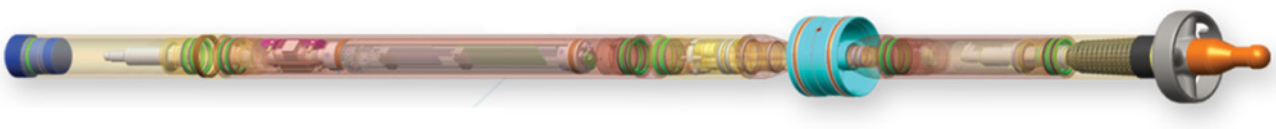


OPERATIONS MANUAL

CHAPTER 4 Job Planning

REV A: 2013 December 30, 2013

XFLD-0004

Table of Contents

This chapter lists the necessary steps to plan for an XEM job.

For specific details refer to:

1. Chapter 1 HSE
2. Chapter 2 Specifications
3. Chapter 3 Theory
4. Chapter 5 Surface Equipment
5. Chapter 6 Tool Preparation
6. Chapter 7 Software Programming (X Connect)
7. Chapter 8 Software Decoding(Rx)
8. Chapter 9 Job Execution
9. Chapter 10 XHop

1. EM SIGNAL

1.1. EM SIGNAL

Prior to performing an EM job it is important to know if EM transmission is supported in the area.It may not be possible to receive EM transmission on surface due to the environment. EM Signal is affected by:

- Formation resistivity
- Mud Resistivity
- True Vertical Depth
- Casing Depth

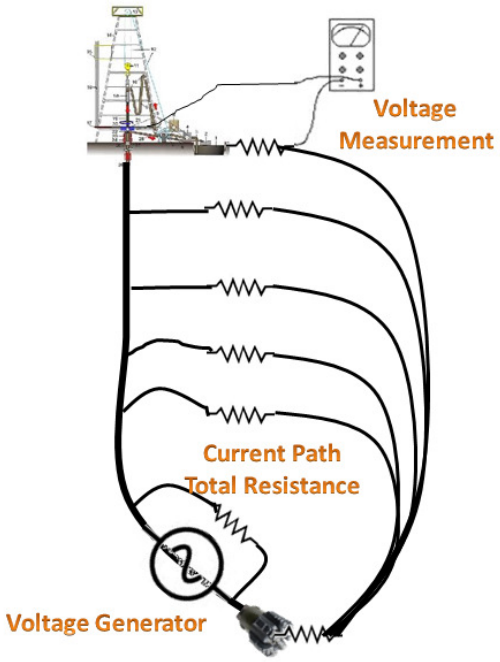


Figure 1 EM Signal Measured on Surface

Additional explanation on environmental effects is provided in the theory chapter. If the XEM will be run in the field for the first time an EM Signal model needs to be generated to evaluate if the signal strength will be appropriate at TD.

- The model is generated in HSPM and can be requested through the District engineers.
- The Model may be requested through a ticket to the XEM In-touch Help desk
- An extensive database is maintained for all locations in North America and some International locations. There is a high possibility that a model already exists for an offset location.

1.2. EM SIGNAL MODEL REQUIREMENTS

The following Information should be requested to generate an EM Model.

1. **Formation Resistivity**: Resistivity data needs to be provided for an offset well in LAS format. Only 1 depth of investigation is necessary; this should preferably be the deep resistivity curve. Ideally this data should be available from surface to the intended Total depth of the well. The data should be available for the open-hole section below the casing shoe. The LAS data should be indexed to the true vertical depth.
2. **Mud Resistivity**: The mud type needs to be specified. If water based mud will be used the mud Resistivity at bottom hole temperature needs to be provided.
3. **Casing Shoe:** Depth provided as per the drilling program.
4. **Collar size**

Assumptions can be used for tool configuration (power and frequency) based on experience.

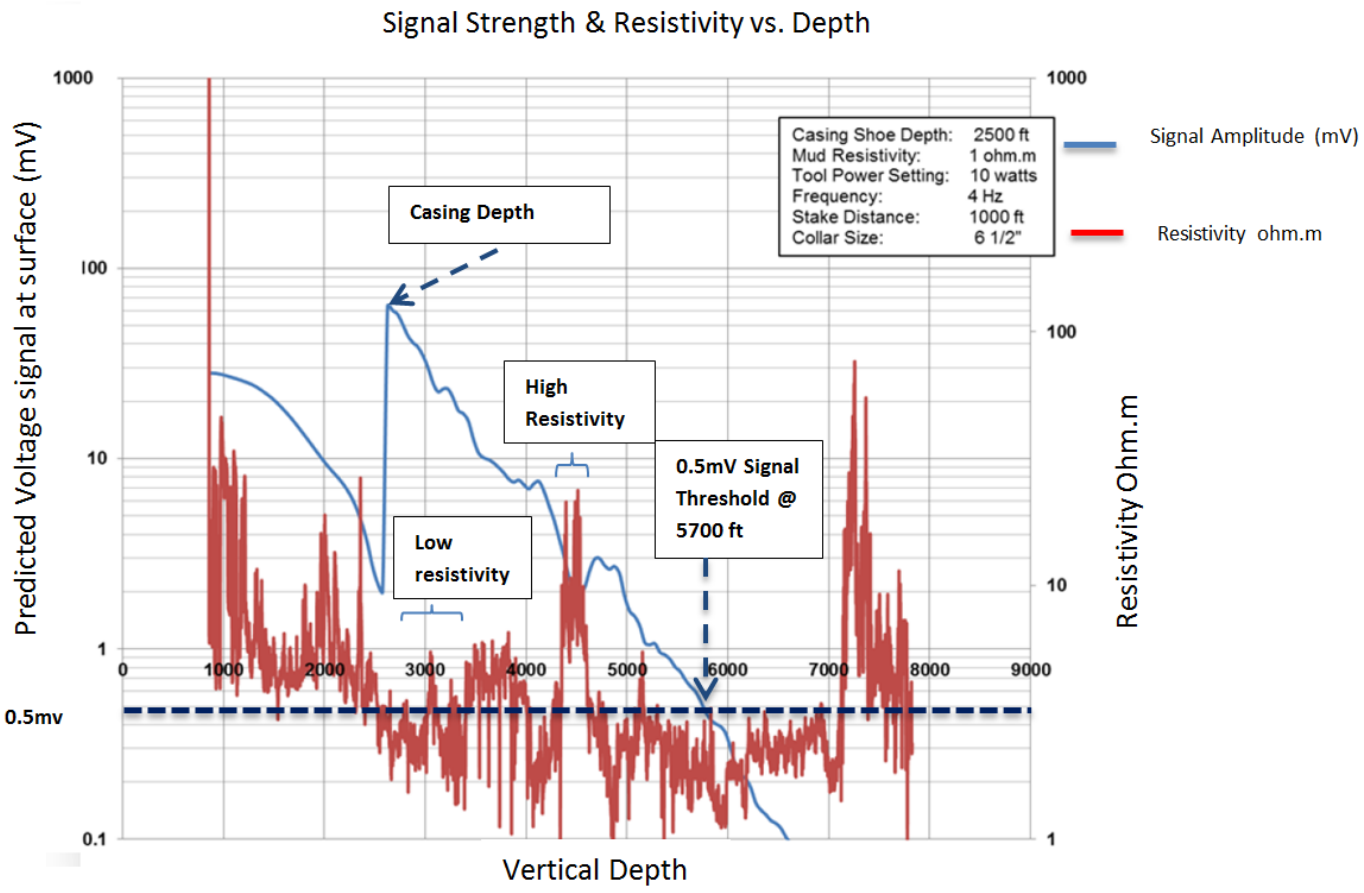


Figure 2 EM Model

In Figure 2, the Signal quality will be affected at a depth of 5700ft.

2. JOB AND SERVICE INFORMATION

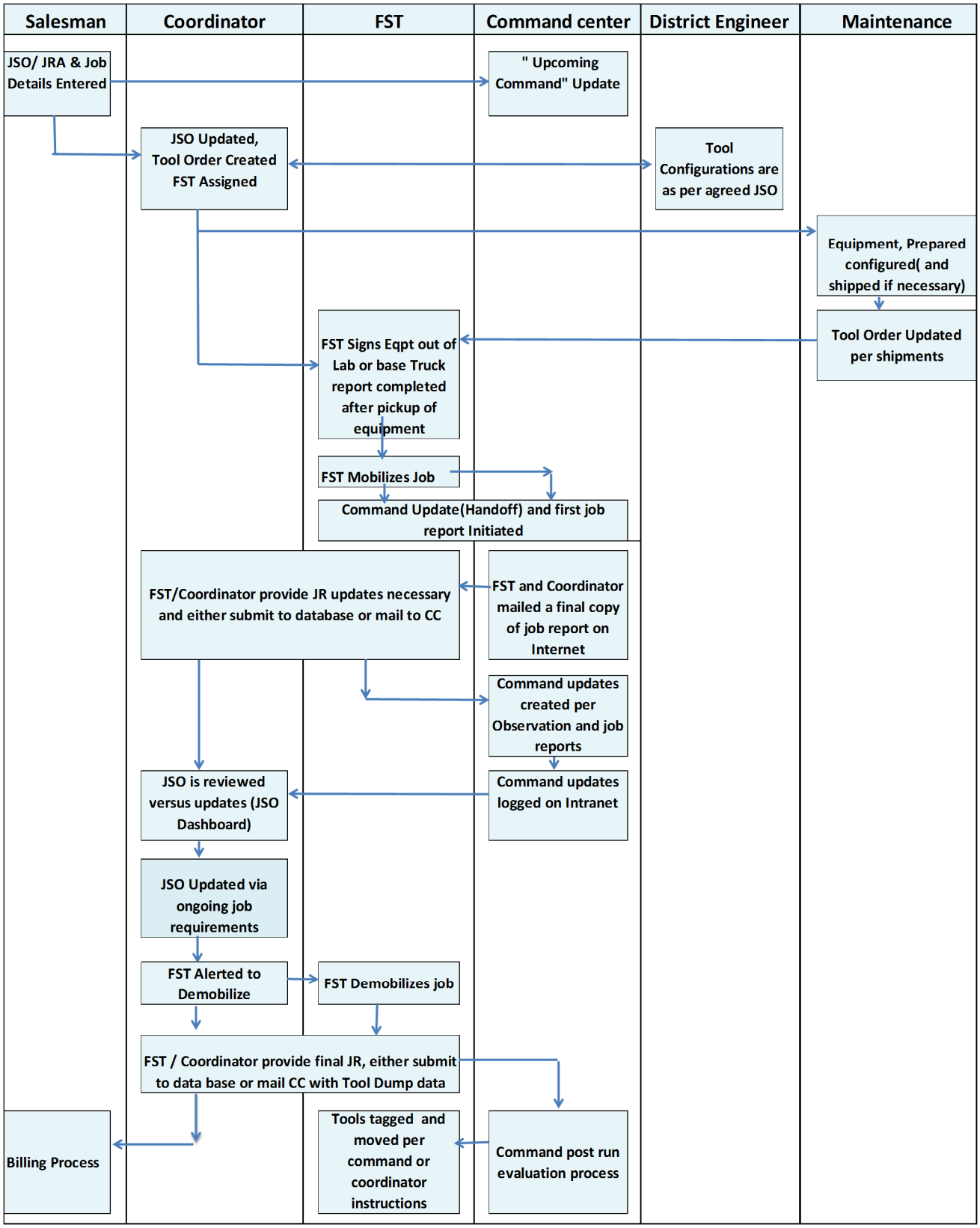


Figure 3 Extreme Work Process

The Extreme Operations work processes are illustrated in Figure 3. Prior to the job, information about the job specifications and services to be provided is uploaded into the JSO spreadsheet; the CDR, JSO and JRA forms are updated. Some information is available initially before the job; the remaining information may be updated at the well site.

In general for an XEM job the following information should be available:

2.1. CLIENT / WELL INFORMATION

- Client Name /Well name/ API No
- Job start date/Spud date/ Service start date/ Service end date
- Geographical Information Latitude/ Longitude
- magnetic field strength / Declination/ DIP
- UTM Zone / Grid convergence
- Contact details (Phone)
- Connectivity network information

Client Name	Enerplus	**AFE / API**	AD130109	
O&G Operator	No	**Spud Date**	6-Oct-13	
New Client	41553	**LSD (Canada Only)**	15-18-50-19w5	
Tool Start Date	Edson, AB	**Tool End Date**	31-Oct-13	
Approx. Well Loc (City/Prov/St)		**Rig Name**	Nabors 10	
New Geographical Location	No	**Known Connectivity**		LAT/LONG Map
Well Name	Enerplus Hz Ansell 15-18-50-19w5	**Latitude / Longitude**	53.3214610	-116.7654410
Field Name	Wilrich	**UTM Zone**		
Field Strength	0.571506	**magnetic Dip/magnetic Declination**	74.66	16.33
Grid Convergence		**RKB Elevation**	1060.7	
North Reference		**Well Type**	S	
Rig Phone #		**Field Service Tech**		
Company Man	Bob	**Primary / Secondary #**	403.896.5264	
Drilling Engineer	Chris Gallant	**Primary / Secondary #**	403.710.4931	

Table 1 Client /Well information

2.2. SERVICE INFORMATION

Detailed information should be obtained about the services that will be performed on all the sections of the well where XEM will be used. This includes:

- Required tool sizes 4.75", 6.5", 8" or 11" that will be used on the job
- If gamma services will be required:
  - An additional gamma probe has to be added to the tool string.
  - Depth information will have to be obtained through WITS.
  - An acquisition system such as Maxwell/ RX5/ Polaris may be required for monitoring and delivering logs and data.
- If PWD (Pressure While Drilling) services will be required.
  - A non-ported plug will be used on the Gap sub if annular pressure will be required.
- If XHop services will be required:
  - An additional XHop probe will be added to the tool string.
  - Information about the Power-Drive SW will be required.
- If DynamX services will be required:
  - The DynamX probe will have to be run instead of the standard Directional probe.
- Batteries will be selected depending on capacity requirements and environmental conditions.
  - Lithium Batteries provide higher capacity.
  - Alkaline Batteries are suitable for high shock and vibration environment.
- Prototype
  - There is always associated risk with new prototypes tools which need to be proven in the field.
- Pipe Screen
  - The Client may prefer to use a screen to prevent the bit/BHA from getting plugged. It is not critical to have a pipe screen when using the XEM.
- Lost In Hole Insurance
  - The XEM is not retrievable; it is rigidly attached to the Gap sub which improves reliability in environments with high shock and vibration. A lost in hole insurance price agreement may be required.
- Collars
  - 1 x NMDC is typically required for the XEM in a directional well.
  - Additional collars, pony drill collars may be required if the tool is long or if non mag spacing is required for the Directional sensors.

