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Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities

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ABSTRACT

In 2000, Chevron began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portions of the Gulf of Mexico. A Joint Industry Participation (JIP) group formed in 2001, and a project partially funded by the U.S. Department of Energy (DOE) began in October 2001. The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if, and how gas hydrates act as a trapping mechanism for shallow oil, or gas reservoirs.

Executive Summary of April 2011 – September 2011 JIP activities:

- **Uncertainty in the wake of the Gulf of Mexico Drilling Moratorium has largely cleared and the comprehensive Chevron assessment of all aspects of Leg III to ensure it fully meets new safety standards has been completed. A program for Leg III that incorporates the Chevron assessment recommendations has been formulated and approved by the JIP Executive Board.**

- **The recommendations are based on an 'industry style' coring organizational system that manages risk by minimizing the number of people and equipment used offshore and conducting the maximum amount of core analysis at suitable onshore locations. This is being called the block concept. The general plan for Leg III is to divide the expedition into three operational blocks as described below.**

- **Block 1 will consist of offshore rig operations, most likely conducted on one of the new Chevron-controlled 6th generation drill rigs rather than on**

smaller, older third party rigs as had been the practice in Legs I and II. Use of a new Chevron-controlled drill rig will provide the JIP with access to the most modern safety designs and operational practices during Leg III operations and eliminate any potential safety gaps in communications, interface and adaptation of safety regulations and practices between third party operators and the Chevron-managed Project team. A modern drilling rig will also provide faster drilling rates, shorter travel time between drilling sites and better/larger equipment more suitable for the complex demands of Leg III. Chevron management has given preliminary approval to this concept, subject to review of final detailed plans and obtaining necessary approvals from rig partners. Discussions are ongoing with NETL to ensure that there is no greater cost burden to the program under this concept than what would have been experienced had Leg III been performed using an older, smaller 3rd party rig as had originally been planned in the pre-Mocando era.

- **Block 1 is restricted to retrieval of pressure cores, wireline logging and wireline MDT. For pressure coring each pressurized autoclave will be checked after retrieval using simple gamma scanners of the type commonly used for offshore conventional coring to ensure good core is in the autoclave. The autoclaves will then be stored horizontally in temperature controlled reefer containers outfitted with shock reduction fittings and maintained at roughly 5° C temperature and with 3,000 psi pressure in each autoclave. Some of the preceding details are preliminary and will need further study and in some cases testing next year. Wireline logging and wireline MDT will also be done. For maximum safety, the offshore block will have only minimal science team staffing (approximately three experienced geologists). All offshore operations will be conducted by Chevron rig crew members and experienced offshore contractors.**

- **Block 2 will consist of logistic operations to safely move the reefer containers and autoclaves from the offshore rig to the onshore analysis location,**

complying with all applicable offshore and onshore regulations and with minimal disturbance to the cores. This work will be done by Chevron's Gulf of Mexico logistics experts. They have been briefed about the Leg III requirements and feel confident they can fulfill the requirements of Block 2 since it resembles in many ways the measures they take for transporting conventional cores, oil and gas samples, etc. from rigs to onshore locations.

- **Block 3 will consist of onshore analysis operations. The site for these operations will be the new Weatherford core lab facility located in Houston. We have had preliminary negotiations with Weatherford who have agreed to this in principle. PCATS and IPTC will be set up in a protected large parking lot between two Weatherford core analysis and storage warehouses. Other core analysis will take place inside the warehouses in space available for JIP use. Science staff housing will be available in nearby hotels and arrangements will be made for local transportation, provision of office space, utilities, other logistics, etc. It is understood that Block 3 will represent a significant paradigm shift for many of the science team who have years of safe and successful experience performing coring analysis work onboard scientific research vessels. The Chevron safety assessment process had absolute minimization of personnel offshore as one of the key criteria and development of the onshore analysis concept was the natural result of that process.**

- **Selection of the Weatherford core lab facility as the onshore analysis site will ensure that the science team is working in a safe, secure location dedicated to and designed for core handling. Quick access to spares, repair resources, emergency services (if needed), etc. are also some of the many benefits of this concept. The JIP Executive Board also recognized that relocation of the core analysis site from a space-constrained and hazardous offshore rig location to a relatively roomy and safe onshore location could enable consideration of cooperative core analysis efforts with other hydrate projects worldwide (JOGMEC, KNOC, RIL, etc.). Such cooperation could facilitate comparison**

of analytical results from devices of different design and origin, real-time collaboration and information sharing between world experts, and a host of other benefits. Ray Boswell and Tim Collett as co-Chief Scientists would be in charge of soliciting and reviewing research proposals and making final decisions about any and all cooperative science work.

- **Georgia Tech and others have investigated a concern about potential 'aging' of the pressure cores (i.e. degradation of quality and physical properties between the time of collection and analysis) inherent in the block concept. Their conclusions were that the time delay will have negligible impact on physical properties given the careful storage and transport measures that are planned.**

- **The timing of Leg III has been shifted to 1H 2013 primarily because several offshore hydrate programs in Japan have booked the PCATS and IPTC devices throughout 2012. These devices are required for Leg III analysis. Accordingly, the JIP has booked PCATS and IPTC for 1H 2013 on a priority basis to ensure availability for Leg III.**

- **Use of PCATS and IPTC in offshore Japan hydrate programs in 2012 will serve as proving grounds for key equipment and devices we intend to use for Leg III, providing an opportunity to monitor and learn from their field experience. Scheduling Leg III in 1H 2013 will enable the project team to make any necessary improvements to equipment or procedures from lessons learned in the 2012 Japan program and thereby improve the reliability and performance of equipment and the quality of analysis of Leg III cores. The project team is also very interested in observing the performance of the new slim-diameter Hybrid PCTB recently designed and produced by Aumann & Associates for use in the Japanese 2012 programs since this may serve as a alternative pressure corer for consideration for Leg III particularly if it can fit in conventional drill pipe.**

- **Since the JIP will be in a monitoring mode in 2012, the Board has instructed the JIP to conserve cash as much as possible during 2012 and identify new sources of funding. The JIP Board is lobbying its participants to make cash contributions and is seeking out new participants an effort to supplement DOE funding to obtain sufficient funding to finance Leg III.**

- **The JIP team will continue to progress the current general plans, costs and timelines for Leg III into detailed plans in 2012 and aggressively seek to reduce costs at every step (always without compromising safety).**

- **Work under existing JIP contracts:**

  1) Modifications to the PCATS machine have been completed and all functional tests have been passed. The final part of the contract will be field testing as part of the 2012 Japan hydrate pressure coring expedition, a significant benefit to the JIP because it presents the opportunity for PCATS to be tested under real-world conditions prior to the JIP Leg III.

