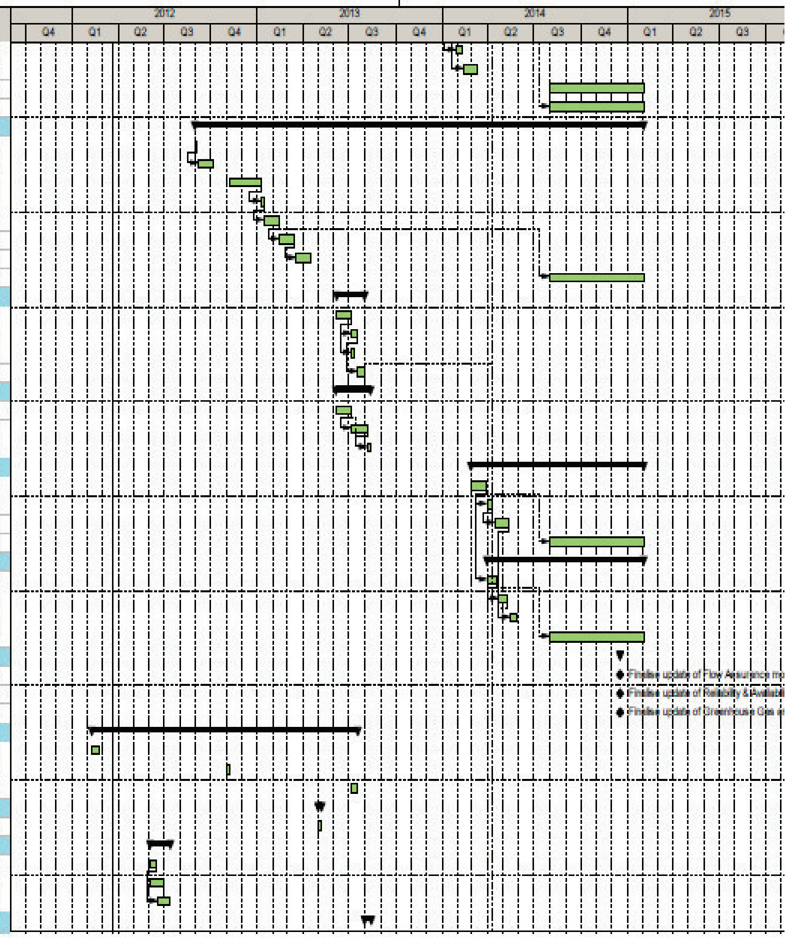
Shell Quest CCS Project Execution Phase Schedule 7 Sep 11 | Quest Planning Layout | 07-S