Service Specifications	Surface hole	Build Section	Hold / Tangent
MWD Type	XEM	XEM	XEM
MWD Service	Full MWD	Full MWD	Full MWD
Tool Size	8"	6.5”	6.5”
gamma		Yes	Yes
PWD (Annular/Bore)			
Xhop			
PD Firmware Version			
DynamX	Yes	Yes	Yes
Battery Type	Lithium	Lithium	Lithium
Prototype			
Client Deliverables			
Pipe Screen			
Lost in Hole Insurance			
Dedicated FST	Yes	Yes	Yes
NMDC Rental			
Steel Collar Rental			
Crossover Rental			
Pony Collar Rental			

Table 2 Extreme Services requested

2.3. JOB SPECIFICATIONS

The tool specifications in Chapter 2 should be compared with operating conditions on the Job. Details of the operating conditions need to be obtained; these include:

- Collar OD/ Collar ID
- Gap sub OD/ID
  - 6.5 Gap subs are available in 4 ½”IF and 4 ½” XH connections
- Mud type
  - The tool is configured separately for WBM and OBM.
  - If possible the mud resistivity should be known for water based mud applications.
- Drilling Parameters
  - Min/Max flow rate
  - Mud weight and viscosity
  - Solids
  - Sand

- LCM limitations
- Operating temperature particularly if > 125 DegC

The flow rate does not affect the quality of the signal, however needs to be within specifications as excessive flow may create washout on the surface of the tool. The solids and sand content also needs to be monitored. For air drilling applications the Mist rate should be confirmed.

XEM is not affected by LCM which blocks the modulator in mud-pulse MWD tools. While the XEM is rated for 150DegC, the temperature should be noted if greater than 125 DegC as equipment reliability is affected at high temperature. This information may help in understanding issues and in maintenance after the job. Staging procedures may be employed while running in to reduce the initial exposure to the high static temperature.

Job Specifications	Units	Surface Hole	Build Section	Hold / Tangent
Depth In	M		610	3100
Depth Out	M	610	3100	4495
Pipe Screen Size				
Connections		6 5/8" REG	4 1/2" IF	
Collar OD	In	8	6.5	
Collar ID	In	3.25	2.8125	
Landing/Gap sub ID	In	3.25	2.8125	
Hole Size	Mm			
Min Flow Rate	m3/min			
Max Flow Rate	m3/min			
Mud Type		WBM	OBM	
Mud Weight (min)	kg/m3			
Mud Weight (max)	kg/m3			
Temperature	℃	<125	<125	
Viscosity	cP			
LCM Expected				
LCM Content	lb/bbl			
LCM Type				
Solids Content	%/vol			
Solids Control				
Sand Content	%/vol			
Mud Program		Gelchem		
FST Trained to Run the Service		Yes	Yes	
Backup Tool		Yes	Yes	
Running Below a Motor		No	No	

Table 3 Job specifications

2.4. BHA

The intended BHA should be requested:

- To compute the bit to survey distance.
- To compute the bit to gamma distance.
- To review the non-magnetic spacing. A drill string interference program is run to confirm if the required non -magnetic spacing is adequate. (Section 2.6)
- To confirm the connections for the Gap sub.
- The BHA should also be reviewed to see if there are components which could have an effect on the reliability of the Gap sub and the XEM tool.
- If High DLS is anticipated it is strongly recommended that flex Monels/ subs should preferably be used above and below the Gap sub to reduce bending moment which can induce stress on the gap joint leading to Insulation failure on the Gap sub.

BIT DATA

BAKER	HC DP 606 X
Type Bit	PDC
TFA	2.226
Jets	22 22 22 22 22
	22 0 0 0 0

Motor Data

Model: 6.75		Pad OD	
Mfg.	Toro		
Bend °	1.5	Stator/Rotor	9/10
Bit to Bend	6.47	Motor Diff	

Expectations

Start Depth	0.00
End Depth	0.00
Drilling Hours	0.00
Avg ROP:	

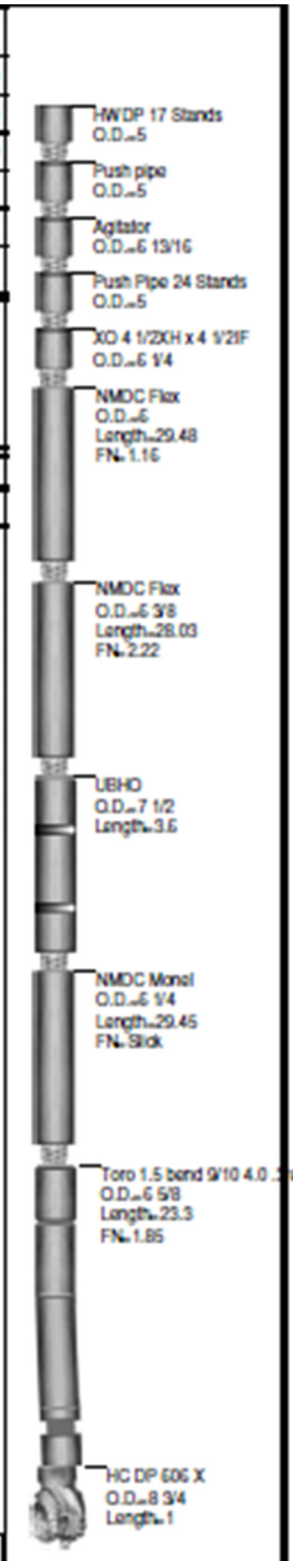
Incl.	IN	0.0	OUT	0.0

Comments

Bit to Survey = 70 ft
Bit to Gamma = 72 ft

BHA Detail

#	Description	Serial #	I.D.	O.D.	Length	Sum	Top Conn
1	HC DP 606 X	7136885		8 3/4	1.00	1.00	4 1/2 REGP
2	Toro 1.5 bend 9/10 4.0 .3rev	675 012		6 5/8	23.30	24.30	4 1/2 XHB
3	NMDC Monel	65570MC	2 13/16	6 1/4	29.45	53.75	4 1/2 XHB
4	UBHO	MSD67754		7 1/2	3.60	57.35	4 1/2 XHB
5	NMDC Flex	9988	2 13/16	6 3/8	28.03	85.38	4 1/2 XHB
6	NMDC Flex	66503010720	2 13/16	6	29.48	114.86	4 1/2 XHB
7	XO 4 1/2XH x 4 1/2IF	rig 2	2 1/4	6 1/4	3.07	117.93	4 1/2 IFB
8	Push Pipe 24 Stands	Rig 04	4.2	5	2,267.30	2385.23	4 1/2 IFB
9	Agitator	SAJT0675-0004		6 13/16	25.59	2410.82	4 1/2 IFB
10	Push pipe	Rig 05	4.2	5	2,266.70	4677.52	B
11	HWDP 17 Stands	Rig 06	3	5	1,566.51	6244.03	B



WinSURV II BHA Proposal

Figure 4 BHA

2.5. WELL PLAN

A well plan should be provided; this typically includes:

- The Well reference information including the UTM zone.
- Latitude, Longitude to calculate the reference G Total value. This value can be used to check the G Total values from the tool during surveys.

Reference Details - WELL CENTRE	
Geodetic System:	US State Plane 1927 (Exact solution)
Ellipsoid:	Clarke 1866
Zone:	Texas North Central 4202
Northing:	351069.00
Easting:	2059900.00
Latitude:	32° 37' 53.4576 N
Longitude:	97° 18' 19.5728 W
Grid Convergence:	0.11° West
Ground Elevation:	689.00
KB Elevation:	WELL @ 709.00ft (Original Well Elev)

Figure 5 Reference Information

- The magnetic field and DIP which can be used to quality check the surveys.
- The Grid correction / Declination required for correcting the well azimuth.
- A vertical section plot which allows the well TVD to be plotted versus the vertical section allowing the well profile to be viewed in the vertical plane (Side view).
- A North /South versus East/West plot which allows the well to be viewed in the horizontal plane. (Top View).
- A listing of the proposed survey stations along the well trajectory. The DLS in the Surveys should be compared to specifications in chapter 2.