  2) Modifications to the IPTC and associated equipment have begun in earnest. Adoption of the block concept and use of an onshore analysis location allowed USGS and Georgia Tech to retain full control of design and operational standards rather than having to adapt the devices to meet offshore Gulf of Mexico regulations and standards. Working in close coordination the two groups conducted tests of the IPTC with ersatz hydrate/sand cores and indentified a number of subsystems that would require modification. Design work has been undertaken, parts ordered and fabrication is underway. The team decided that the IPTC and devices would be built to withstand a maximum 5,000 psi but would be normally operated at the 1,500-3,000 psi range. Similar to PCATS the final part of the IPTC contract will be field testing of the prototype system as part of the 2012 Japan hydrate pressure coring expedition, with the same real-world testing benefits.

  3) Engineering studies during the Leg III assessment determined that the HPTC could not be safely deployed using off-the-shelf drilling casing as had

been originally planned due to post-Macondo increased safety factor requirements for drill pipe stresses. The project team explored custom-made drilling casing that would meet the required new safety factors but these options were cost-prohibitive and in every case prototypes. The project team has recommended and the Executive Board approved the halt of HPTC construction in its current state and commencement of research into small diameter replacement pressure corer alternatives. Construction of the large diameter HPTC coring device has been completed to the extent requested by the JIP and fit-up tests of the HPTC autoclaves to the PCATS machine have been successfully completed. Current plans are to crate up and place the HPTC (completed to the extent requested by the JIP) into secure storage. The project team will observe the performance of the new slim-diameter Hybrid PCTB recently designed and produced by Aumann & Associates for the Japan program since this may serve as a small diameter alternative pressure corer particularly if it can fit in conventional drill pipe.

4) Schlumberger have recently completed their final draft of Leg II deliverables. <u>Subtask 7.4</u> – Post-drill Phase: Schlumberger performed post-drilling analysis and synthesis to further validate the JIP WBS code (HYDRAPLASTIC) and temperature modeling. Specifically the following was undertaken: 1. Analyzed and evaluated data from all sites including drilling reports and available core data. 2. Fully updated the MEM using detailed log and core information. 3. Performed validation of wellbore stability code, hydraulics model and downhole temperature model. 4. Updated relationships used to predict thermal and mechanical properties. 5. Validated core temperature modeling. <u>Subtask 7.5</u> Improve Wellbore Stability Model: Schlumberger upgraded the HYDRAPLASTIC wellbore stability code with advanced features designed to incorporate the knowledge gained during the JIP Phase II. New features include: 1. An Unequal Horizontal Stress Option to handle unequal horizontal stresses such as those observed in Atwater Valley. 2. A Friction Hardening Option to address friction hardening seen in recent laboratory data. 3. A Creep Option to

model the operational time window associated with hole closure due to plastic creep of soft sediments. These draft deliverables are currently being reviewed by the project team.

- **New contract negotiations: Contracts for support, studies and equipment likely required for Leg III continue to be negotiated but will not be signed until lessons learned from the 2012 Japan programs are in hand, detailed plans for Leg III are completed, and the amount of available Leg III funding is known.**

- **Leg II final results publication: The JIP was notified that our proposal to the Journal of Marine and Petroleum Geology for a special thematic volume dealing with the scientific results of the GOM JIP Leg II expedition has been accepted. The science team continues to work on papers for this special volume.**

- **WesternGeco has generously donated seismic data in blocks surrounding WR 313 and GC 955 locations and allowing access to this data to a larger group of JIP researchers. This data has been delivered to Chevron and is currently being quality checked and prepared for distribution to various JIP research organizations.**

More information is available on the JIP website: http://gomhydratejip.ucsd.edu/

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1.0 Introduction

In 2000, Chevron Petroleum Technology Company began a project to learn how to characterize the natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. Chevron is an active explorer and operator in the Gulf of Mexico, and is aware that natural gas hydrates need to be understood to operate safely in deep water. In August 2000, Chevron working closely with the National Energy Technology Laboratory (NETL) of the United States Department of Energy (DOE) held a workshop in Houston, Texas, to define issues concerning the characterization of natural gas hydrate deposits. Specifically, the workshop was meant to clearly show where research, the development of new technologies, and new information sources would be of benefit to the DOE and to the oil and gas industry in defining issues and solving gas hydrate problems in deep water.

Based on the workshop held in August 2000, Chevron formed a Joint Industry Project (JIP) to write a proposal and conduct research concerning natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. The proposal was submitted to NETL on April 24, 2001, and Chevron was awarded a contract based on the proposal.

The title of the project is **"Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities".**

1.2 Objectives

The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). These naturally occurring gas hydrates can cause problems relating to drilling and production of oil and gas, as well as building and operating pipelines. Other objectives of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

1.3 Project Phases

The project is divided into phases. **Phase I** of the project was devoted to gathering existing data, generating new data, and writing protocols that will help the research team determine the location of existing gas hydrate deposits. During **Phase II** of the project, Chevron drilled data collection wells to improve the technologies required to characterize gas hydrate deposits in the deepwater GOM using seismic, core and logging data. **Phase III** of the project began in September of 2007 and will focus on obtaining logs and cores of hydrate bearing sands in the GOM.

1.4 Research Participants

In 2001, Chevron organized a Joint Industry Participation (JIP) group to plan and conduct the tasks necessary for accomplishing the objectives of this research project. As of March 2010, the members of the JIP were Chevron, Schlumberger, ConocoPhillips, Halliburton, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), Total, JOGMEC, Reliance Industries Limited, The Korean National Oil Company (KNOC), and Statoil.

1.5 Research Activities

The research activities began officially on October 1, 2001. However, very little activity occurred during 2001 because of the paperwork involved in getting the JIP formed and the contract between DOE and Chevron in place. Several Semi-Annual and Topical Reports have been written that cover the activity of the JIP through September 2011.

1.6 Purpose of This Report

The purpose of this report is to document the activities of the JIP during April 2011 – September 2011. It is not possible to put everything into this Semi-Annual report, however, many of the important results are included and references to the JIP website, http://gomhydratejip.ucsd.edu/, are used to point the reader to more detailed information concerning various aspects of the project. The discussion of the work performed during this report period is organized by task and subtask for easy reference to the technical proposal and the DOE contract documents.

2.0 Executive Summary

Chevron formed a Joint Industry Participation (JIP) group to write a proposal and conduct research concerning natural gas hydrate deposits in the deepwater portion of the Gulf of Mexico. The proposal was submitted to NETL on April 24, 2001, and Chevron was awarded a contract based on the proposal.