Activity ID	Activity Name	Original Duration	Start	Finish
OPSEE1560	Develop and implement M&I contracting plan	10.0d	28-Jan-14	10-Feb-14
OPSEE1600	Prepare Permanent Organisation for OPERA	20.0d	11-Feb-14	10-Mar-14
OPSEE1540	Include Technical Integrity Framework & AI-F	132.0d	01-Aug-14*	02-Feb-15
OPSEE1590	Implement M&I Management Systems and D	132.0d	01-Aug-14*	02-Feb-15
Logistics and Infrastructure		887.0d	30-Aug-12	02-Feb-15
OPSEE1610	Assure required infrastructure (building/upgr	5.0d	30-Aug-12	05-Sep-12
OPSEE1620	Acquire Logistics Equipment & Services	22.0d	06-Sep-12	05-Oct-12
OPSEE1640	Implement Logistics Management Systems	44.0d	07-Nov-12	07-Jan-13
OPSEE1650	Assure Inventory Management Activities	5.0d	08-Jan-13	14-Jan-13
OPSEE1660	Develop/Update L&I Plans & Procedures	22.0d	15-Jan-13	13-Feb-13
OPSEE1670	Develop Logistics & Infrastructure Transition	22.0d	14-Feb-13	15-Mar-13
OPSEE1690	Refine Logistics cost estimates for OPERATE	22.0d	18-Mar-13	16-Apr-13
OPSEE1680	Implement L&I Transition Plan	132.0d	01-Aug-14*	02-Feb-15
Wells (Design and Operation)		56.0d	07-Jun-13	01-Aug-13
OPSEE1700	Define well operating procedures for OPERA	20.0d	07-Jun-13	04-Jul-13
OPSEE1720	Define the Well Integrity Management Syster	10.0d	05-Jul-13	18-Jul-13
OPSEE1710	Conduct Well Operability Review (on well sta	5.0d	05-Jul-13	11-Jul-13
OPSEE1730	Conduct readiness review for wells (in prepa	10.0d	19-Jul-13	01-Aug-13
IM/IT Infrastructure and Telecoms		69.0d	05-Jun-13	12-Aug-13
OPSEE1740	Check status of IM applications and data cor	22.0d	05-Jun-13	04-Jul-13
OPSEE1750	Check status of equipment/vendor data to pc	22.0d	05-Jul-13	05-Aug-13
OPSEE1760	Include operations related IT scope in OPER	5.0d	06-Aug-13	12-Aug-13
Procurement & Materials Management		341.0d	27-Feb-14	02-Feb-15
OPSEE1790	Develop / Implement procurement managem	22.0d	27-Feb-14	28-Mar-14
OPSEE1800	Upload all data to materials management sys	10.0d	31-Mar-14	11-Apr-14
OPSEE1810	Develop/Implement transition plan	22.0d	14-Apr-14	13-May-14
OPSEE1780	Execute operations procurement execution p	132.0d	01-Aug-14*	02-Feb-15
Contracting (Strategy & Management)		309.0d	31-Mar-14	02-Feb-15
OPSEE1830	Develop / Implement Contracts Management	15.0d	31-Mar-14	18-Apr-14
OPSEE1840	Develop/Implement transition plan	15.0d	21-Apr-14	09-May-14
OPSEE1850	Ensure all operations data / documentation a	10.0d	14-May-14	27-May-14
OPSEE1820	Execute Operations Contracting Execution P	132.0d	01-Aug-14*	02-Feb-15
Integrated Systems Effectiveness		0.0d	16-Dec-14	16-Dec-14
OPSEE1860	Finalise update of Flow Assurance models a	0.0d		16-Dec-14
OPSEE1870	Finalise update of Reliability & Availability moc	0.0d		16-Dec-14
OPSEE1880	Finalise update of Greenhouse Gas and Ene	0.0d		16-Dec-14
SD and HSSE / SP		526.0d	09-Feb-12	18-Jul-13
OPSEE1930	Verify implementation of Security and Emerg	10.0d	09-Feb-12	22-Feb-12
OPSEE1920	Main HAZOP and HSE Case	5.0d	01-Nov-12	07-Nov-12
OPSEE1940	Verify the implementation of the Permit to Wc	10.0d	05-Jul-13	18-Jul-13
Risk and Opportunity Management		7.0d	01-May-13	07-May-13
OPSEE1950	Conduct Risks and Opportunities workshop !	5.0d	01-May-13	07-May-13
Permits and Consents		40.0d	04-Jun-12	13-Jul-12
OPSEE1970	Review Permits and Consents requirements	10.0d	04-Jun-12	15-Jun-12
OPSEE1960	Implement Permits & Consents Plan	20.0d	04-Jun-12	29-Jun-12
OPSEE1980	Handover all Permits and Consents to Opera	20.0d	18-Jun-12	13-Jul-12
Cost Modelling		14.0d	31-Jul-13	13-Aug-13



Actual Work — Critical Remaining Work — Summary
Remaining Work — Milestone

Page 2 of 3

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Shell Quest CCS Project Execution Phase Schedule 7 Sep 11 | Quest Planning Layout | 07-Sep-11 20:00

Activity ID	Activity Name	Original Duration	Start	Finish
OPSEE1990	Update Activity Based Cost Model for busine	10.0d	31-Jul-13	13-Aug-13
Operations Organisation (incl. Venture Set-Up)		209.0d	02-Mar-12	25-Dec-12
OPSEE2010	Mobilise operations team and execute operat	30.0d	02-Mar-12	12-Apr-12
OPSEE2000	Implement Operational Design Execution Plans	132.0d	25-Jun-12*	25-Dec-12
Operations Competency		278.0d	19-Sep-13	23-Jun-14
OPSEE2200	Develop training material for operators and si	66.0d	19-Sep-13	19-Dec-13
OPSEE2210	Conduct operators and site personnel training	132.0d	20-Dec-13	23-Jun-14
Commissioning and Start-up (CSU)		712.0d	13-Apr-12	25-Mar-14
OPSEE2020	Mobilise CSU execution team	5.0d	13-Apr-12	19-Apr-12
OPSEE2030	Develop detailed CSU execution plan (Level 4	44.0d	23-Jan-14	25-Mar-14
Project to Asset Transfer		1202.0d	02-Mar-12	18-Jun-15
OPSEE2090	Establish accountability for delivery of Project	20.0d	02-Mar-12	29-Mar-12
OPSEE2100	Finalise Project to Asset Transfer activity rec	20.0d	30-Mar-12	26-Apr-12
OPSEE2110	Establish Project to Asset Transfer leadershi	15.0d	05-Jun-13	25-Jun-13
OPSEE2120	Develop and implement detailed Project to As	178.0d	28-Jan-14	30-Sep-14
OPSEE2130	Evaluate Project to Asset Transfer status as	10.0d	28-Jan-14	10-Feb-14
OPSEE2140	Transfer custodianship from Project team to	22.0d	02-Jan-15	02-Feb-15
OPSEE2150	Carry out Final Acceptance Audit (FAA)	10.0d	03-Feb-15	16-Feb-15
OPSEE2160	Transfer ownership of Asset from Project tea	22.0d	18-May-15	18-Jun-15