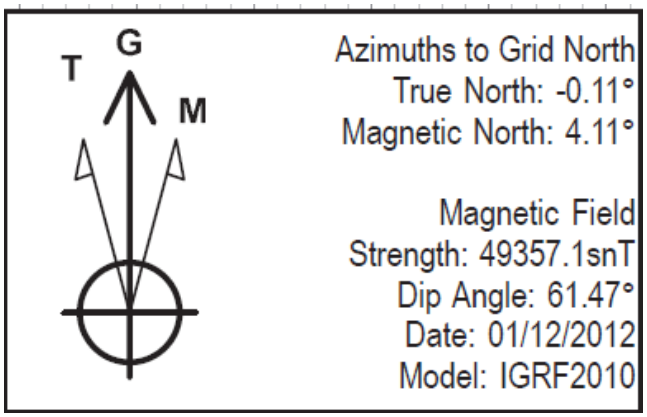


Figure 6 Grid correction

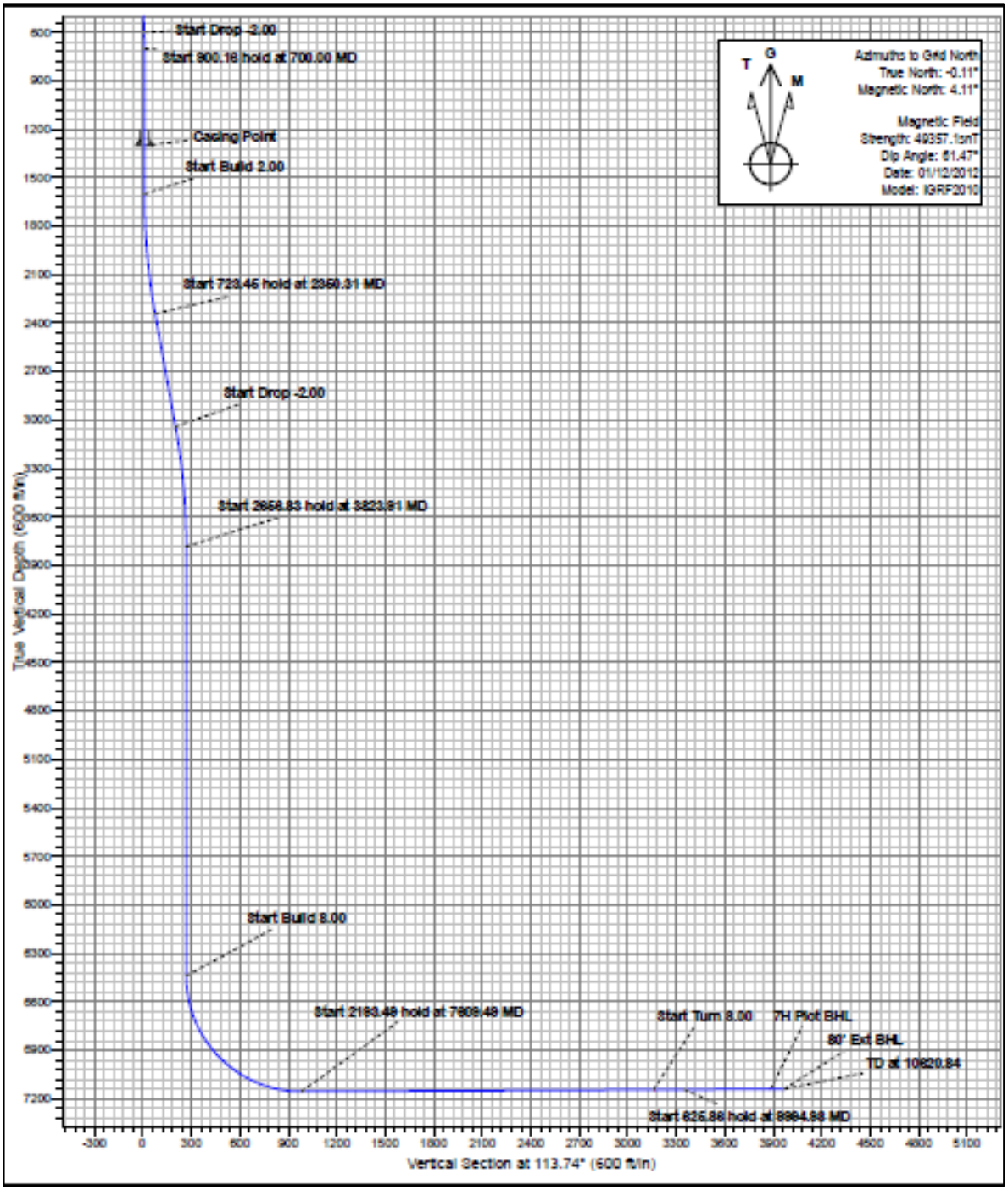


Figure 7 Vertical Section

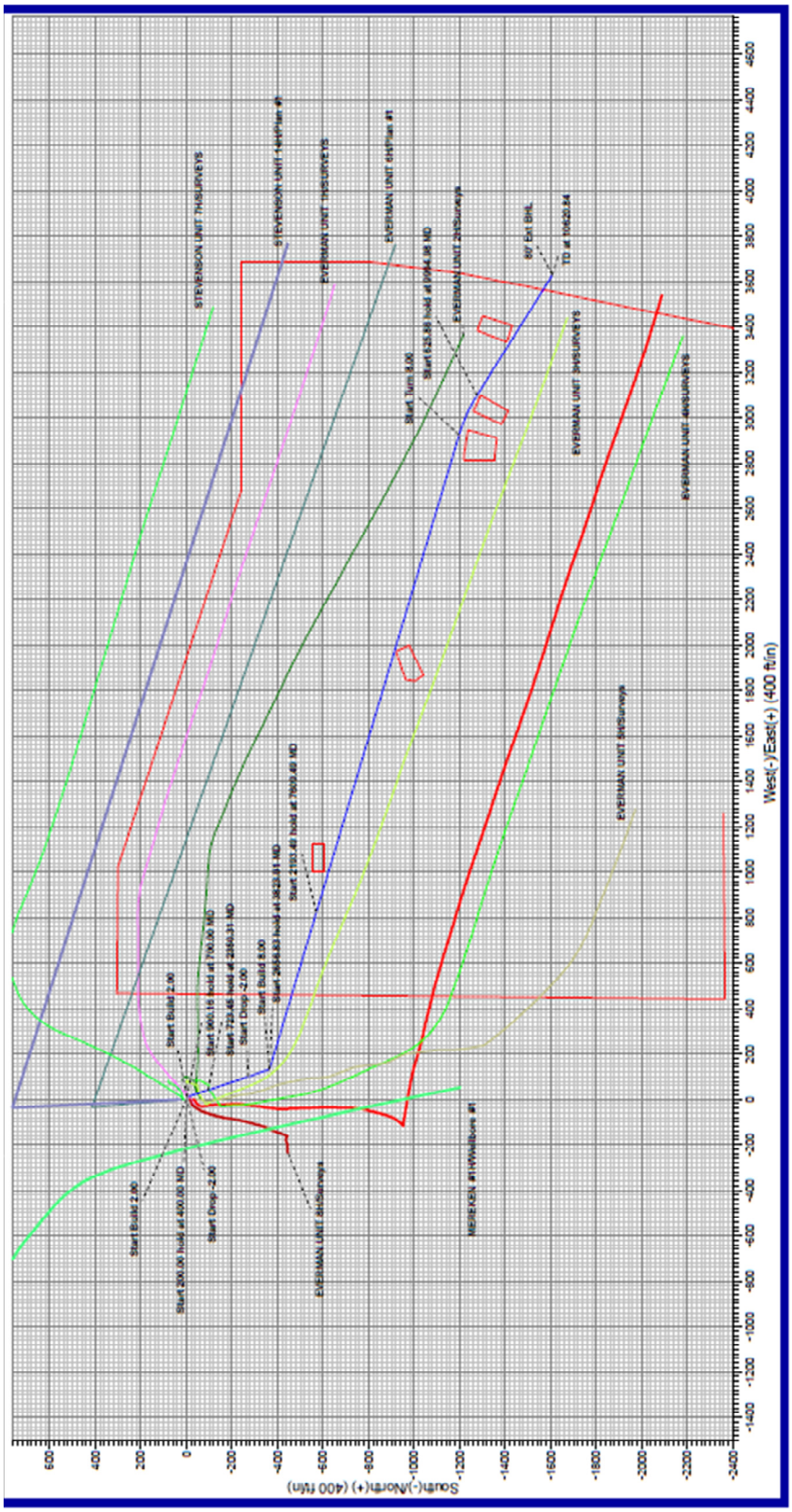


Figure 8 Well - Plan North-South\ East West

2.6. DRILL STRING INTERFERENCE

The Schlumberger survey Tool Box can be used to estimate the Drill String Interference which varies with Well location, Inclination and Direction. If Interference is > 0.5 degree additional non-magnetic subs may be required.

Schlumberger **Estimated Drillstring Magnetic Interference Report**

Client:		**Field:**	
Rig:		**Well:**	
BHA:	Steerable assembly	**Description:**	Manual Input
Engineer:		**Date:**	14/02/2012

Grid Azimuth:	113.74	deg	**Magnetic Azimuth:**	109.42	deg
Declination:	4.21	deg	**Grid Convergence:**	-0.11	deg
Inclination:	90	deg	**Dip Angle:**	61.47	
Field Strength:	49357	nT	**BHA Type:**	One	
BHA Size:	Large				
D1:	24.3	ft			
MP:	69.4	ft			
D2:	143.9	ft			
Interfering Field:	159	nT	**FAC Variation |B|:**	20	nT
Min Surveys for DMAG:	20		**FAC Variation Dip:**	0.04	deg

Azimuth Error Calculation Result: 0.36 deg **(2 Sigma)**

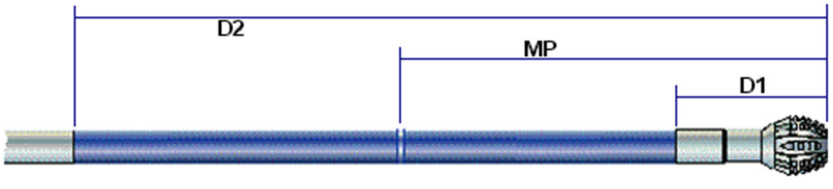


Figure 9 Drill string Interference Estimate

If Drill string interference is identified on the job the surveys can be corrected with DMAG with assistance from the local Surveying team.

2.7. ANTICOLLISION

EOU and Proximity Scans may be provided if requested in advance with support from the regional OSC center.

2.8. JOB RISK ANALYSIS

A risk factor has to be estimated for the job, this should be based on:

- If XEM is being run first time for a Client or in a Geographic location
- If specialized services are offered
- Training competency of personnel involved
- Mud properties
- Temperature
- Flow rate
- BHA considerations

If the total risk exceeds specified thresholds the job may need input from the Operations Engineering / Engineering teams. A sample Job Risk Analysis is illustrated in Figure 10. Some jobs need to be monitored by the Engineering team.

				Job Number	AB-PAT-0016
				Date	30-Sep-13
Job Specifics	**Rating**	**Surface**	**Build**	**Hold/Tangent**	**Operations Engineering/Engineering Comments**
Client					
Existing	0	0	0	0	
SLB	5				
New	10				
Geographical Region					
Existing	0	0	0	0	
New	5				
Connectivity					
Yes	0				
No	3				
Service Type					
Xpulse	0				
XEM	3	3	3	3	
Service Requested					
Inc Only	0				
Inc/AZ	3				
Full MWD	5	5	5	5	
Gamma	5		5	5	
PWD	5				
XHop	10				
DynamX	10	10	10	10	
Lithium	0	0	0	0	
Alkaline	10				
Prototype					
No	0				
Yes	5				
FST Trained to Run the Service					
No	10				
Yes	0	0	0		
Backup Tool					
No	5				
Yes	0	0	0		
Client Deliverables					
No	0				
Yes	5				
Mud Type					
WBM	0	0			
OBM	3		3		
Air/Mist	5				
Air/Only	10				
Solids Content					
>7%	5				
Sand Content					
>1.5%	10				
LCM					
None	0				
Any	5				
Temperature					
<125C	0	0	0		

125C - 150C	5				
Flow Rate/Tool Size/Collar ID					
>317GPM, 400GPM - 4 3/4"- 2 11/1	5				
>660GPM - 6 1/2" - 2 13/16"	5				
>800GPM - 6 1/2", 8" - 3 1/4", 3 3/8"	5				
>900GPM - 8" - 3 1/4"	5				
>1056GPM - 8" - 3 1/2"	5				
BHA Considerations					
No Motor	0				
PDC Bit	3				
Motor	3				
Rotary Steerable	5				
XO's	3				
Stabilizers	3				
Below Motor (Vortex)	10				
	Total	18	26	23	
		No Operations Engineering Input Required	Email to Operations Engineering	Email to Operations Engineering	

Risk Ratings		**Special Client Considerations or Comments**
<20 – Level 1	No Operations Engineering Input Required	
20-40 – Level 2	Operations Engineering Input Required	
>40 – Level 3	Operations and Engineering Input Required	

Approvals	
Coordinator Approval:	**Date:**
Operations Approval:	**Date:**
Ops Eng Approval:	**Date:**
Engineering Approval:	**Date:**

Figure 10 Job Risk Analysis

2.9. JOB SERVICE ORDER

A job service order is required for all jobs. This typically includes:

- Accounting information
- Operating and standby charges as per contract.
- Additional charges
- Detailed description of services which may include 24/7 support.

A section of the service order (un-priced) for a typical job is illustrated in the Table below.

Services and Pricing			
Surface Section	**Daily**	**Monthly**	**Standby**
XEM Full MWD 8"			
DynamX			
Build Section	**Daily**	**Monthly**	**Standby**
XEM Full MWD			
Gamma			
DynamX			
Hold / Tangent	**Daily**	**Monthly**	**Standby**
XEM Full MWD			
Gamma			
DynamX			
Special Arrangements			
Incidentals			
Mileage	$0 per km		
Personnel Charge	$0 per day / $0 per day standby		
Accommodations	$0.00 per night		
Subsistance	$0 per day		
Battery charges	$0 per amp hour		
RT Gamma logs	$0 per day / $0 per day standby		
Post Run DynamX log			
NMDC Collar rental	0 per collar per day		
Pony Collar rental	0 per collar per day		
Inspection/Recut of Tubulars	0 per piece		
LIH Coverage XEM™	0 per day without gamma / $0 per day with gamma		
Lost-In-Hole (LIH) Charges	$0 for XEM, $0 for gap sub $0 for gamma		
Excessive Wear and Tear	Cost plus 0%		
Damaged Beyond Repair (not covered by LIH coverage)	Cost plus 0%		
Trucking	Cost plus 0%		
24/7 support	Included		

Table 4 Job Sales Order

3. TOOL ORDER PROCESS

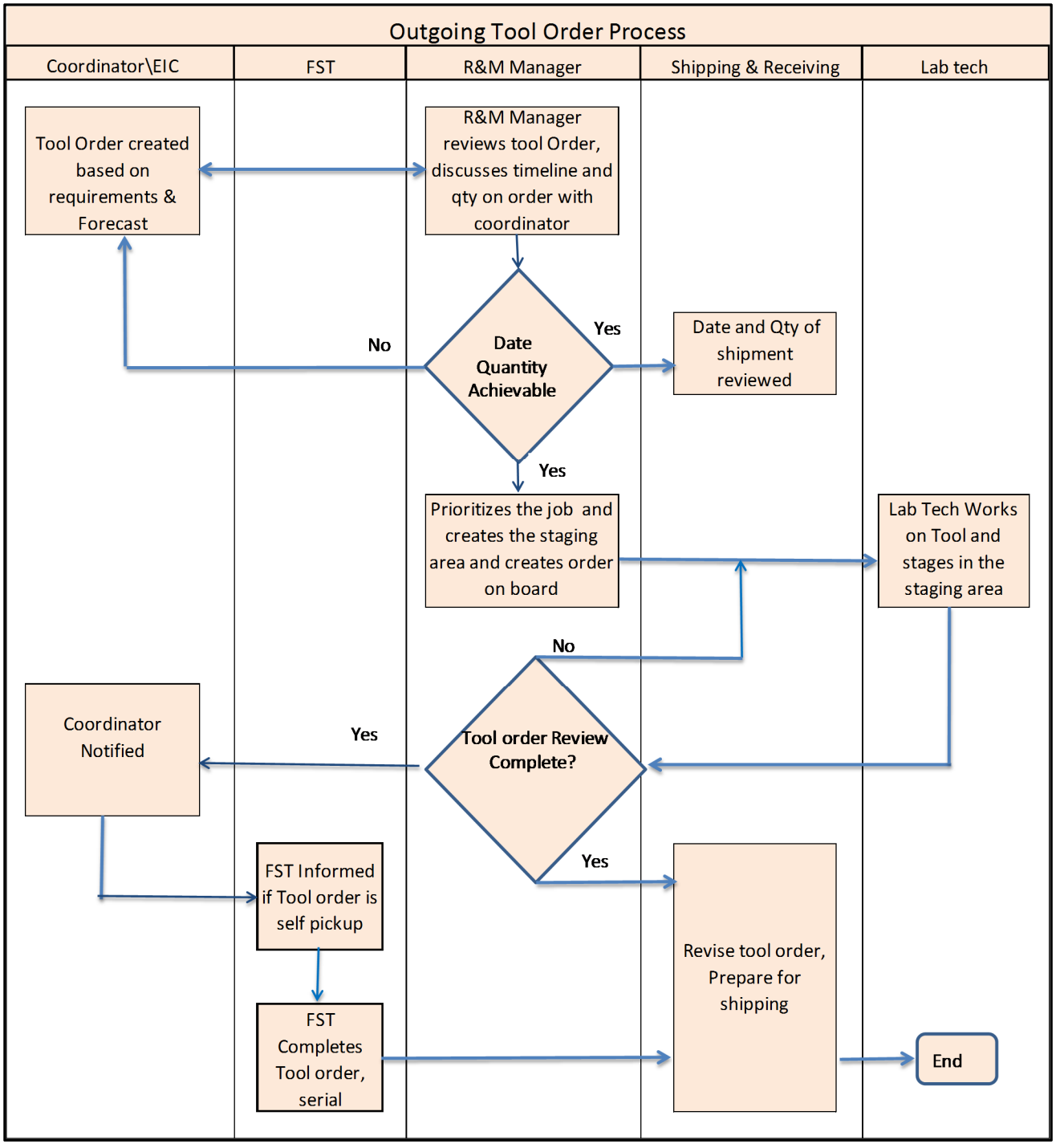


Figure 11 Tool Order process

As illustrated in Figure 11 the first step in preparing equipment for a Job is for the Coordinator to prepare a tool collar order based on the Job forecast:

The Tool order illustrated in Figure 12 contains:

- A list of all probes, subs and equipment that will be used on the job based on specifications and requirements (Listed in Section 2)
- A list of the tool inventory is provided in Section 7
- The sending location and receiving location
- Instructions for the Maintenance team. The Maintenance team prepares the tool/equipment as per specifications and updates the order.
- An FST mobilizes the equipment to the field.