The title of the project is **"Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico: Applications for Safe Exploration and Production Activities".**

The **primary objective** of this project is to develop technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). **Other objectives** of this project are to better understand how natural gas hydrates can affect seafloor stability, to gather data that can be used to study climate change, and to determine how the results of this project can be used to assess if and how gas hydrates act as a trapping mechanism for shallow oil or gas reservoirs.

The project is divided into phases. **Phase I** of the project is devoted to gathering existing data, generating new data, and writing protocols that will help the research team determine the location of existing gas hydrate deposits. During **Phase II** of the project, Chevron drilled wells to obtain data for improving technologies required to characterize gas hydrate deposits in the deepwater GOM using seismic, core and logging data. **Phase III** of the project (the current phase) has an objective of collecting and analyzing data on hydrate bearing sands. Both logging and coring operations are planned in Phase III.

Phase III is roughly divided into two parts. Phase IIIA centered on a LWD drilling expedition (completed in 2009) to test methodologies to predict the locations and hydrate saturations of large, coarse-grained deepwater geobodies located in the hydrate stability zone. Phase IIIB will focus on retrieval and analysis of pressure cores from such geobodies, as well as wireline logging and (if possible) wireline formation tests. The end of Phase IIIB will also include preparation and release of Final Integrated Reporting for the entire project.

3.0 Phase III A (Leg II) Activities

During the 2009 LWD leg, ongoing third party operations at one of the target drilling locations required that the Leg II expedition shift to an alternative site at a nearby block (AC21). LWD data at AC21 was successfully retrieved, and subsequent to completion of Leg II the JIP science team recommended that (for the sake of completeness) a pre-drill estimate should be made of this location. The estimate was done the same way as the pre-drill estimates at GC 955 and WR 313. Seismic inversion work in support of this objective was completed during this reporting period. As noted in the previous report, reading in the pre-stack seismic data took more time than anticipated because the tapes containing the seismic gathers are fairly old and problematic. Post-drill updates were completed by year's end.

The original and fully processed GOM JIP Leg II well log database was loaded onto the Lamont-Doherty Earth Observatory web site: http://brg.ldeo.columbia.edu/ghp/. The web site includes original and processed data, in the same formats as GOM JIP Leg I. LDEO will add the processed MP3 shear-wave and PeriScope data when it is received from Schlumberger.

Expanded (non JIP) access to this database has been advertised in the DOE/NETL "Fire in the Ice" newsletter and one research request has been submitted to date and approved.

The JIP was notified that our proposal to the Journal of Marine and Petroleum Geology for a special thematic volume dealing with the scientific results of the GOM JIP Leg II expedition has been accepted. The science team is currently working on papers for this special volume. Special thanks go to Tim Collett and Ray Boswell (Co-Chief Scientists) for leading this effort.

4.0 PHASE III B (LEG III) ACTIVITIES

Phase III B work was significantly impacted by the Gulf of Mexico drilling moratorium that was announced in late May 2010. Shortly after the moratorium JIP Leg III preparations were put on hold in order to wait for lifting of the moratorium and subsequent clarification of regulatory, legislative, permitting, operational and commercial changes in the Gulf of Mexico.

Chevron has also completed an extensive assessment of the Leg III program in light of new regulations and the fact that the bar for safe operational practices in the Gulf of Mexico has been raised far higher. Key elements of the assessment team's recommendations have been reviewed and approved by the JIP Executive Board form the design and operational basis of the Leg III as summarized in the following sections.

Leg III planning and feasibility work has progressed significantly since March. The times and costs associated with Leg III coring, wireline logging and wireline MDT activities in the post-Macondo era as compared to the simpler Leg II LWD operation in the pre-Macondo era have been studied in detail and results revealed that the Leg III coring operation will take significantly more time at each site and have a significantly higher costs per well than Leg II. A large part of the difference in cost is that the Leg III wireline coring, logging and Modular Dynamic Testing (MDT) operations are far more time consuming than the simple Log While Drilling (LWD) operations of Leg II. There were also far higher costs associated with safely conducting the Leg III wireline operations while maintaining an open hole in the soft unconsolidated sediments at the proposed drilling sites for extensive periods of time. Achieving these goals will require expenditures for large quantities of drilling mud and appropriately sized storage tanks and mixing and pumping equipment.

The team has concentrated on methods to maximize safety and the amount of potential scientific data that can be obtained while decreasing cost to fit within an expected modest budget. All avenues for savings and efficiencies have been explored, and the base planning has been modified to accommodate as many of these ideas as can be done without compromising safety.

4.1 SEGREGATION OF WORKFLOWS

The top priority of the Leg III assessment was to maximize safety, and one of the main methods of doing so was by reducing the number of people exposed to the harsh offshore rig conditions to an absolute minimum. The analysis team recommended that conventional offshore oil and gas coring and logging practices should be followed, which means that experienced professionals will be on rig to conduct these operations and the cores will be transported to an onshore location for analysis by the science team.

By breaking down the core acquisition into major work blocks the team has been able to maximize safety and limit the amount of interference between the block interfaces. Under the block concept the work flows become:

- Block 1 -Core Acquisition, involving the physical rotary table operations required to cut and retrieve core
- Block 2 -Core handling involving a the methods of core preservation and handling at surface from the time it reaches the rotary table until it is in the analysis lab
- Block 3 -Core Analysis where the science team analyze the cores collect data and undertake studies

Each block will develop a risk mitigated workflow to maximize the deliverable for its particular focus. By moving the analysis block to a shore location there are significant safety increases and cost and efficiency savings to the overall program. There will still be onsite direction and control from the science team in the core acquisition and handling blocks, but only to the extent necessary to ensure safe delivery of good quality core for the analysis work.

