Drilling Services - Operations Outside ofSpecifications

The intent of the *Out of Operational Specifications Policy and Procedures Manua*l is to establishguidelines for Operations personnel to use in implementing and supporting the practice ofdetermining whether Baker Hughes tools and equipment have been subjected to environmentsor operational conditions which are beyond stated specifications and to provide Baker Hughesfield engineers with guidelines to prevent or minimize Out of Specifications (OOS) conditions.Tools run in an OOS condition can result in diminished life expectancy of the tools or possiblysignificant damages with associated costs. Assignments of resulting cost to the parties whoknowingly or neglectfully operate Baker Hughes tools and equipment out of specifications is anintegral part of the policy.

This confidential document is intended for internal Baker Hughes use. Only the *Reclaim ProcessChecklist* (GOP-20-10-0000-00-01), the *Customer Notification Document* of the *Out ofSpecification Run Report* (GOP-20-10-0000-00-02), and the *Drilling Services – SupplementalTechnical Specifications* (TDS-20-60-0000-00) may be used for customer communication.Otherwise, external distribution of the document is in all cases a violation of Company policy.Should distribution be required (or part thereof) please consult Product Line Management andLegal.

Statement of Policy:

Any use of Baker Hughes Drilling Services equipment which subjects it to conditions which exceedthe stated environmental specifications or exceed what are considered normal operatingconditions, resulting in damage to or reduction in life expectancy of any Baker Hughes DrillingServices asset is considered an Out of Specification Operation (OOS). Financial responsibility forsuch OOS damages or loss resides with the customer and will be assessed and charged inaccordance with the Baker Hughes Drilling Services Price Book.

Consistent operation of the equipment at the high end of the specification limits individually orcollectively (temperature, bending moment and dogleg severity – per Technical Data Summary)will lead to reduced lifetime expectations of the equipment. In addition, while specifically LateralVibration has been identified as the most destructive type of vibration and has defined time-limits for determining Out-Of-Specification operation, instantaneous lateral shock of suchsignificant magnitude may also constitute Out-Of-Specification operation

Scope

In the application of this policy and these procedures, several general points should be observed:

The specifications and limitations of equipment must be clearly presented to the customer for alltools and equipment when used, discretely or integral to Baker Hughes BHA designs. Technicalspecifications stored internally in the BHOS document center, or made available to customersare the primary reference for these specifications. The Baker Hughes Drilling Services Price Bookdefines rates and surcharges as well as the limits of damages.

The most limiting of specifications of the components in a BHA is the predominant specificationfor the entire BHA.

The Baker Hughes Drilling Services Price Book has been developed in conjunction with the OOSpolicy and will serve along with published technical specifications as supporting documentationvisible to our customers. Contracts and Terms and Conditions agreements should referencethese documents.

It is recognized that organizational structures vary across global Baker Hughes operations.Specific procedures with job titles and lines of reporting will not be applicable to all. Therefore, ageneric framework of roles and requirements for the implementation of the Out of OperationalSpecification (OOS) policy will be provided here. Associated forms and documentation will beprovided (see Appendices) to help establish consistency in our practices, as well as in ourpresentation to customers.

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Responsibility and Authority

Baker Hughes personnel are obliged to operate any equipment which is the property of BakerHughes Drilling Services within its specifications. While adhering to these specifications, BakerHughes Drilling Services personnel will provide recommendations to the customer that willoptimize the performance and reliability of the equipment. When any Baker Hughes DrillingServices equipment is operated outside specifications, Baker Hughes Drilling Services personnelwill follow the procedure detailed below and notify the customer in writing using the report form*Out of Specification Run Report* (GOP-20-10-0000-00-02). Specific requirements of Baker HughesDrilling Services personnel are outlined below:

**Field Service Engineer:** In the event of exceeding operational specifications, immediateattempts should be made to alleviate the condition according to the relevant Baker HughesDrilling Services guidelines and procedures. The customer's field representative will be advised ofthe situation and any corrective actions made. If such attempts prove unsuccessful and the outof specification drilling continues, causing the drilling to exceed any relevant time constraints orother specification limits, the customer representative will be asked to sign the CustomerNotification Document of the Out of Specification Run Report form. This document acknowledgesthat any damage occurring to Baker Hughes equipment may result in a claim for the repair ofthis damage. If the customer representative refuses to sign the form, this will be documented assuch. The Baker Hughes Drilling Services field personnel will then inform their Baker HughesDrilling Services Operations Coordinator and forward the Out of Specification Run Report file and(a copy of) the Customer Notification Document. Under certain special circumstances, thecustomer may not be notified of an OOS condition. In these circumstances, the Baker HughesDrilling Services field personnel should indicate so, and the reasons for not notifying the customershould be clearly captured.

**Operations Coordinator:** The Operations Coordinator, upon receipt of both documents, willinform the customer of the occurrence and provide a copy of the Customer NotificationDocument to the customer or the account representative for that customer. The OperationsCoordinator will also inform the customer that, if drilling operations continue, a claim may resultfor any damage. The Operations Coordinator will also validate data from the field and inform theRepair and Maintenance facility that a tool has been operated OOS and that potential damagemay exist. It is also his/her responsibility to upload the Out of Specification Run Report file into theMaPS reporting system so that the OOS incident is noted (magenta color for the job involved).Detailed information on any damage seen is to be documented as outlined on the *ReclaimProcess Checklist* (GOP-20-10-0000-00-01).

**Customer Claim Administrator:** In the procedures detailed here, the customer claim

administrator functions in several ways by:

• Insuring communications between Baker Hughes departments and personnel.• Serving as keeper of the required documentation and hardware in support of claims.• Assembling the formalized claim package.

**Manager:** If a dispute arises over a claim for damages, a Baker Hughes operations manager will

negotiate with the customer in accordance with the customer reclaim procedure.

**Others:** In some locations, additional or alternate groups are involved in the roles genericallydescribed here. For example, Technical Support, Applications Engineering, Reliability, Sales, MaPSreporting etc., might be involved in various ways. Each location must define the roles andresponsibilities according to their organization.

Reporting of OOS Operations

The reporting of OOS operation within Baker Hughes depends on the effect the operation has onBaker Hughes Drilling Services equipment and the ability to deliver contracted service to thecustomer.

OOS Operation without Tool for Service Failures

Any occurrence of OOS, regardless if Baker Hughes Drilling Services equipment failed or not,needs to be reported by the Field Service Engineer (FSE) through the OOS Run Report to theOperations Coordinator and uploaded into the MaPS Job Center. This reporting will ensure thatthe AMO facility can initiate the appropriate service level prior to return of the equipment, newequipment can be prepared, and abnormal wear and tear can be claimed. Additionally, this formof reporting will ensure that all OOS occurrences without tool failures are tracked, allowing toinitiate OOS mitigating actions beyond those possible on the rig, (BHA design, changes to drillingprograms, changes to third party equipment, addressing OOS risks and their effects during thewell design phase and pre-spud meetings, etc.).

OOS Operation with Tool for Service Failures

In case of a tool or service failure it is additionally required to report a tool failure (TF) incidentusing the FRACAS module of MaPS. This report ensures that a follow-up is created for theindividual incident using the same process that is applied to PSDI failures.

Figure 1: MaPS/ FRACAS reporting for OOS operation

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | ***Good Run*** | | | | | | | | | | |  | **Operations**  **Coordinator** | |
|  | | | Start  (Performing Run) | | | | | | | | | |  | Enter Run Data in  MaPS Job Center | | |  | End |
|  | | ***OOS Run*** | |  | | **Field Service**  **Engineer** | | | | | |  | **Operations**  **Coordinator** | |
|  | | | Start  (Performing Run) | |  | | File OOS Report  and Send to  Operations  Coordinator |  | | Enter Run  and upload OOS Data  into MaPS Job Center | | | | | | |  | End |
|  | ***OOS Run***  ***with Failure*** | | |  | | **Field Service**  **Engineer** | | | | | | |  | **Operations**  **Coordinator** | |
|  | | | Start  (Performing Run) | |  | | File OOS and  Incident Report  and Send to Ops  Coordinator | |  | | Enter Run and Upload  OOS Data into MaPS  Job Center. Upload  FRACAS Incident | | | | | |  | End |

Out of Specification Run Report Form

The OOS Run Report is a temporary document designated for theperiod of a job (customer notification, internal reporting, claim fordamages, MaPS updates). By no means must an OOS Run Report file remain the ultimate source for OOS incident related data.