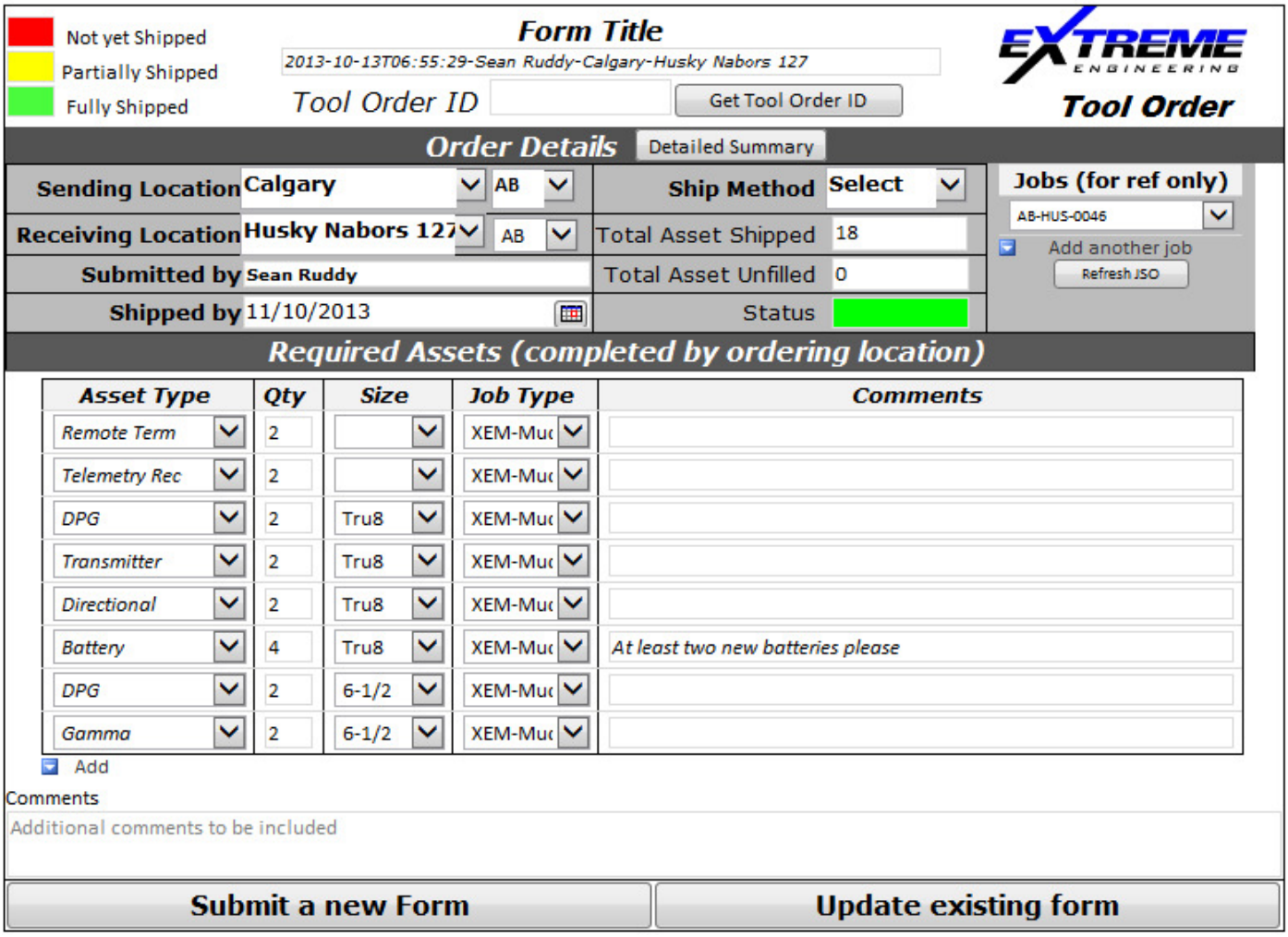


Figure 12 Tool collar order

A shipped assets form is completed which contains the list of the assets, serial numbers, the method of shipping and the shipped date is completed when the equipment is shipped out.

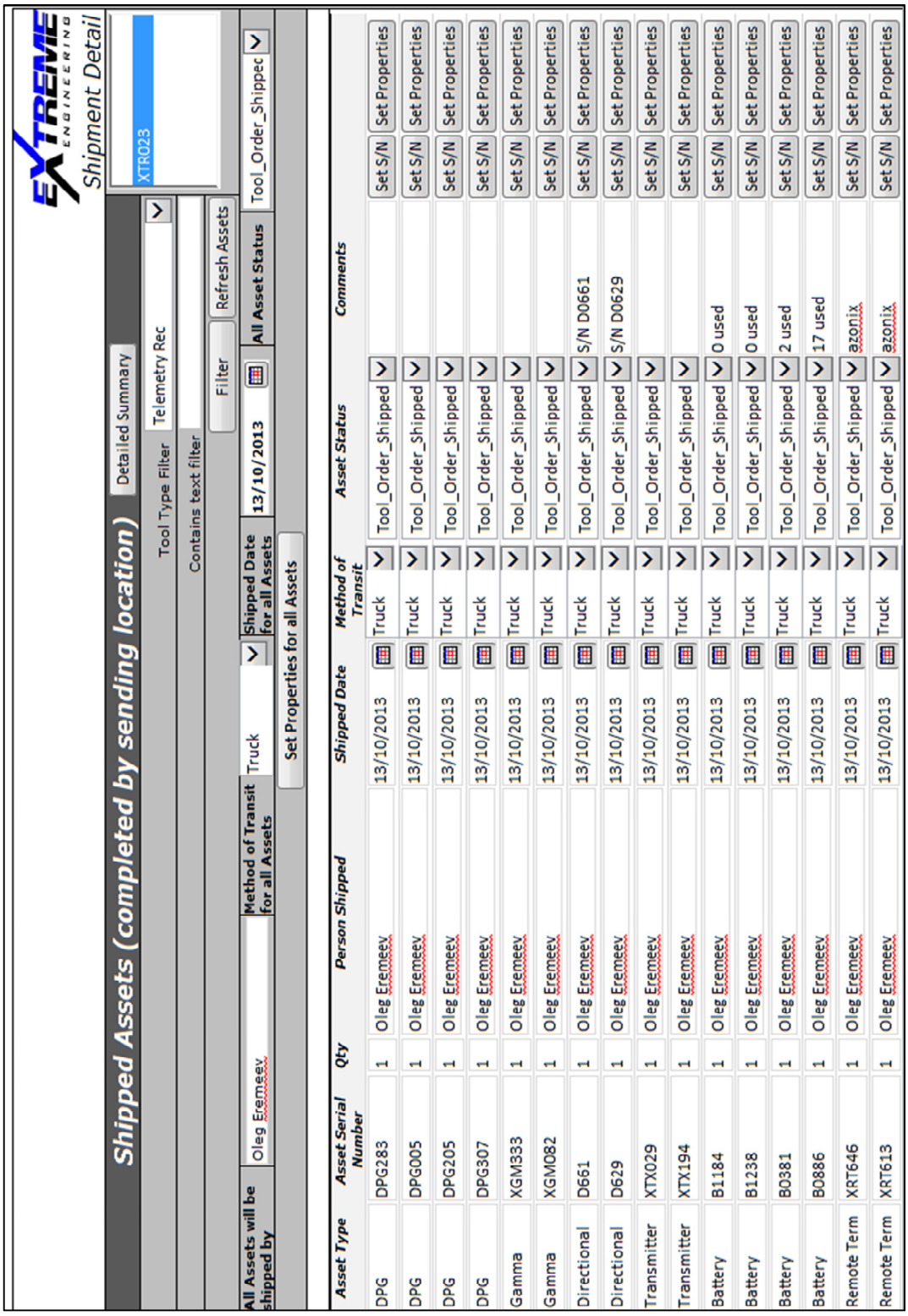


Figure 13 Shipping Form

4. EQUIPMENT CONSIDERATIONS

4.1. SURFACE EQUIPMENT

The surface equipment including the XTR and XRT/Azonix can be placed anywhere on the Rig where AC power supply is available. A remote connectivity kit can be used to provide wireless network connection from an Ethernet network.

The XTR firmware should be upgraded for compatibility with the V10 software. A 04XTRU0001 upgrade kit is required to upgrade the XTR firmware.

Only the Antenna (stakes) are connected to the XTR. Depth, Hook Load and information from other sensors needs to be imported through W.I.T.S (Well site Information Transfer Specification) provided by EDR, HSPM-Maxwell, RX5 or other acquisition systems at the Rig.

Equipment Zone Certification

For Land applications where there are no certification requirements, the XRT and XTR can be placed in the Dog House. If there is a requirement to comply with ATEX zone requirements the XTR / XRT can be placed in a Unit. A Rig floor display which meets the requirements can be placed on the Rig floor and connected remotely with the XRT/XTR.

Zone- 2 is classified as an area in which an explosive mixture is not likely to occur in normal operation and if it occurs it will exist only for a short time. The Azonix terminal can be used on the Rig floor if there is a requirement for the Rig display to be certified for Zone 2.

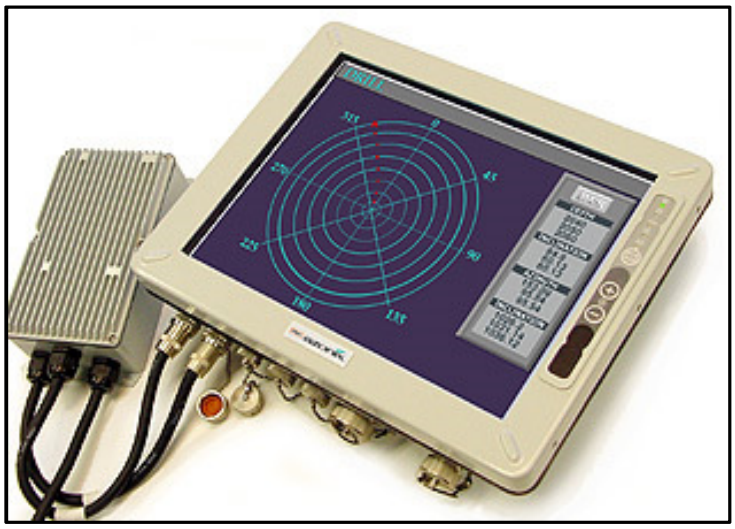


Figure 14 Azonix Terminal,

Zone 1: An area in which explosive mixture is likely to occur in normal operation. An Azonix ADU display can be used on the Rig floor if there is a requirement for the Rig display to be certified for Zone 1.

Figure 15 ADU

Intrinsic Safety

Intrinsic safety (IS) is a protection technique for safe operation of electrical equipment in hazardous areas by limiting the energy available for ignition. In some cases there is a requirement to have all sensors at the Rig to be intrinsically safe. The only sensor connected on the Rig floor is the BOP stake.

The BOP stake picks up signals and feeds them to the XTR. There is a minimal possibility for a spark occurring on the BOP as there is no power input to the stake.

The intrinsic system in the XTR has to be evaluated fully. If there is a requirement to have intrinsically certified sensors on the Rig floor, the BOP input can be taken from another stake driven to the ground away from the Rig floor.

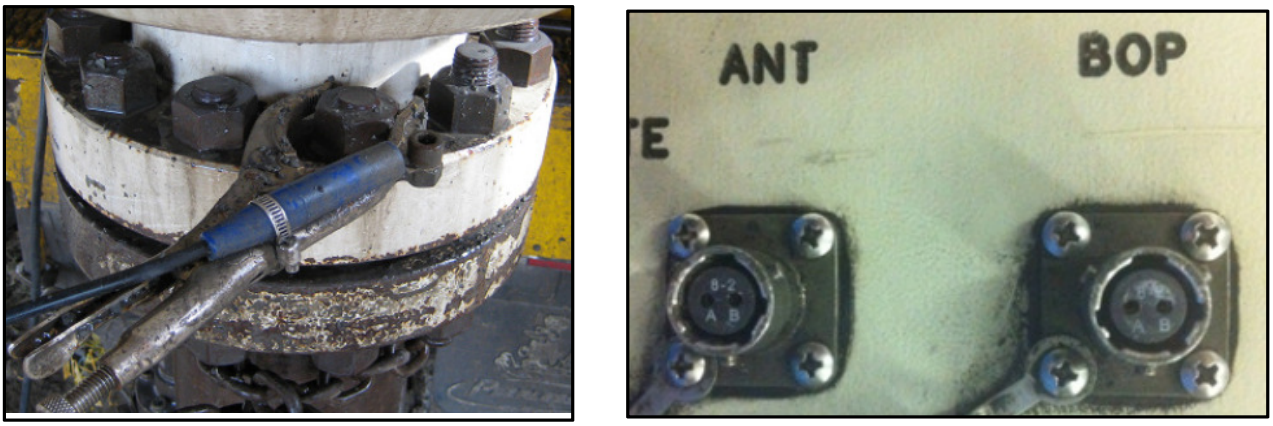


Figure 16 Connections on the BOP and XTR

110/220V Power Supply

Figure 17 AC Power Supply

- The commonly used XTR in the field is rated for 110V AC power supply.
- If only 220V AC supply is available, a special XTR configured for 220V should be requested or a 220 /110V transformer should be available.

Antenna Placement

The EM signal will get progressively smaller with depth. It is recommended to optimize the Antenna placement to ensure that there will be adequate signal at TD.

- The Spacing between the Bop and Grounding stake can be increased.
- Additional stakes can be placed in the same direction as the Well Azimuth.
- If there is an existing well nearby this can be used as a stake.
- The stakes can be moved to a wet place with salt so that the contact impedance is reduced.

Additional Information on Antenna placement is given in the Theory Chapter.

Electrical interference from Rig Equipment

- Power supply to the Rig Hoisting, circulation and rotation systems can cause interference on the EM signal. This interference will increase during drilling conditions when there is more strain on Rig equipment.