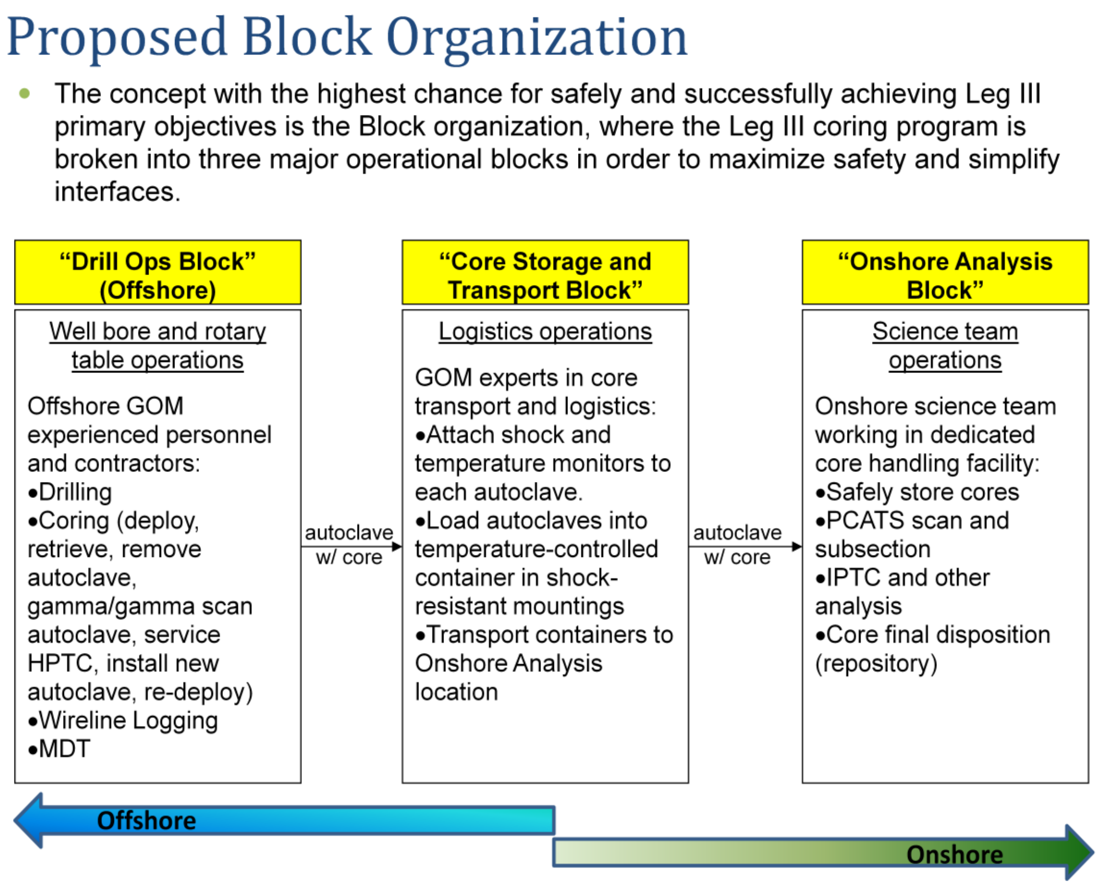


Figure 1 Block Organizational Concept

4.2 MINIMIZING LOGISTICAL FOOTPRINT

By optimizing the workflows and modularizing equipment it should be possible to have all necessary offshore equipment shipped to the rig on one supply vessel, potentially in advance of the actual Leg III operations. Minimizing our personnel and equipment footprint ensures that rig up and rig down times are minimized and that only the people and equipment critical to the task at hand are mobilized. This concept also provides a great deal of operational flexibility in the timing and rig used for the program.

4.3 DETAILED TIME AND MOTION WORKFLOWS

The coring operation has been broken down into work flow time units of 10-15 minutes. Detailed analysis of the work flow allows optimization and has pointed out areas where additional analysis could enable lowering the incidence of failure and increasing the quality, repeatability and reliability of the core capture and handling work flows. In the core acquisition phase emphasis of additional work will center on the pressure corer design, core catcher design and handling process from core capture until the core reaches the rig floor. The detailed core handling workflow study has demonstrated the benefits of minimal rig site handling, and the use of the core bbl autoclaves as transportation chambers. Further studies will also focus on optimizing the movement of the core from the time it reaches the rig floor until it is in a controlled environment storage container. Of particular concern for future work will be the interface issues such as modifying design and procedures to speed up the transition of the core from the rig floor to the storage container, determining equipment and procedures required to facilitate safe and efficient transfer.

It is the intent of the project team to extend this level of detail to the analysis of the onshore analysis block to achieve the same benefits. Onshore studies will consider equipment and procedures to optimize core transfer from the autoclaves to the PCATS unit and thence to other analytical devices.

4.4 DETAILS OF WORK PROGRESS ON EQUIPMENT

4.4.1 Drill Pipe and HPTC Core Barrel

The design for the large diameter HPTC bbl was undertaken on the assumption that all wireline logging would be accomplished through the large diameter HPTC outer barrel using the drill casing as the functional equivalent of a riser in order to save time. This resulted in a design of the core barrel with a large enough ID to allow a 5 7/8 inch diameter wireline logging tool to pass through the bit and a 6 1/2 inch bore through all equipment. The Leg III assessment engineering study of the technical issues surrounding large diameter drilling tubulars capable of supporting this tool in the deep water depths at the well sites showed the rental drilling casing originally considered for this task did not meet post-Mocando increased safety factors and that only a true drill pipe (rather than a drilling casing) could be used with any assurance of success. The project team contacted a number of vendors looking for drilling pipe with sufficiently larger enough internal diameters to support the use of the HPTC. No vendors had existing drilling pipe. One vendor had done some engineering work on a prototype 7 5/8 inch drilling pipe although it had not yet been built or tested yet. If the JIP decided to use this prototype drill pipe it would have had to be purchased at significant expense. Further, as a prototype it would not have a track record for successful usage and would raise safety and reliability concerns to a level intolerable for the JIP. The only alternative for Leg III was to procure or redesign a smaller diameter pressure corer to fit in conventional drill pipe in sizes commonly available on the Gulf of Mexico rental market and conduct wireline operations in open water as is common practice with rigs equipped with ROVs. Therefore a decision was made to cease fabrication of the HPTC (in near-complete state), and preserve, box up and securely store it for ultimate delivery to the DOE for disposition.

The focus for the project team is now on obtaining or designing and fabricating a smaller diameter pressure corer. One such smaller diameter pressure corer was recently developed and fabricated by Aumann & Associates for other clients. It is usable in much smaller diameter drilling pipe which may be readily available on rigs and from rental suppliers. Our focus will be on observing the client's testing and deployment of this new slim diameter pressure corer during its deployment in 2012 and based on the field results and additional engineering studies decide whether it is safer, more reliable and more economical to obtain identical versions of this pressure corer and matching drilling pipe or whether to design and fabricate a small diameter pressure corer with simpler construction more suited to Leg III requirements and adaptable to a wider range of common drilling pipe sizes.

4.4.2 Core Bits/ Logging

Because a slim pressure corer can be run in conventional drill pipe, the log through drill pipe concept can no longer be accommodated with standard logging tools. This does not pose a major impediment in that logging in open water has become a more or less standard technique on rigs with adequate ROV support. Negating the logging through bit requirement allows the pressure corer and drill bit interface to be simplified and leads to a simpler bit design at a cheaper cost.

4.4.3 Surface Handling

On the rig floor the core will be maintained under pressure and handling equipment and operational procedures put in place to allowing safe and fast transport of the pressure corer to a service van for removal of the autoclave and scanning of the autoclave by standard hand-held gamma measuring devices to confirm there is good core in the autoclave. Future work will concentrate on verifying the suitability of the hand-held gamma measuring device to confirm good core by testing samples in autoclaves and improving the workflow and methods of ensuring hydrate stability and core quality at all times. Once good core is confirmed workflow methods and equipment will be developed to transfer the autoclaves to the refrigerated storage container(s).

4.4.4 PCATS

Modifications to the PCATS machine have been completed and all functional tests have been passed. The final part of the contract will be field testing as part of the 2012 Japan hydrate pressure coring expedition, a significant benefit to the JIP because it presents the opportunity for PCATS to be tested under real-world conditions prior to the JIP Leg III.

4.4.5 IPTC

Similar to the PCATS, the Instrumented Pressure Testing Chamber (IPTC) will require modifications to handle longer pressure cores as well as design, fabrication and testing of various analytical devices such as an effective stress cell, microbiological sampling cell, etc. Modifications to the IPTC and associated equipment have begun in earnest. Adoption of the block concept and use of an onshore analysis location allowed USGS and Georgia Tech to retain full control of design and operational standards rather than having to adapt the devices to meet offshore Gulf of Mexico regulations and standards. Working in close coordination the two groups conducted tests of the IPTC with ersatz hydrate/sand cores and indentified a number of subsystems that would require modification. Design work has been undertaken, parts ordered and fabrication is underway. The team decided that the IPTC and devices would be built to withstand a maximum 5,000 psi but would be normally operated at the 1,500-3,000 psi range. Similar to PCATS the final part of the IPTC contract will be field testing of the prototype system as part of the 2012 Japan hydrate pressure coring expedition, with the same real-world testing benefits. Completion of the IPTC and associated analytical cells is targeted for late 2012/early 2013.

5.0 Conclusions

Uncertainty in the wake of the Gulf of Mexico Drilling Moratorium has largely cleared and the comprehensive Chevron assessment of all aspects of Leg III to ensure it fully meets new safety standards has been completed. A program for Leg III that incorporates the Chevron assessment recommendations has been formulated and approved by the JIP Executive Board.

The recommendations are based on an 'industry style' coring organizational system that manages risk by minimizing the number of people and equipment used offshore and conducting the maximum amount of core analysis at suitable onshore locations. This is being called the block concept. The general plan for Leg III is to divide the expedition into three operational blocks as described below.

The timing of Leg III has been shifted to 1H 2013 primarily because several offshore hydrate programs in Japan have booked the PCATS and IPTC devices throughout 2012. These devices are required for Leg III analysis. Accordingly, the JIP has booked PCATS and IPTC for 1H 2013 on a priority basis to ensure availability for Leg III.

Since the JIP will be in a monitoring mode in 2012, the Board has instructed the JIP to conserve cash as much as possible during 2012 and identify new sources of funding. The JIP Board is lobbying its participants to make cash contributions and is seeking out new participants an effort to supplement DOE funding to obtain sufficient funding to finance Leg III.

The JIP team will continue to progress the current general plans, costs and timelines for Leg III into detailed plans in 2012 and aggressively seek to reduce costs at every step (always without compromising safety).

6.0 References

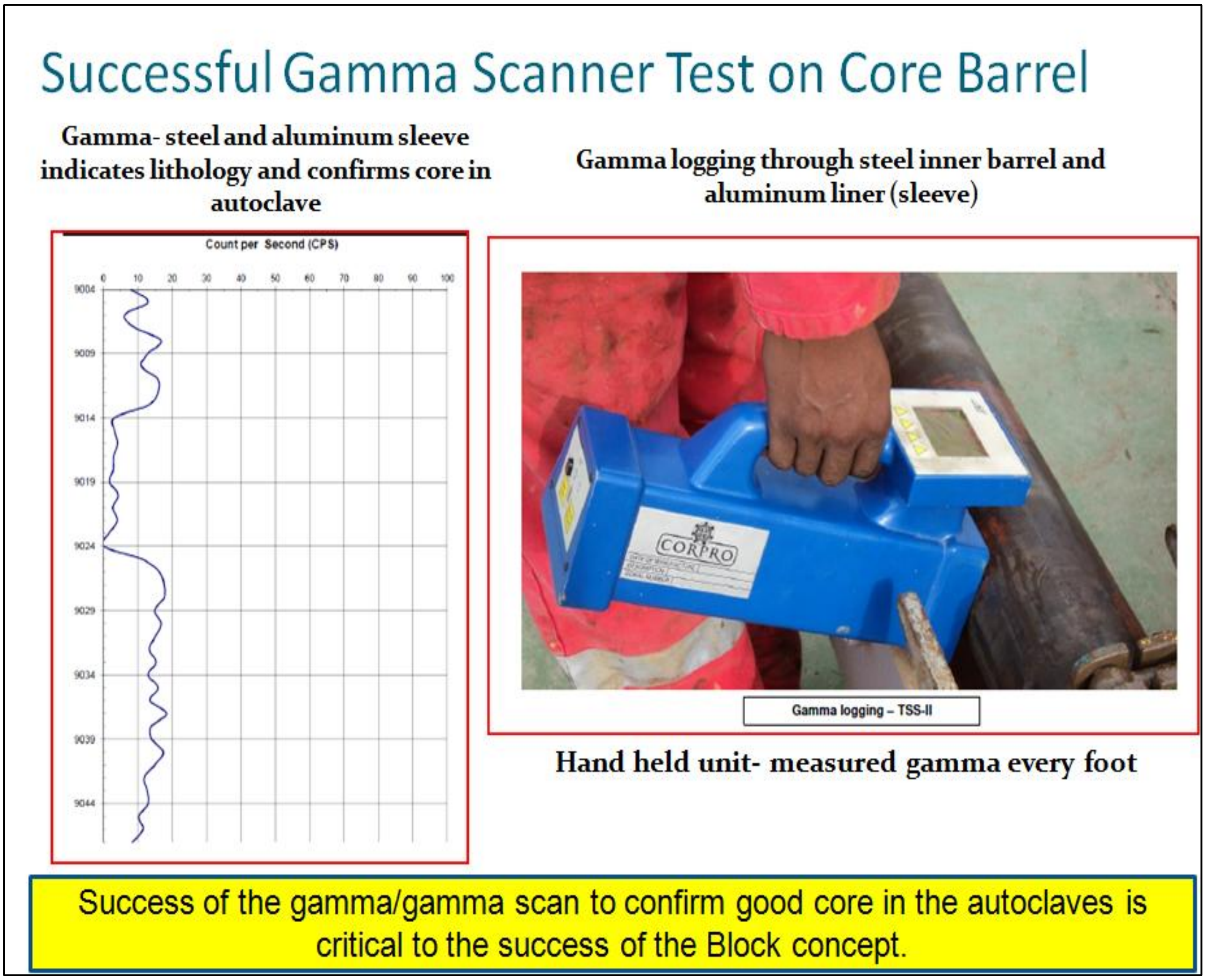
No external references were used for this report.