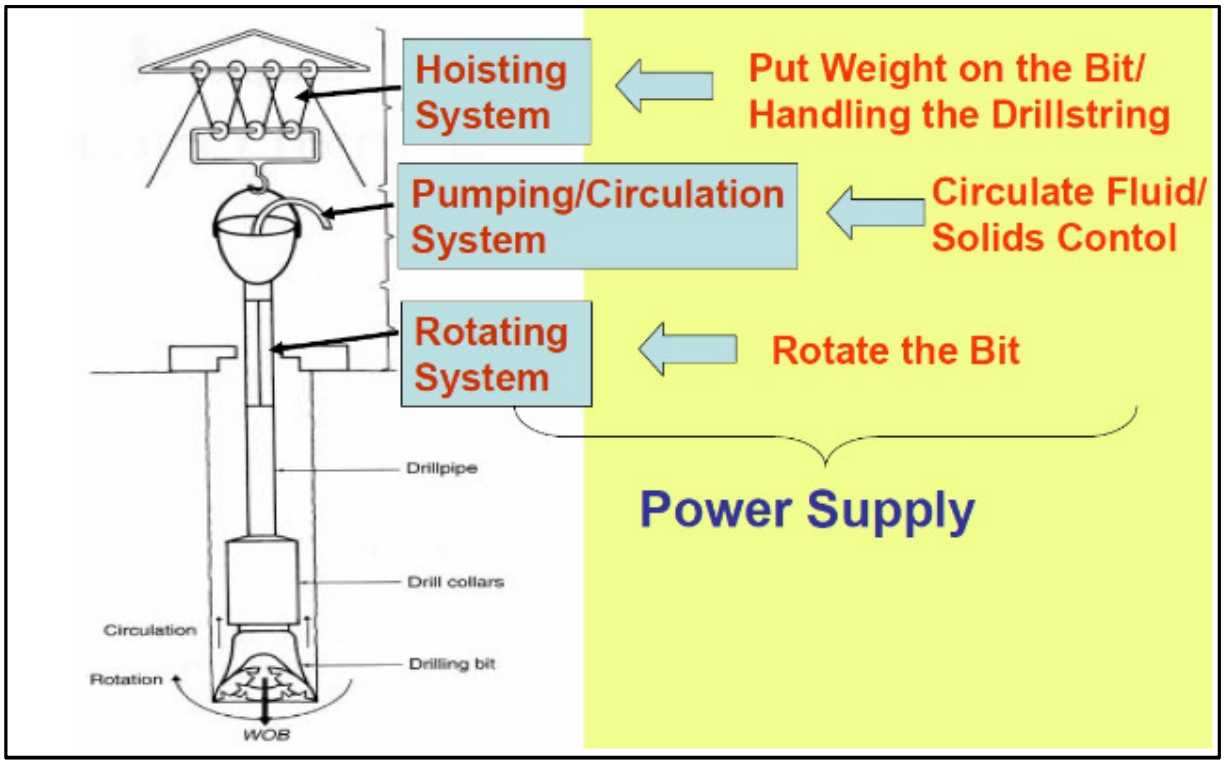


Figure 18 rig Systems

- An electrician should be consulted to ensure that Rig equipment that uses electrical power including the generators, the SCR room, TDS/ rotary, pumps, compressors is adequately grounded according to required standards.
- An Isolation transformer can be used to isolate the XEM surface equipment from electrical noise present in the power supply.
- If there are noise sources with a consistent frequency they can be suppressed by a Notch filter applied in the XEM Rx.

Gamma Acquisition system

An acquisition system such as Maxwell/ RX5 or the Polaris RDS may be required to monitor Gamma Data.

The Polaris RDS is a unique Logging system that allows for on-site or remote gamma logging depending on the needs of the client. The RDS system allows monitoring in Real time as well as delivery of Logs and data in Pdf and ASCII format. The Polaris system requires WITS data from the XTR /Azonix and Depth from EDR system.

The Polaris RDS SOP provides instructions on configuring, setting up and execution of Operations during the job.

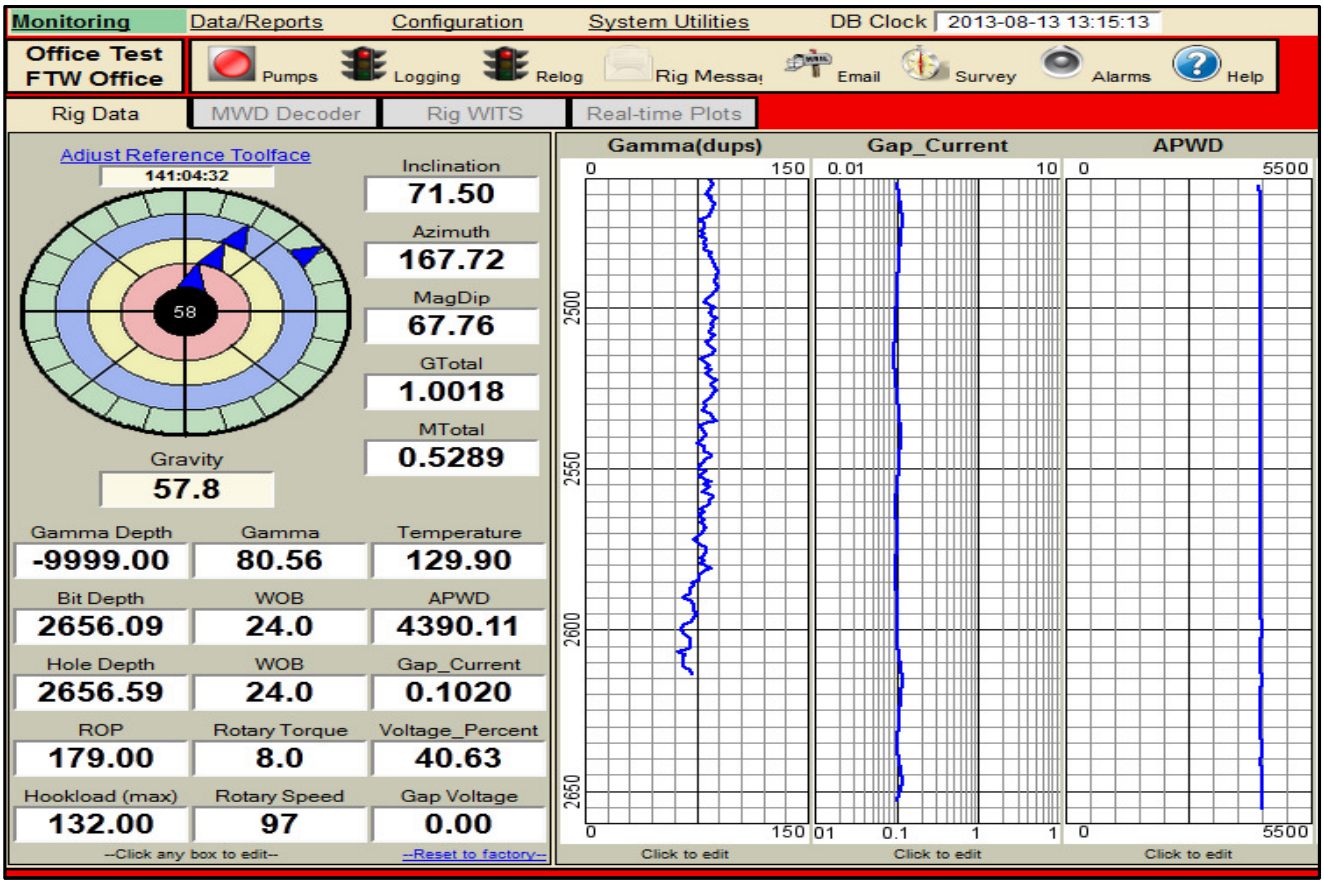


Figure 19 Polaris Logging Screen

4.2. GAP SUB

Figure 20 Gap sub

A Gap sub is needed for every XEM Job. The XEM tool-string is hung off from the Gap sub:

- The 6 ½" Gap sub is available with 4 ½" IF and 4 ½" XH Connections. The String connection needs to be checked prior to mobilization.
- Hard banding has been removed from the Gap sub as debris from the hard bands affects the LCP material used for Insulation in the Gap sub.
- Stress relief Grooves on the Pin and Bore back on the Box are typically not present on all Gap subs. If required, modifications will have to be done prior; New Gap subs from the Manufacturing Center can be requested with these features.
- The thread connections on the Gap sub should be inspected by a certified inspection company.
- The Insulation in the gap sub is important and will affect the signal transferred across the Gap. The insulation needs to be tested with a gap sub tester. The **07-PROC-0015** Gap sub Electrical test procedure provides guidelines on testing the Gap sub (The Pass/ fail criteria is currently under review).
- It is recommended that the Gap sub NOT be washed with a pressure "water" spray at the base. Non-conductive fluid should be used instead.
- In some cases the Gap sub has a Non ported Set screw plug which blocks annular pressure measurements. If annular pressure measurements are required the Gap sub should be run with a ported plug.

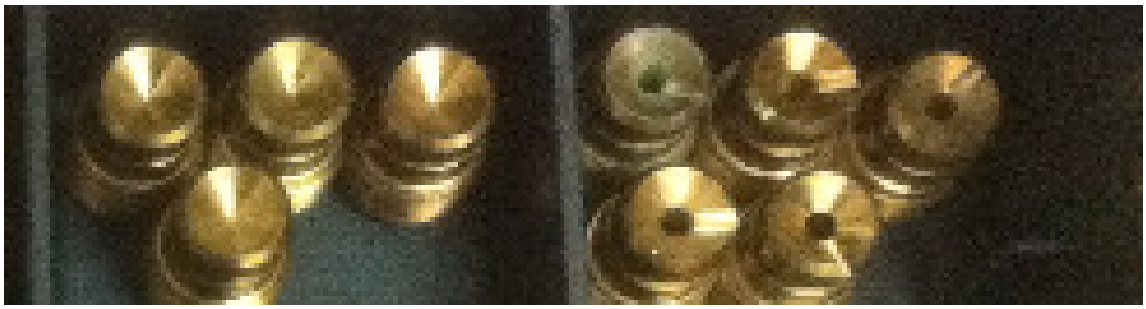


Figure 21 Plugs (Non Ported) (ported)

- All O rings (Grounding Spider and Set Screw) must be changed out every time the tool is removed. If using a ported screw, the plug port needs to be pressure tested before running down hole.
- On occasions, when crossing over from Mud to Air, mud seats form on ledges in the hex head on the Setscrew and prevent acquisition of accurate annular pressure measurements. New conical shaped plugs are available for the 4 ¾" Gap sub and can be requested through the XEM In-Touch help desk. These however require a special screwdriver to install instead of the hex key.

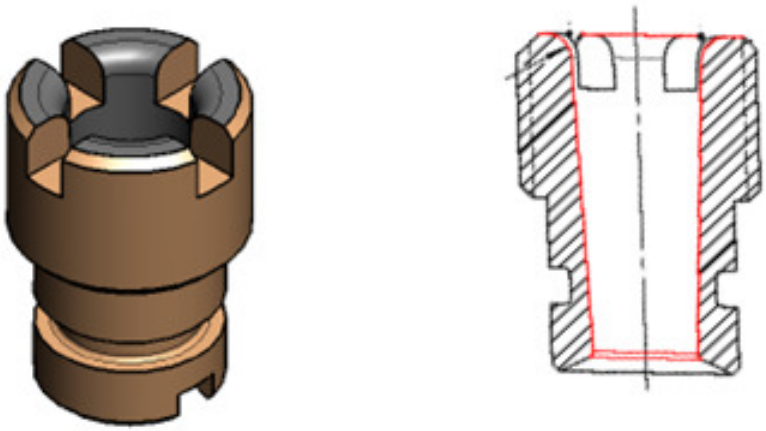


Figure 22 New conical Setscrew

4.3. DRILL COLLARS

The XEM can be run in any standard Non Mag Drill Collar. Sometimes due to the length of the tool string an additional Monel or pony may be required. The Monel in which the XEM is run:

- Is attached to the Gap sub and should have the same connections as the Gap Sub.
- Should be inspected at the base for collar hot spots which can affect the quality of the Directional measurements.
- Should be strapped with the OD, ID and length measured prior to the run.
- The Drill collar ID needs to be provided so that the rubber centralizers on the probes are adjusted accordingly.

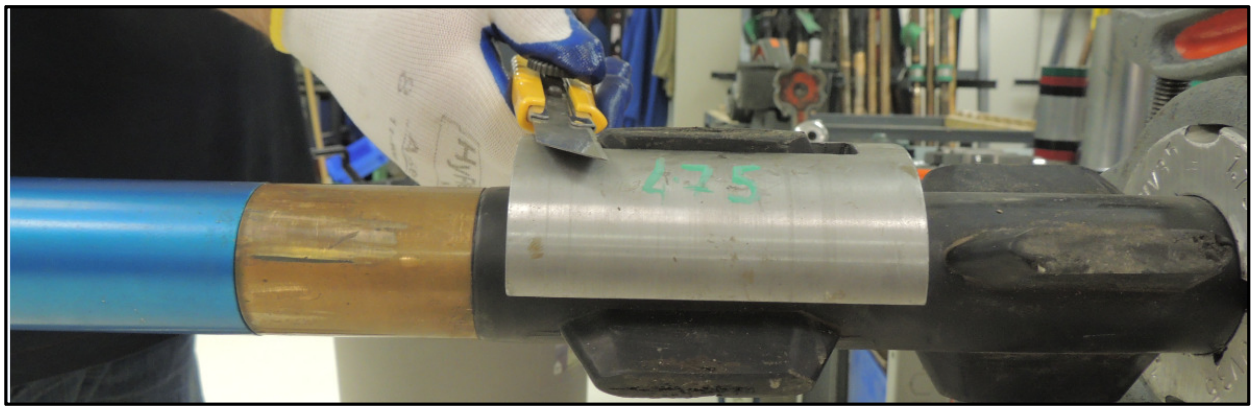


Figure 23 Centralizer rubber shaved off

- If gamma Service will be provided the collar thickness in front of the gamma sensor needs to be determined if different from the nominal value for the collar. The gamma correction and the total gamma API value may be shifted from offset logs.

Figure 24 Flex Monel Drill collar with variation in OD

4.4. XEM TOOL STRING

- XEM probes can be adapted for different collar sizes:
  - The Landing and Grounding spiders are fixed for different tool sizes.
  - The Centralizers on be ROTC have to be adapted. When downsizing the string the rubber on the centralizer can be shaved off.
- The Top 2 components in the XEM Tool String are the DPG and XTX. The positions of all other probes can be interchanged as required.
- The DPG has Bore / Annular pressure sensors. If annular pressure measurements are required a ported set screw has to be run on the Gap sub.
- The DynamX probe contains shock and vibration sensors in addition to Directional sensors. It is recommended to run the DynamX in Air Drilling conditions.