7.0 Appendices (located on following pages)

7.1 Appendix A – Project Timeline

	2011				2012				2013			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Pressure Corer Development Program												
HPTC Pressure Corer/BHA- Final Design	completed									t		
HPTC Pressure Corer/BHA- Fabrication	XXX	XXX	XXX	XXX						b		
HPTC Log-Term Storage / Warehousing					X					d		
Hybrid PCS Design Discussions			X									
Hybrid PCS Field Test Observation (Japan)						?				a		
Hybrid PCS Order and Fab (if approved by Board)							???	???		w		
Pressure Corer - Inventory & DOE Turnover									tbd	a		
IPTC Pressure Core Laboratory Tools Program										i		
Design	XXX									t		
Fabrication / Certification		XXX	XXX	XXX						i		
Autoclave fit-up test				X						n		
Calibration / Testing				XXX	XXX					g		
IPTC Field Test Observation (Japan)						?						
Deployment									tbd	D		
Demob / Refurbish									tbd	O		
Inventory and DOE Turnover									tbd	E		
PCATS Deployment												
Autoclave fit-up test				X						f		
PCATS Field Test Observation (Japan)						?				u		
Leg III Offshore Drilling Program										n		
Drilling Assessment Study	XXX	XXX								d		
Drill Rig Tender (to determine 3rd party rate)									tbd	i		
Drilling Permit Applications									tbd	n		
Pre-spud Safety Meeting									tbd	n		
Leg III Expedition (~10 days incl mob/demob)									tbd			
Science Program										o		
Program Development and Management	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX		f		
Science Team Meeting - Finalize Science Plan									tbd			
Science Team Deployment									tbd	L		
Post-cruise Studies									tbd	e		
Reporting										g		
Leg III Initial Results Workshop									tbd			
Leg III Initial Results Publication									tbd	III		
Leg I-III Final Reports									tbd			
DOE/JIP Project Close-out									tbd			

7.2 Appendix B – Initial Trial Gamma Scan of Conventional Core



7.3 Appendix C – HPTC/PCATS Autoclave Fit-up Test

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HPTC

Autoclave to PCATS Matchup Test Procedure

REV	DATE	DESCRIPTION	ORIG	CHK	APPR
A	09/26/2011	New Release	JTA Sr.	JTA Sr.	
B	09/29/2011	Added Geotek details	Mel	Mel	
C	10/04/2011	Added Test Results	JTA Sr.	JTA Sr.	
D	10/07/2011	Edited	PJS	PJS	

Document No.: HPTC004

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1. INTRODUCTION

The High Pressure Temperature Corer (HPTC) was developed under a contract between the Joint Industry Chevron Energy Technology Company ("Company"), a division of Chevron U.S.A. Inc. and Aumann & Associates, Inc. as part of the "Gulf of Mexico Hydrate Joint Industry Participation Agreement" ("JIP Agreement"). New tools were manufactured during 2011. The autoclaves were assembled and successfully proof tested at 150% of working pressure and passed a final acceptance test in September 2011.

The Geotek Pressure Core Analysis and Transfer System (PCATS) was modified by Geotek Ltd, (also under contract to the Joint Industry Chevron Energy Technology Company) in order to operate with the new HPTC. It is desired that the new design of HPTC also be lab tested to verify satisfactory matchup and transfer under pressure to the PCATS equipment. This document describes the procedure and documents the results this matchup test.

2. EQUIPMENT TO BE TESTED

HPTC Autoclave
Pressure Core Analysis and Transfer System (PCATS)
Inner Tube Pulling Tool
Transfer Adapter
Transfer Cap

3. TEST FACILITY

The tests will be conducted at the Geotek, Ltd. facilities in Daventry, U.K.

4. REFERENCE DOCUMENTS

The following reference documents should be on hand for use during the tests.

Item	Document Number	Description
1.	10800	HPTC Assembly Drawing
2		HPTC Autoclave Test Procedure
3.		HPTC Maintenance Manual

5. TEST PROCEDURES

Five different tests will be conducted:

1. Physical matchup of the HPTC and PCATS hardware.
2. Simulated core transfer under pressure
3. Ability to manipulate the liner and cut the core liner in PCATS.
4. Transfer of the core liner from PCATS to a storage container under pressure.
5. Function of the Star Odi "fish pill" pressure/temperature recorder.

5.1. Safety

5.1.1. A hard hat must be worn during any overhead lifts.

5.1.2. Safety glasses must be worn anytime a pressurized chamber is being accessed or if a grinder or other equipment that could produce airborne particles is being used.

5.1.3. Use caution around high pressure fluids and especially around gasses that may be present during pressure testing.

5.1.4. Use a locked loop when lifting with a lift strap whenever possible.

5.1.5. Use care in balancing parts from an open loop lift strap or when using the spinning buggy.

5.1.6. Never unscrew the bullet valves more than the prescribed amount or force them past the retaining ring or remove the retaining ring while there is pressure in the system. They could become projectiles and cause injury or death.

5.1.7. Work quickly but don't rush. Being in a hurry can cause an accident.

5.1.8. Attend safety or tool box meetings and follow all safety requirements.

5.2. Pressure Testing

5.2.1. Pressure testing shall be completed in a safe environment including, as needed, the use of blast protection barriers, a suitable test bay, a cordoned evacuated test area, or other suitable methods to protect personnel in the event of a safety incident.

5.2.2. Non-authorized personnel shall be restricted from the test area by use of suitable barriers or other adequate means to ensure controlled access to the immediate test area.

5.2.3. The test medium shall be potable (tap) water for the HPTC . Additives (rust inhibitors or other) are not required. Corrosion inhibitors may be used in the PCATS.

5.2.4. Devices used to measure test pressure (pressure transducers, pressure read out boxes, dial gauges, or other) shall be calibrated and suitably correlated and adequate for the pressures being used.

6. Inspection and Testing Records

Records of any inspections and tests undertaken shall be signed as completed and retained for customer turnover.

Client representatives should sign the test data sheets in the "Witnessed by:" lines.

6.1. General Procedures

The following general principles apply to all assembly procedures:

6.1.1. Parts and tools are to be treated well and not abused.

6.1.2. Care should be taken to protect parts and tools from the weather as much as possible.

6.1.3. Use thread protectors, if available, until ready to assemble or run in the hole.

6.1.4. Unless otherwise instructed, always coat both pin and box threads with a coat of thread dope or "Never Seize" lubricant on stainless steel parts before assembly.