- Depending on power requirements 1, 2 or 3 Lithium Batteries can be used. Alkaline Batteries are available for tough drilling conditions; they have lesser life compared with Lithium Batteries.

- The gamma Ray probe is only included in the string if the service is required. Depth for gamma Logs/Data needs to be acquired

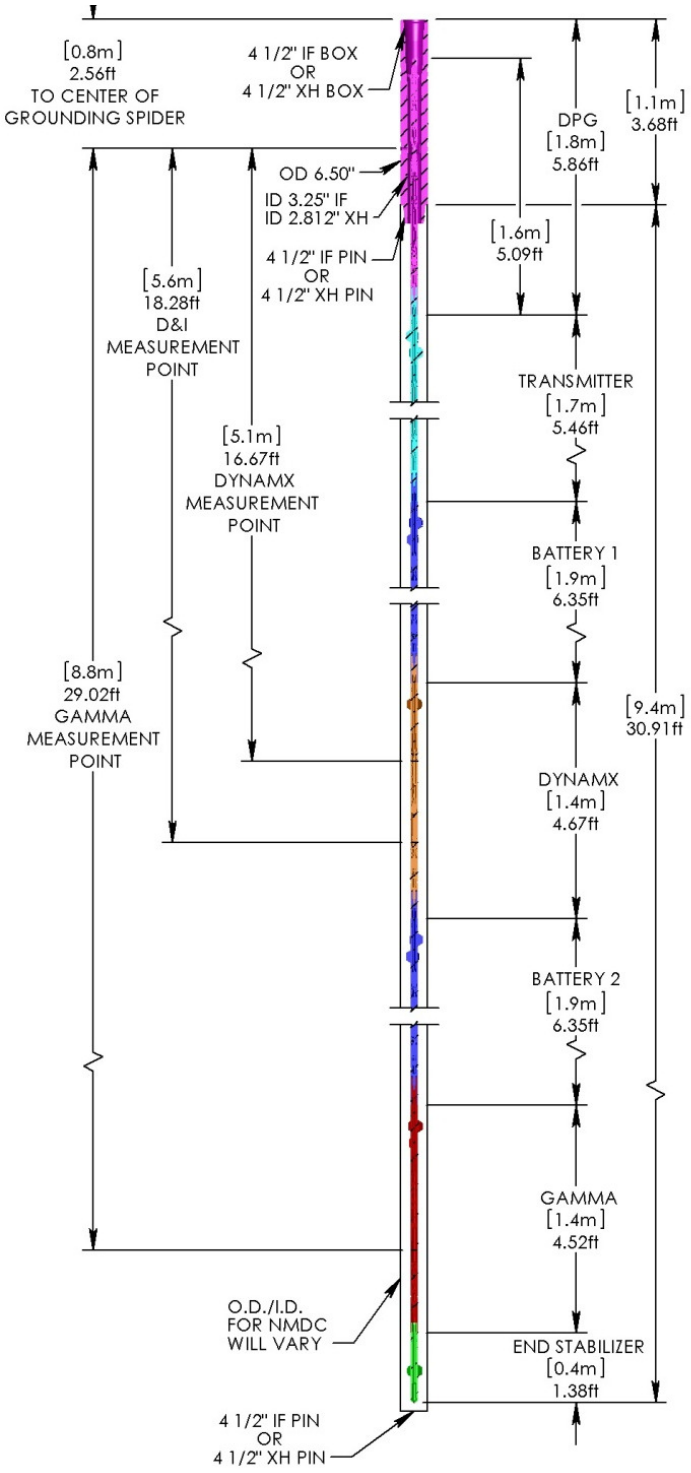


Figure 25 XEM Tool string

XHop (22XHop0001)

An XHOP probe can be run at the bottom of the XEM tool string. This allows transmission from a Schlumberger RSS to surface; Chapter 10 provides guidelines for running the XHop in the field. A 04XHOP0002 field Integration kit will be required to enable the XHop to be run in the field.

Figure 26 XHop probe

The New Hi-Voltage XTX: (22HVTX0001)

The original XTX (Transmitter) has limited ability to generate current in very high impedance systems. The new HV (Transmitter) has the ability to generate over four times more current into these systems, thus increasing the observed surface signal by the same amount. This provides better signal strength on surface particularly when drilling in an oil based mud environment.

Figure 27 Hi Voltage probe

The New High Voltage probe is 78.6” long as opposed to the old XTX probe which is 65”. A Hi voltage primer for the field is available. A 04HVTX0001 retrofit kit can be ordered to upgrade the XTX probe 22X-EM0005 to a 22HVTX0001 probe.

The DPG(S)

A New design for the DPG reinforces the neck providing capability to handle shock and vibration in tough drilling conditions. This also minimizes harness related issues. This is known as the DPG(S)

Figure 28 DPGS

The DPGS is available in 6.5” Size (22DPGS3001) & 8” (22DPGS5001). Kits for the DPGS are currently being finalized by Engineering.

4.5. TOOL CONFIGURATION

The configuration editor can be used to prepare a Tool configuration. The Configuration editor Manual provides guidelines on how to make configurations for an XEM Job.

The configurations can also be obtained from the Extreme Intranet website or requested through In-Touch. It is recommended to use the standard configurations available on the Extreme Intranet website. The signal power and frequency can be adjusted by Downlinking. The initial levels are set based on experience.

Downlinking can be performed to change the Power. The Current discharged from the gap sub for conventional tools can be increased from 0.3 to 5 Amps. At Higher Current there will be more Battery consumption. The Frequency can be modified however lower frequencies will usually result in better signal strength.

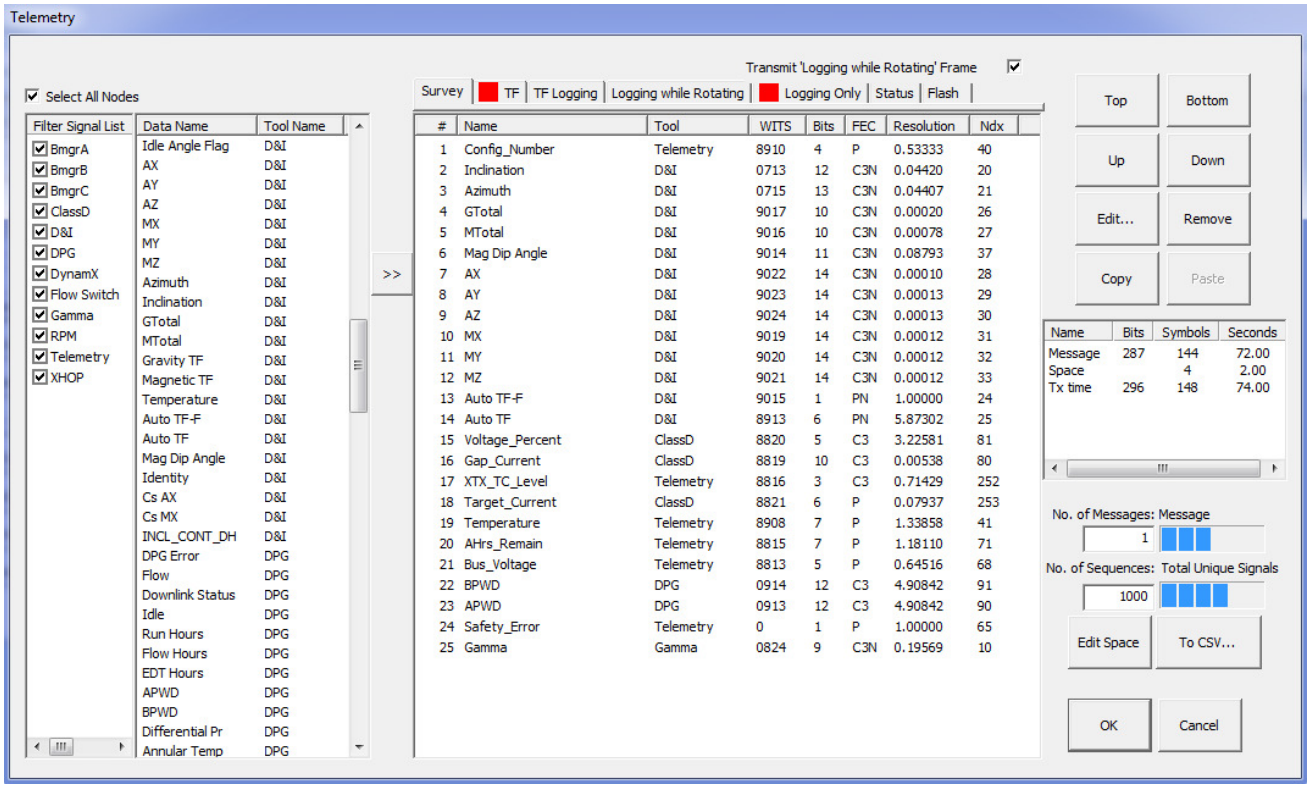


Figure 29 Configuration Editor

Due to the complexity of the options in the configuration editor, there is control of the configuration editor so that people that are not trained to make configurations do not end up making configurations that may not work properly.

Configurations can be requested from the command center using the Configuration request form. A notice period preferably greater than 24 Hours should be provided.

Configuration Request Form	
Tool Type	XEM
IDLE or Non-IDLE	IDLE
DynamX	Yes
Continuous Inc and Azm	Yes
ATF Switch	5-3
APWD	Yes
Gamma	Yes
Mud Type	WBM
Alkaline or Lithium	Lithium
XHop	Yes
High Voltage	Yes
Version	10
All version 10 configs include PWD (XEM only) and Temperature	
Ensure the inclination of the well will not exceed 70 degrees	
Notes:	
Please indicate selection in right hand column and e-mail request to: Command@extremeeng.com	

Figure 30 Configuration request form

The request form should be completed as follows:

Tool type: Select XEM (For jobs where XEM will be used)

IDLE or No IDLE Configuration: Idle configuration can be selected to save battery so that the Tool can be switched on at pre-defined values of Inclination or Temperature. Currently the Inclination threshold is typically set at 70° Inclination; this value may not work for Horizontal wells.

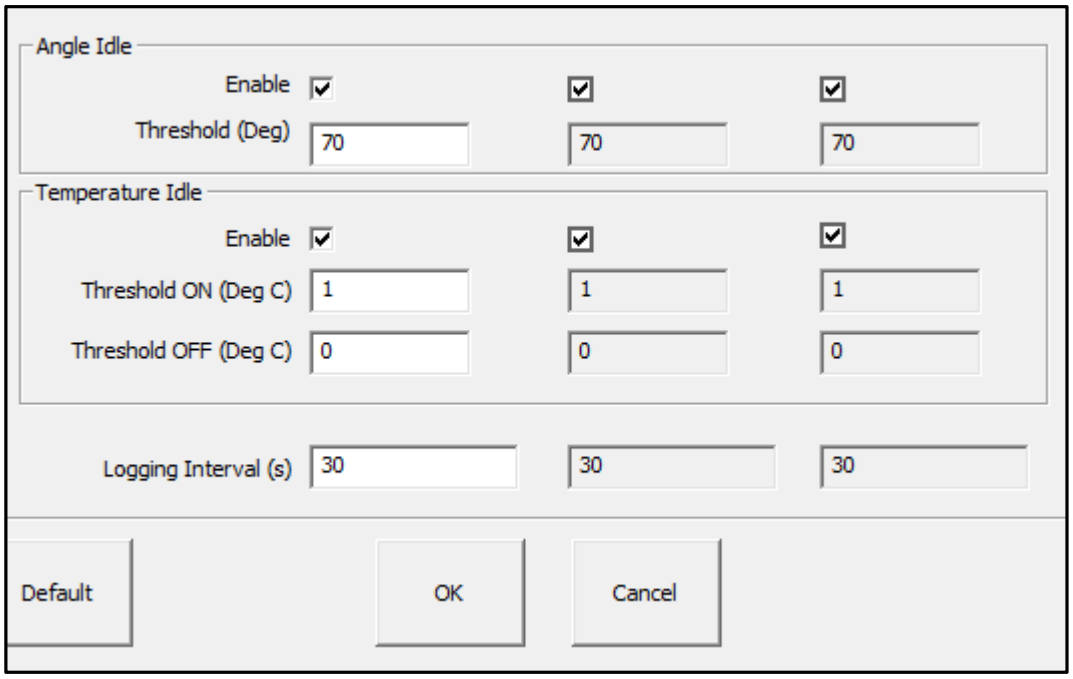


Figure 31 Idle/ Temperature configuration

Continuous Inclination & Azimuth: Select "Yes" if Continuous Inclination or Azimuth is required.

ATF Switch: This provides the thresholds for crossing over from MTF to GTF and back. The Options are 5-3°, 8-5° & 15-10°. For Air drilling where the Gravity measurements are affected by vibration at low Inclinations, the 15-10° configuration may be used.

Select the Option that may be applicable for your case.

APWD: Select "Yes" if Annular Pressure while drilling is required. V-10 configurations include Pressure and temperature.

Gamma: Select "Yes" if gamma is required.

Mud type: Select "Oil based mud" or "Water based mud" depending on the Mud type that will be used for the job.

Alkaline or Lithium: Typically Lithium battery is used in most applications, alkaline batteries may be used to avoid risk of rupturing in high Shock and vibration environment. Select the type of batteries that will be required.

XHop: An XHop can be used instead of a Can terminator if it is required to communicate with an RSS. Select "Yes" if an XHop probe will be used.

Hi Voltage: Select “Yes” if a High Voltage Transmitter probe will be used.

Version: Select the software version that will be used by the surface equipment for the job. (The current software version supported by Engineering is V-10).

In the Notes Section additional information should be provided, this could for Instance include requirements to take Surveys when the flow is reduced but not completely switched off.

5. XEM TOOL CALCULATORS

5.1. TOOL STRING CALCULATOR

The XEM Tool String calculator can be used to calculate the survey and the gamma offset. The sheet is available in metric and imperial units.