6.1.5. Unless otherwise instructed, always coat seals and seal surfaces with a coat of seal grease before assembly.

6.2. Autoclave Assembly

6.2.1. ☑ Assemble the autoclave according to normal assembly practices with the ball valve closed to simulate the autoclave condition at the completion of a coring run.

Comments: The autoclave had been pre-assembled and tested in Salt Lake City immediately prior to shipping to Geotek.

AAI Supervisor: James T. Aumann Sr. Date: 09/30/2011

Procedure Witnessed/Approved by: ________ Date: ________

6.3. Physical Match-up Test

The purpose of this procedure is to conduct a preliminary fit-up and dry run using a non-pressurized PTCB autoclave to verify that all components fit together and operate properly. This is intended to be a pre-test to avoid damage to components and more easily troubleshoot in case problems are discovered. It is not necessary for clients to observe or witness this procedure. It assumes starting with an assembled autoclave as described in 6.5 above.

6.3.1. ☑ Move the autoclave assembly to the PCATS transfer unit.

6.3.2. ☑ Make sure the inner tube plug is fully extended and latched into the seal sub.

6.3.3. ☑ Install the transfer adapter, on the end of the seal sub on the autoclave. Verify proper fit and make-up.

6.3.4. ☑ Install the pulling tool on the end of the manipulator rod of the PCATS. Verify proper fit and make-up.

6.3.5. ☑ Join the flange of the HPTC transfer adapter to the flange on the PCATS. Verify proper fit and make-up.

6.3.6. ☑ Use PCATS to extend the rod to latch the pulling tool onto the inner tube plug to grab the inner tube plug.

6.3.7. ☑ Unscrew, but do not remove the six retaining screws on the crossover sub.

6.3.8. ☑ Use PCATS to pull out the inner tube plug, core liner and core catcher. Verify that the inner tube plug and liner are moved into the PCATS chamber.

6.3.9. ☑ Use the PCATS manipulator to push the inner tube plug and liner back out of the PCATS chamber.

Comments: On the initial attempt the inner tube plug stuck in the PCATS just past the liner cutter. It was determined that there was a misalignment in the spool that joins the ball valve to the manipulator inside the PCATS. This section and the entire PCATS assembly was realigned and all flanges tightened. The test was repeated successfully.

AAI Supervisor: Jim Aumann/AAI Date: 09/30/2011

Geotek Supervisor: John Roberts/Geotek Date: 09/30/2011

6.4. Prepare Autoclave Assembly for Pressurized Transfer Test

The purpose of this procedure is to pressurize the autoclave and place it in a condition that simulates an autoclave after a coring run. It assumes starting with an assembled autoclave as described in 6.5 above.

6.4.1. ☑ Connect the port in the end of the inner tube plug to the supply hose from the high pressure pump.

6.4.2. ☑ Use the hex key wrench inserted into one of the pivot pins to open the ball slightly.

6.4.3. ☑ Lift the autoclave assembly and tilt it so that ball valve is the highest point in the assembly.

6.4.4. ☑ Turn on the water supply from the high pressure pump to the autoclave assembly until water begins to come out of the slightly open ball valve or fill from the ball valve end with a hose until the inner barrel is full.

6.4.5. ☑ Close the ball with the hex key.

6.4.6. ☑ Lower the tool back to a horizontal position.

6.4.7. ☑ Start the pump and increase pressure to 5000 psi or other lower test pressure if desired.

NOTE: A short period of time may be needed to allow the pressure to stabilize as any air trapped in the inner barrel assembly will go into solution and could lower the pressure slightly. This minor reduction in pressure is not necessarily an indication of a leak. The rate of pressure loss due to this effect will gradually decay and should stop within about 10 minutes.

6.4.8. ☑ Close the supply bullet valve in the inner tube plug.

6.4.9. ☑ Drain the supply hose.

6.4.10. ☑ Disconnect the supply hose

Note: The autoclave is now in the same condition as if it had just completed a coring run and was brought to the surface. It is ready for the transfer test.

Comments: Two false starts initially when the sample port bullet valve on the inner tube plug leaked and the pressure in the autoclave was lost. We removed the bullet valve, cleaned and inspected it and used higher closing torque on the third attempt which then held pressure.

AAI Supervisor: Jim Aumann/AAI Date: 09/30/2011

Geotek Supervisor: John Roberts/Geotek Date: 09/30/2011

Witnessed/Approved by:__________ Date:__________

6.5. Simulated Core Transfer Test Under Rated Pressure

The purpose of this test is to verify that the HPTC and PCATS work properly together to transfer the core liner from the autoclave to the PCATS under pressure. The procedure is exactly the same as would be used in actual operations. It assumes starting with an autoclave as prepared and pressurized as in section 6.7 above.

6.5.1. ☑ Move the autoclave assembly to the PCATS transfer unit.

6.5.2. ☑ Connect the sample port at the end of the inner tube plug to a high pressure pump with a calibrated gage.

6.5.3. ☑ Start the pump and pressurize the hose to the expected autoclave chamber pressure.

6.5.4. ☑ Open the bullet valve in the inner tube plug and measure the pressure and record the pressure reading. This is the simulated coring pressure.

Simulated Coring Pressure = 357 bar (5180 psi).

6.5.5. ☑ Close the bullet valve in the inner tube plug.

6.5.6. ☑ Drain the supply hose and remove it from the port on the inner tube plug.

6.5.7. ☑ Screw the transfer adapter onto the end of the seal sub on the autoclave.

6.5.8. ☑ Screw the pulling tool onto the end of the manipulator rod of the PCATS, withdraw the manipulator, close the ball valve and fill PCATS with fluid.

6.5.9. ☑ Join the flange of the HPTC transfer adapter to the flange on the PCATS chamber.

6.5.10. ☑ Pressurize this chamber to the pressure measured in 6.8.4.

6.5.11. ☑ Install the transfer cap end of the ball valve seal sub.

6.5.12. ☑ Rotate the autoclave until the ports are aligned vertically.

6.5.13. ☑ Attach the lower end hose from the PCATS to the lowest port in the transfer sub.

6.5.14. ☑ Pump until water flows out of the top port. Stop the pump and install a plug in the port.

6.5.15. ☑ Pressurize this chamber to the transfer pressure measured in 6.8.4. This is the transfer pressure.

Transfer Pressure = 357 bar(5180 psi).

6.5.16. ☑ Open the PCATS ball valve and bleed the flange connection with fluid and pressurize to the same pressure as inside the HPTC and equalize. Extend the rod on the PCATS to engage the inner tube plug. Stop when the force increases substantially.

6.5.17. ☑ Move the rod with the inner tube plug, liner and core catcher attached into the PCATS chamber. Observe and note the force (or motor torque) required.

Average Force (or Motor Torque) = Moderate with a few minor increases.

6.5.18. ☑ Observe the inner tube plug, liner and core catcher entering the PCATS chamber on the X-ray monitor.

6.5.19. ☑ Close the ball valve on the PCATS after the core liner and core catcher have fully moved into the PCATS chamber.

6.5.20. ☑ Bleed off the pressure and drain the chamber between the PCATS and also the lower chamber. Remove the hose from the lower chamber.

Comments: Everything functioned as designed on the first attempt. The pressure/temperature graph in the Appendix is data recovered from the "fish pill" recorder we installed in the inner tube plug.

AAI Supervisor: Jim Aumann/AAI Date: 09/30/2011

Geotek Supervisor: John Roberts/Geotek Date: 09/30/2011

Witnessed/Approved by:__________ Date:__________

6.6. PCATS Manipulation Test

The purpose of this test is to verify that the PCATS is fully compatible with the HPTC liner and is able to handle the longer HPTC liners. Typical PCATS tests include:

6.6.1. ☑ Scan the core liner as it is being transferred from the autoclave to the PCATS.

6.6.2. ☑ Cut off a section of core liner and move it to a storage chamber.

6.6.3. ☑ Bleed the pressure off the PCATS chamber and extract the inner tube plug.

6.6.4. ☑ Remove the pressure temperature recorder and download and display the data and compare it to the known test history.

Comments: The HPTC autoclave and PCATS functioned perfectly together. The inner tube plug to liner interface was easily identified in the X-Ray as well as the cut liner after Step 6.6.2. The cut liner was easily transferred to the storage container under pressure. (See photos and plot of the downhole recorder data in the Appendix.)

AAI Supervisor: Jim Aumann/AAI Date: 09/30/2011

Geotek Supervisor: John Roberts/Geotek Date: 09/30/2011

Witnessed/Approved by:__________ Date:__________

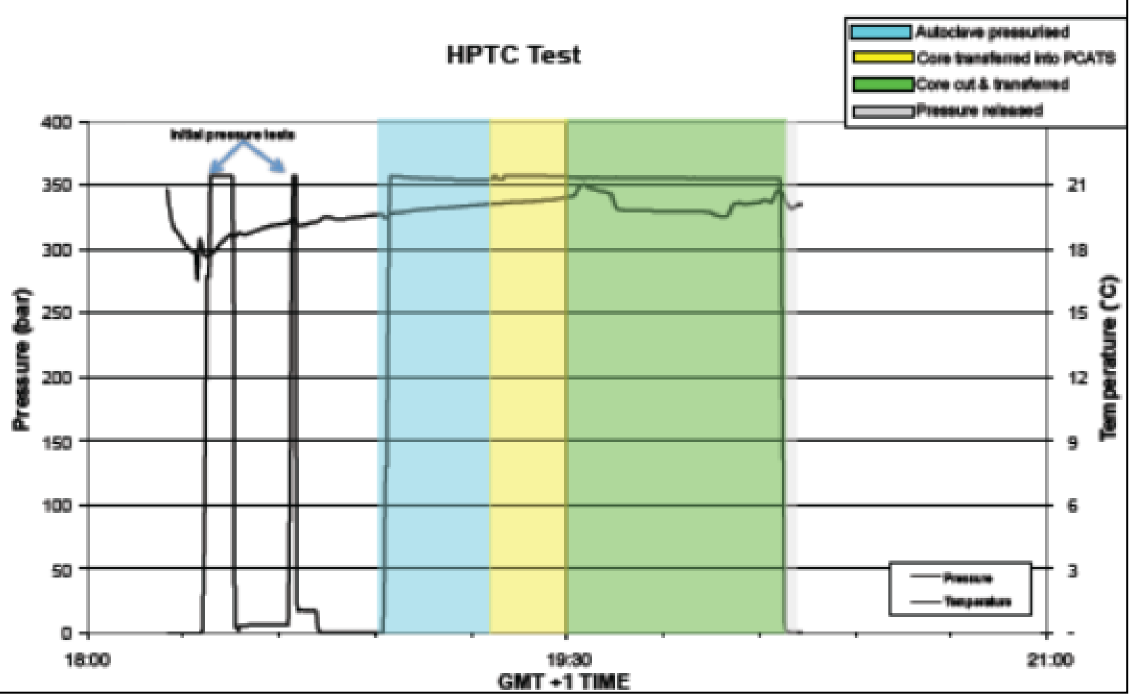
APPENDIX

A. Plot of the pressure/temperature data.
B. Photos taken during the tests.

Appendix A

Pressure-Temperature Record of HPTC-PCATS Interface Test

30 Sept 2011
at Geotek Ltd.



Appendix B

Observation of HPTC-PCATS Interface Test

30 Sept 2011
at Geotek Ltd.

page 1

Right: Inserting the liner and the inner tube plug into the autoclave.

Below: Adding the seals to the inner tube plug during tool dressing prior to the initial pressure test.

Above: The assembled tool ready for pressure testing.

Right: The tool pumped up to 5000 psi prior to attaching it to PCATS.

Above: Attaching the connecting flange to the top of the autoclave.

Right: Checking the fit of the HPCT latching 'grabber' (or pulling tool) on the top of the inner tube plug.

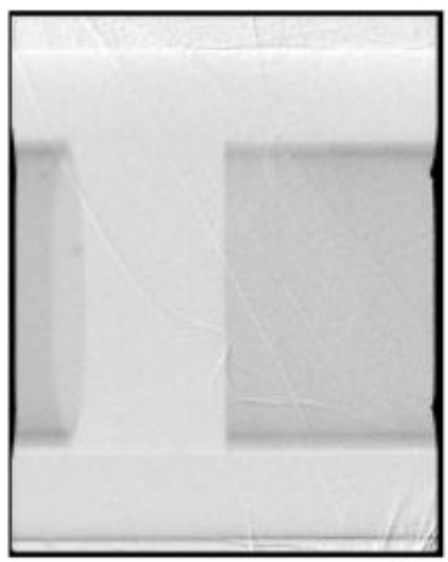
page 4

Above: The HPTC grabber attached to the end of PCATS manipulator

Below: Following connection and pressure equalization with PCATS the 'dogs' are released enabling the core to be transferred inside PCATS at 5000 psi.

Above: When aligned in PCATS to the correct position the cut is made

Below: The cut is confirmed in the X-ray image before the core is transferred into a storage chamber.



Right: After the core is cut it can be transferred to a storage chamber which is removed until the core is required for further processing.

Above: Having removed the core the inner tube plug is extracted from the PCATS.

Above: The remainder of the cut liner still attached to the inner tube plug.

Below: The HPTC grabber is still securely attached to the PCATS manipulator.

Right: The end of a successful test!

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