Selection of the Probes

1. Select the probes from a drop down menu

Tool 1	DPG	0.7m	8in
Tool 2	Transmitter HV	1.995m	78.565 in
Tool 3	Battery	1.93m	76 in
Tool 4	Directional - DynX	1.42m	56 in
Tool 5	Battery	1.93m	76 in
Tool 6	Gamma	1.37m	54 in
Tool 7	End Stabilizer	0.42m	16.5 in

Table 5 Tool Selection

2. Measure the distances on the Gap sub as shown in Figure 32 below before each run:
   - (A) Distance from the Set screw to the bottom of the Gap sub.
   - (B)Total length of the Gap sub

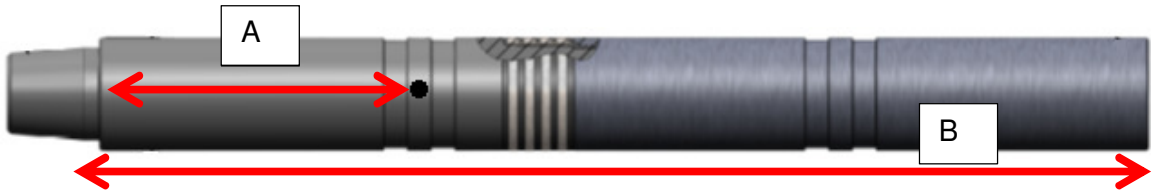


Figure 32 Gap sub with Distances

3. Obtain the Length of the following:
   - Collar 1 Length: Length of the Monel below the Gap sub.
   - Collar 2 Length: Length of additional collar if used.
   - Length of the BHA below collar 2 (listed in the BHA).

4. The Measured distances are input into the Tool string calculator

Measure distance from DPG set screw to gap sub bottom face (pin)	0.3m (0.98ft)
Measure the total length of the gap sub	1.1m (3.6ft)
Measure the XEM collar (Collar 1) length	10 (32.8ft)
Measure the Additional collar in which XEM is run (Collar 2) length	0
Length of the BHA below collars (From BHA)	16.38m (53.75)

Table 6 Distances in tool string calculator

5. The offsets and Distances are automatically calculated by the program.

Distance from bit to Directional Sensor	20.37m (66.8ft)
Distance from bit to gamma Sensor	17.05m (55.39ft)
Distance from top of collar 1 to Directional Sensor	5.52m (18.09 ft)
Distance from top of collar 1 to gamma Sensor	8.84m (28.986)

Table 7 Calculated Distances

The bit to survey and bit to gamma offsets need to be entered in the configuration tab of the XEM Rx.

5.2. XEM GAMMA CALCULATOR

The gamma CPS to API calibration factor is loaded in the Tool at the base. Gamma is corrected for Mud thickness and collar thickness. The correction factor needs to be calculated using the XEM gamma calculator.

Inputs into the calculator include:

- OD”
- ID”
- Mud weight
- bit size
- Collar type

Collar OD (in)	Collar ID (in)	Mud Weight (ppg)	bit Size (in)	Collar Type
6.75	2.875	10.9	6.875	Steel

Table 8 gamma calculator input

The Total correction factor is automatically calculated. The calculator uses functions provided by CBG.

Collar and Barrel Correction	
Collar Wall Thickness	1.938
Density of NMDC	8.800
Density of Steel	7.960
Density of Be-Cu	9.140
Be-Cu Housing OD	1.750
Be-Cu Wall Thickness	0.150
Collar/Barrel Correction Factor	**6.025**
Mud Correction	
Total Mud Annulus Thickness	1.188
Mud correction factor	**1.180**
Gamma Correction Factor	**7.112**

Table 9 gamma calculator Results

The Total correction factor needs to be entered in the software. Currently there are ongoing revisions to the gamma calculator.

5.3. XEM BATTERY PREDICTION

The XEM Battery prediction sheet provides an estimate of the remaining Battery capacity.

Current Status	
Measured Load (A)	1.00
Scale Current	18%
Tool Face	0.70
Surface Gains	10000
Ahrs/hr	0.23
Ahrs/day	5.42

Proposed Configuration						
Target Current (Configuration)	0.30	1.00	2.00	3.00	4.00	5.00
Predicted Measured Load (A)	0.30	1.00	2.00	3.00	4.00	4.44
Scale Current	5%	18%	36%	54%	72%	80%
Tool Face	0.70	0.70	0.70	0.70	0.70	0.70
Predicted Surface Gains	33333	10000	5000	3333	2500	2250
Ahrs/hr	0.11	0.23	0.60	1.23	2.12	2.59
Ahrs/day	2.67	5.42	14.50	29.62	50.78	62.13

Table 10 Battery Prediction

The Inputs include:

1. Measured Load:
   In V10 the value for the (Gap Current) can be used instead of the Measured Load.
2. Scale Current
   In V10 the value for the (voltage %) seen on the display can be used instead of scale current.

3. The Service type specifies the proportion of time the XEM is transmitting. There are 3 x Service types:
   - Survey only – 40% Inclination, azimuth & qualifiers
   - Tool Face – 70% Inclination, azimuth, qualifiers & tool-face (steering)
   - Gamma jobs – 90% Inclination, azimuth, qualifiers, tool face (steering) & gamma

   The Ampere Hours per day are given for the Target settings from 0.3 to 5Amp.

This can be compared to the Total capacity of all the Batteries in the string.

Current Status	
Measured Load (A)	1.00
Scale Current	10%
Tool Face	0.70
Survey / Tool Face / Gamma	10000
[illegible]	0.17
Ahrs/day	4.08

Proposed Configuration						
Target Current (Configuration)	0.30	1.00	2.00	3.00	4.00	5.00
Predicted Measured Load (A)	0.30	1.00	2.00	3.00	4.00	5.00
Scale Current	3%	10%	20%	30%	40%	50%
Tool Face	0.70	0.70	0.70	0.70	0.70	0.70
Predicted Surface Gains	33333	10000	5000	3333	2500	2000
Ahrs/hr	0.11	0.17	0.38	0.73	1.22	1.85
Ahrs/day	2.55	4.08	9.12	17.52	29.28	44.40

Table 11 Battery Prediction with Service Type

6. XEM FIELD SUPPORT SYSTEM

In addition to the regional coordinators the following support systems are available for the XEM tool

1) The Extreme command center +18886930247, ExtremeCommandCenter@extremeeng.com responsible for:
   - 24/7 Monitoring of services
   - Troubleshooting
   - Diagnostics and tool functionality check after the runs
   - Remote survey qualification
   - Remote gamma logging support

2) In Touch help desk for XEM at the XPTC product center responsible for:
   - Reference documentation
   - Answering technical queries and assistance
   - Sharing knowledge through Case histories, best practices and lessons learnt

   The XEM In-Touch help desk is currently manned by Dan Klimuk DKlimuk@extremeeng.com ; Dave Dexter DDexter@extremeeng.com

3) Field training Champion : Dan Bukovec: DBukovec@extremeeng.com responsible for providing:
   - Training field Hands
   - Access to Online training through the E -Compliance system
   - Updating Training reference material

4) International Operations Support Manager Dave Dexter : DDexter@extremeeng.com responsible for support to International locations

5) North America Land Support Manager : Chris Rust: CRust@extremeeng.com responsible support to locations in North America-Land

24/7 COMMAND CENTER

THE COMMAND CENTER IS THE 24/7/365 OPERATIONAL HUB for Extreme Engineering™'s remote rigsite operations worldwide. Dedicated, experienced staff provide continuous support to each Extreme Engineering™ service. The quality of remote service offered by the Command Center is intended to exceed that of a typical msanned operation without the cost or risk of additional rigsite personnel.

COMMAND CENTER FEATURES

1. Proactive, remote troubleshooting
2. 24HR live monitoring of all ongoing Extreme Engineering™ services
3. After hours field operations dispatch
4. Remote gamma logging
5. Remote survey qualification

REMOTE GAMMA-RAY LOGGING

In addition to traditional on-site gamma logging, we are capable of performing the same service remotely. As part of our mobilization we also set up a WITS (wellsite information transfer specification) feed from our surface equipment into the rig's EDR (electronic drilling recorder). Real-time data is then accessible over the internet. At predetermined intervals, or as needed, the Command Center Specialist will download a depth-based file and import the data into our logging software. After quality control is performed, the log is exported and sent to the client. It is a lower cost alternative to traditional on-site gamma logging and also limits our field staff's time on location.

Figure 33 Command center

7. FIELD EQUIPMENT

Field Equipment (used at the well site) along with Part Numbers are listed below. The equipment consists of

- XEM Assets (Probes and subs)
- XEM additional and new probes
- General equipment for the field
- XEM Specific equipment, required for XEM jobs
- XEM Upgrade equipment

7.1. XEM ASSETS

- Assets includes different probes and subs
- Separate Kits are available for the 4.75", 6", 8" & 11" sizes. In each size kits can be ordered with either
    - Lithium Batteries commonly used for most drilling applications
      or
    - Alkaline Batteries used for air drilling where there is high shock and vibration
      or
    - 20 cell alkaline Batteries which have higher capacity compared with standard alkaline batteries
    - Mid probe centralizers are added for air drilling to improve stabilization.
- Gamma Ray or XHop are listed in Section 7.2.

1. 4.75" Assets

04EMKB2001 - X-EM 4.75" Tool string Kit with Lithium Batteries

PART ID	Rev	Description	Qty
04DOBA0001	A	Lithium Battery Kit	2
02X-EM2005	D	EMT4.75 Gap sub	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM2001	D	EMT 4-3/4" DPG Probe with ID Ring	2
22X-EM0005	D	EMT Transmitter Probe with ID ring 1	2

Table 12 4.75" Tool String Kit with Lithium Batteries

04EMKB2002 - X-EM 4.75" Tool string Kit with standard Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM2005	D	EMT4.75 Gap sub	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0002	A	Standard Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Un sized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM2001	D	EMT 4-3/4" DPG Probe with ID Ring	2

Table 13 4.75" Tool string kit with standard alkaline Batteries

04EMKB2003 - X-EM 4.75" Tool string Kit with 20-Cell Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM2005	D	EMT4.75 Gap sub	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0003	A	20-cell Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM2001	D	EMT 4-3/4" DPG Probe with ID Ring	2

Table 14 4.75Tool string kit with 20 cell alkaline Batteries

2. 6.5” Assets

04EMKB3001 - X-EM 6.50" Tool string Kit with Lithium Batteries

PART ID	Rev	Description	Qty
02X-EM3005	D	EMT 6.50 Gap sub	2
04DOBA0001	A	Lithium Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM3001	D	EMT 6-1/2" DPG Probe with ID Ring *	2

Table 15 6.5Tool string kit with Lithium Batteries

* New upgrades are available, see Section 7.2

04EMKB3002 - X-EM 6.50" Tool string Kit with Standard Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM3005	D	EMT 6.50 Gap sub	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0002	A	Standard Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM3001	D	EMT 6-1/2" DPG Probe with ID Ring *	2

Table 16 6.50" Tool string kit with Standard Alkaline Batteries

04EMKB3003 - X-EM 6.50" Tool string Kit with 20-Cell Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM3005	D	EMT 6.50 Gap sub	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0003	A	20-cell Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM3001	D	EMT 6-1/2" DPG Probe with ID Ring *	2

Table 17 6.50" Tool string Kit with 20 Cell Alkaline Batteries

3. 8” Assets

04EMKB5001 - X-EM 8.00" Tool string Kit with Lithium Batteries

PART ID	Rev	Description	Qty
02X-EM5001	A	8.00" Gap sub Assembly	2
04DOBA0001	A	Lithium Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM5001	D	EMT 8" DPG Probe with ID Ring *	2

Table 18 8" Tool string Kit with Lithium Batteries

* New upgrades are available, see Section 7.2

04EMKB5002 - X-EM 8.00" Tool string Kit with Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM5001	A	8.00" Gap sub Assembly	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0002	A	Standard Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM5001	D	EMT 8" DPG Probe with ID Ring *	2

Table 19 8" Tool string Kit with alkaline Batteries

04EMKB5003 - X-EM 8.00" Tool string Kit with 20-Cell Alkaline

PART ID	Rev	Description	Qty
02X-EM5001	A	8.00" Gap sub Assembly	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0003	A	20-cell Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM5001	D	EMT 8" DPG Probe with ID Ring *	2

Table 20 8" Tool string Kit with 20 cell alkaline Batteries

4. 11" Assets

04EMKB7001 - X-EM 11.00" Tool string Kit with Lithium Batteries

PART ID	Rev	Description	Qty
02X-EM7001	A	11.00" Gap sub Assembly	2
04DOBA0001	A	Lithium Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring*	2
22X-EM7001	A	EMT 11.00" DPG Probe	2

Table 21 11" Tool string Kit with Lithium Batteries

* New upgrades are available See Section 7.2

04EMKB7002 - X-EM 11.00" Tool string Kit with Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM7001	A	11.00" Gap sub Assembly	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0002	A	Standard Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM7001	A	EMT 11.00" DPG Probe	1

Table 22 11" Tool string Kit with alkaline Batteries

04EMKB7003 - X-EM 11.00" Tool string Kit with 20-Cell Alkaline Batteries

PART ID	Rev	Description	Qty
02X-EM7001	A	11.00" Gap sub Assembly	2
03ROTC0167	A	Mid Probe Centralizer	10
04DOBA0003	A	20-cell Alkaline Battery Kit	2
22DYNX0002	B	DynamX D&I Probe 150C	2
22ROTC0001	B	End Stabilizer Assembly w/ CAN terminator-Unsized	2
22X-EM0005	D	EMT Transmitter Probe with ID ring *	2
22X-EM7001	A	EMT 11.00" DPG Probe	2

Table 23 11" Tool string Kit with 20 cell alkaline Batteries

* New probes are available See Section 7.2

7.2. OPTIONAL/ NEW PROBES & KITS

PART ID	Rev	Description	Qty
22XGAM0001	C	gamma probe with ID Ring[1]	2
04XHOP0002	A	XHop Field Integration kit[2]	2
22HVTX0001	A	High Voltage Transmitter probe[3]	2
22DPGS3001	A	6.5" DPGS Probe[4]	2
22DPGS5001	A	8" DPGS Probe[4]	2

Table 24 Additional New probes and accessories

1. Only the additional gamma probe 22XGAM001 is required only when gamma service are provided.
2. The 04XHop0002 XHop field Integration kit is required when XHop services are provided. This currently contains

PART ID	Rev	Description	Qty
02ROTC0028	00A	Male Hand Held ROTC 1750	2
22CABL0016	00A	2m V69 5TP Female HH ROTC Cable	2
22XHOP0001	B	XHOP Probe, unsized	2
22XHOP0005	E	XHOP System Tester Box Rev E	2
22XHOP0008	A	XHOP Short Extension Module	4
22XHOP0009	B	XHOP Long Extension Module	2

Table 25 XHop Field Integration kit content

3. The 22HVTX0001 is an upgrade of the 22X-EM0005 XTX probe. The 22X-EM0005 can be upgraded with a 04HVTX0001 retrofit kit which contains:

PART ID	Rev	Description	Qty
03HVTX0001	A	HV TX Pressure Housing	1
03ROTC0178	A	ID ring HVTX	1
19BOLT0114	00A	#8-32 x 5/16" Flat Head Phillips Mach. Screw, A286	4
22HVTX0002	A	HV Transmitter Bay2	1
22HVTX0003	A	HV Transmitter Bay3	1
03JIGS0411	A	Battery Manager centralizer	1

Table 26 04HVTX0001 retrofit kit

4. The 22DPGS3001 is an upgrade of the 22X-EM3001 DPG probe, the 22DPGS5001 is an upgrade of the 22X-EM5001 DPG probe. At the time of writing the Manual the Kits for the HVTX are being finalized.

7.3. GENERAL EQUIPMENT

There are 4 specific Kits in the General equipment; these are required to run an MWD Job.

04GNKB0001 - General Kit Box

PART ID	Rev	Description	Qty
04GNKB0010	A	General Kit Box - Loose Equipment	1
04GNKB0020	A	General Kit Box - General Tote #1	1
04GNKB0030	A	General Kit Box - General Tool Box	1
04GNKB0002	A	General Kit Box Liquids & Aerosols	1

Table 27 General Kit Box

04GNKB0010 - General Kit Box Loose Equipment

PART ID	Rev	Description	Qty
20BOXA0006	A	MWD Aluminum Transport Box 96"x36"x36"	1
91HAND0084	A	Jack Stand Set (2), 3-Ton Heavy Duty	2
91HAND0024	00A	1 3/4" Friction Tong	2
91HAND0042	00B	Castle Tool Handle	1
02X-EM0006	00A	ISOLATION TRANSFORMER BOX ASSEMBLY	1
04BATT0001	C	Battery Recovery Kit	1
04FSTS0008	A	Extended Connectivity Kit	1
04AZNX0001	A	Azonix Terminal Kit	2

Table 28 General Kit Box Loose equipment

04GNKB0020 - General Kit Box Tote #1

PART ID	Rev	Description	Qty
20BOXR0001	A	19 Gallon Gray Tote	1
22KEYB0001	B	USB Keyboard	2
12EXTN0003	A	25FT Extension Cord	2
91MISC0001	A	AC Power Strip (North American Standard)	2
92WITS0002	00A	Pason WITS 422 Interface Box	2
92WITS0001	00A	25ft 422 Communications Cable	2
02JIGS0295	A	Pick-Up Sling Assembly (with Bumpers)	1
02PULS0033	00A	MPT Pulser Vibration Motor Assembly	1
02ROTC0028	00A	Male Hand Held ROTC 1750	1
02ROTC0038	A	Female Hand Held ROTC 1-3/4"	2
22CABL0016	00A	2m V69 5TP Female HH ROTC Cable	2
22CABL0030	01A	15m HH ROTC Extension Cable, V69, 5TP, 22AWG, (Amp	2
22CABL0037	01A	X-EM 2m AC Power Cable	2
22CABL0104	A	10ft USB to CIR8P (cable mount PT06A-12-8P) Cable	1
22JIGS0020	E	Battery Probe Tester RevE	1

Table 29 General Kit Box Tote#1

04GNKB0030 - General Kit Box Toolbox

PART ID	Rev	Description	Qty
20TOOL0002	00A	Cantilever Tool Box 18" x 10" x 13"	1
91HAND0008	00A	Utility Knife with Spare Blades	1
91HAND0040	00A	13 pc. Hex Key Set .050" to 3/8"	1
91MEAS0007	00A	6" Electronic Digital Caliper	1
11BATT0015	A	1.5V silver oxide Battery	1
90TAPE0003	01A	Electrical Tape, Black	1
91HAND0027	00A	Lifting Sling, 2" wide, 3' long	2
91HAND0067	00A	Multi-bit Screwdriver	1
91HAND0081	A	Steel Wire Brush	1
15SEAL0002	A	Thread Sealant Tape, PTFE, 1/2" x 250"	1
30TIES0002	A	Cable Tie, 11.8"	100
90TAPE0007	A	Duct Tape, Lt Duty, Silver, 48mm x 55m	1
91MISC0002	A	3M Scouring Pad (Scotch Brite Pad)	5
91HAND0113	A	Mag-lite Flashlight, LED, 2 AA Batteries	1
91HAND0054	00A	Brass O-Ring Pick Set	1
91HAND0107	A	Diameter Tape Measure	1
39HUBS0004	00A	USB 2.0 4 port Hub w/power	2
91HAND0114	A	Medium Grit Emery Cloth	2
41LABL0008	A	Custom Yellow Tags	50
41LABL0009	A	Custom Red Tags	50
02PULS0059	00A	MPT Spider Toolface Tester	2
91HAND0074	00A	8" Combination Slip Joint Pliers	1
91HAND0115	A	1-3/8" Socket, 1/2" Square Drive, 6-Point Std	1

Table 30 General Kit Box tool Box

04GNKB0002 - General Kit Box Liquids & Aerosols

PART ID	Rev	Description	Qty
17LOCT0003	00A	Loctite 243, 50ml, Blue, Removable, Medium S	2
17LOCT0005	00A	Loctite 603, 50ml	2
15LUBE0003	00A	Dow Corning 111 Valve Lube and Sealant (Grease)	2
15LUBE0004	00A	Dow Corning #44 Silicone Bearing Grease	2
15CLNR0003	00A	Electrosolv Contact Cleaner	1

Table 31 General Kit Box Liquids and Aerosols

7.4. XEM SPECIFIC EQUIPMENT

This includes specific equipment required for an XEM Job.

04EMKB0001 - X-EM Kit Box Add-On

PART ID	Rev	Description	Qty
04EMKB0010	A	X-EM Kit Box Add-On - Loose Equipment	1
04EMKB0020	A	X-EM Kit Box Add-On - Tote #2	1
04EMKB0030	A	X-EM Kit Box Add-On - Tool Box Add-On	1
04EMKB0040	A	X-EM Kit Box Add-On - X-EM Consumables	1

Table 32 X-EM Kit Box Add On

04EMKB0010 - X-EM Kit Box Loose Equipment Add-On

PART ID	Rev	Description	Qty
02JIGS0008	B	EM Surface Ground Antenna with Driver	2
22CABL0133	A	X-EM 100m Low Noise ANT Extension Cable with spool	2
22X-EM0001	D	EMT Surface Receiver, 110V	2
91HAND0103	A	2" Friction Tong	2

Table 33 XEM Kit Box Loose Add On

04EMKB0020 - X-EM Kit Box Tote #2

PART ID	Rev	Description	Qty
20BOXR0001	A	19 Gallon Gray Tote	1
22X-EM0021	B	EMT System Test Box	2
22CABL0063	01A	XEM 2m ANT&BOP system tester cable	4
22CABL0071	A	Clamp cable assembly	4
22CABL0055	01A	X-EM 15m Low Noise ANT BOP Clamp Cable	2
22CABL0058	01A	X-EM 25m Low Noise Coaxial ANT Clamp Cable	2
22CABL0056	01A	X-EM 25m Low Noise ANT Extension Cable	4
22X-EM0014	B	EMT Gap sub Tester	1
11BATT0003	00A	Alkaline Battery 9V, 570mAh	1
03JIGS0228	B	4.75" Castle Ring Tool	1
03X-EM2017	C	EMT 4.75 Castle Ring, BeCu	2
03JIGS1228	B	6.5" Castle Ring Tool	1
03X-EM3017	C	EMT 6.50 Castle Ring, BeCu	2
03JIGS5228	B	8.00" Castle Ring Tool	1
03X-EM5007	B	03X-EM5007 8.00" Castle Ring	2
02JIGS5000	A	8.00" O-Ring Insertion Tool	1
02JIGS5001	A	8.00" O-Ring Pick Tool	1
22JIGS0037	A	Alignment Overshot w/ X-EM Rotation Head Assembly	1

Table 34 XEM Kit Box Tote #2

04EMKB0030 - X-EM Kit Box Tool Box Add-On

PART ID	Rev	Description	Qty
91HAND0063	00A	Torque Wrench, 3/8 Drive, 20-100 ft.lbs	1
91HAND0072	00A	3/8" Socket, 5/16" Hex bit	1
91HAND0080	A	Wire Tube Brush	1
92TEST0010	A	AMPROBE Digital Multimeter, AC Voltage Detector	1
11BATT0016	A	3V CR2032 Coin Cell Battery	1
91HAND0036	00A	Snap Ring Plier, 0.038" Tip Dia	1
02X-EM0025	B	XEM Knob Assembly	2
03X-EM0046	B	Bore Pressure Test Jig	2
02X-EM0031	A	Bore Pressure Test Fitting Assembly	2
02X-EM0030	A	Annulus Pressure Test Fitting Assembly	2
22X-EM0022	00A	DPG Shock Pump with Male Quick Connect	2
03X-EM2038	00B	4.75 SEALED GROUNDING PLUG BECU	2
03X-EM2036	00B	4.75 Ported Grounding Port	2
02X-EM2030	00A	4.75 GAP SUB PRESSURE TEST FIXTURE	2
03X-EM3028	00B	6.50 SEALED GROUNDING PLUG BECU	2
03X-EM3026	00B	6.50 Ported Grounding Set Screw	2
02X-EM3030	00A	6.50 GAP SUB PRESSURE TEST FIXTURE	2
03X-EM5012	A	03X-EM5012 8.00" Grounding Plug	2
03X-EM5017	A	03X-EM5017 8.00" Grounding Port	2
02X-EM5030	A	8.00 Gap sub Pressure Test Fixure	2

Table 35 XEM Kit Box Tool Box Add -On

04EMKB0040 - X-EM Kit Box Consumables

PART ID	Rev	Description	Qty
19BOLT0152	00A	#6-32 x 1" long socket head cap screw, alloy steel	3
19SNAP0022	00A	Internal Snapring, 5/8" bore, Stainless Steel	10
09ORNG0004	70LTN	Size 004 O-Ring Low Temp Nitrile	10
09ORNG0012	75V	Size 012 O-Rng, VITON 75D	10
09ORNG0229	70LTN	Size 229 O-Ring Low Temperature Nitrile	20
09ORNG0234	70LTN	Size 234 O-Ring	20
09ORNG0347	70V	Size 347 O-Ring, 75D, Viton	20
03X-EM2024	00A4	X-EM PEEK 4.75" Grounding Spider Back-Up Rings	16
03X-EM3022	00A4	X-EM PEEK 6.5" Grounding Spider Back-Up Rings	16
03X-EM0048	00B	Bore Pressure Port Protector, ID: 0.208 - 0.211	10

Table 36 XEM Kit Box Consumables

7.5. XEM UPSIZE EQUIPMENT

This consists of Upsize kits which can be used to adapt the DPG and Centralizers to the required size.

04EMKB2009 - X-EM 4.75" Sizing Kit

PART ID	Rev	Description	Qty
02ROTC0012	B	Six Fin Centralizer Assembly - Un-cut Fins	15
04X-EM2001	B	EMT 4-3/4" DPG Probe Sizing Kit	2

Table 37 XEM 4.75" Sizing Kits

04EMKB3009 - X-EM 6.50" Sizing Kit

PART ID	Rev	Description	Qty
02ROTC0012	B	Six Fin Centralizer Assembly - Un-cut Fins	15
04X-EM3001	B	EMT 6-1/2" DPG Probe Sizing Kit	2

Table 38 XEM 6.5" Sizing Kits

04EMKB5009 - X-EM 8.00" Sizing Kit

PART ID	Rev	Description	Qty
02ROTC0012	B	Six Fin Centralizer Assembly - Un-cut Fins	15
04X-EM5001	B	8.00" EMT DPG Probe Sizing Kit	2

Table 39 XEM 8" Sizing Kits

04EMKB7009 - X-EM 11.00" Sizing Kit

PART ID	Rev	Description	Qty
02ROTC0012	B	Six Fin Centralizer Assembly - Un-cut Fins	15
04X-EM7001	A	11.00" EMT DPG Probe Sizing Kit	2

Table 40 XEM 11" Sizing Kits

04EMKB7007 - X-EM 11.00" Add-On Kit

PART ID	Rev	Description	Qty
02X-EM7030	A	11.00 Gap sub Pressure Test Fixture	2
03JIGS7228	A	11.00" Castle Tool	1
03X-EM7007	A	11.00" Castle Ring	2
03X-EM7012	A	11.00" Grounding Plug	2
09ORNG0355	V75	Size 355 O-Ring, VITON 75D	20
91HAND0111	A	Castle Tool Handle (for 11" Tool)	1

Table 41 XEM 11" Add on Kit

8. REFERENCES

1. EM Signal Diagram and EM Model : Dave Smith
2. Extreme Work process: Sean Ruddy
3. JSO Form: Sean Ruddy
4. Tool Collar order: Sean Ruddy
5. BHA proposal : Chris Rust
6. Well Plan: Chris Rust
7. Drill string interference: Chris Rust
8. Polaris RDS SOP: Corey McFarlin
9. 07-PROC-0015 Gap sub Insulation Test: Michael Campbell
10. High Voltage Signal Primer : Dave Smith
11. Tool Configuration Editor Manual: Ryan Kirby
12. XEM Tool string calculator: Ryan Kirby/ Sean Ruddy
13. XEM Battery Prediction sheet: Ryan Kirby/ Simone Anderson
14. Field Equipment : Dan Klimuk
15. Training reference Material : Dan Bukovec

9. REVIEWS

1. Dave Dexter
2. Chris Rust