**Note**

Each OOS Run Report must be uploaded into the MaPS Job Center. Any data not uploaded into the MaPS Job Center is notaccessible to the organization (Baker Hughes) or will be lost overtime and thus compromises improvements. This also applies toincorrectly uploaded data.

The *Out of Specification Run Report* (GOP-20-10-0000-00-02, short: OOS Run Report) is an Excelfile which by default contains two worksheets, the Setup sheet and one empty OOS IncidentReport sheet (OOS Incident (1)). The OOS Run Report is run related. This means, only one OOS RunReport per run must be used for reporting all OOS Incidents which occurred during a run.However, the OOS Run Report can contain multiple OOS Incident Reports, one per OOS Incident.

**Note** The Excel file must have Macros enabled to run the OOS Run

Report.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Note** |  | Do not delete the Setup or the OOS Incident (1) worksheet. This  would corrupt the report structure and can make the file invalid  for being uploaded into the MaPS Job Center. OOS Incident sheets  numbered 2 or higher may be deleted, if necessary. |

The Setup sheet provides general instructions for use, the option to change unit settings, andallows the creation of additional OOS Incident Reports. A new OOS Incident Report can be createdby simply clicking the button Add new OOS Incident Report in the right upper corner of the Setupsheet. A newly created OOS Incident Report sheet is inserted after the last existing worksheet,named and numbered analogously, and automatically populated with run reference data fromthe OOS Incident (1) sheet.

Use always the button on the Setup sheet to create a new OOS

Incident Report. To just copy an existing OOS Incident Report

**Note**

sheet and manually paste it into the Excel file may corrupt the report structure and can make the file invalid for being uploadedinto the MaPS Job Center.

Do not change or overwrite already completed OOS IncidentReports from previously reported OOS incidents to report a newOOS incident. Always create and complete a new OOS IncidentReport to report a newly occurred OOS incident (for the very first OOS incident that occurs this is not necessary because the first

**Note**

OOS Incident Report exists already by default). At the end of therun the number of OOS Incident Reports (worksheets) in the OOSRun Report (Excel file) and the number of reported OOS incidentsmust be the same to enable a correct upload into the MaPS JobCenter.

The OOS Run Report form features two tasks: Baker Hughes internal reporting and customernotification of OOS incidents. An electronic copy of the OOS Run Report (the entire Excel file)should be used for Baker Hughes internal reporting to facilitate OOS data entry into MaPS. Anelectronic copy can easily be uploaded into the MaPS Job Center. Furthermore, some data areonly contained in the Excel file, not in MaPS data fields. When an individual OOS Incident Report ofthe OOS Run Report is printed out, the official Customer Notification Document is received, whichcontains only data and information intended to be disclosed to a customer.

OOS Run Report features:

• Facilitates automatic OOS data upload into MaPS Job Center.• Provides comprehensive list of operational specifications.

• Offers simple, multiple-choice selection of operational specifications with violated OOS

criterion.

• Exhibits consistent layout with FRACAS Offline Incident Report.• Enables tracking of customer's acknowledgement of OOS notification.• Supports organized and easy OOS Incident Report filing.• Offers optimized data entry.

• Applies to OOS incident reporting throughout the entire course of a job (from pre-run

inspections to post-run data analysis).

The OOS Incident Report form (OOS Incident worksheet) consists of two parts. The first partcovers general OOS reporting and is divided into three sections:

Reference Data: In this section run reference data is captured. Location, SAP Sales Order/MaPSJob No., MaPS Run No. and OOS Incident Date are essential to be able to upload OOS data intothe MaPS Job Center. The rest of the fields are primarily meant for customer information, toprovide the customer with all run related reference data. Filling in these fields is especiallyimportant when the OOS Incident Report is printed out and used as Customer NotificationDocument. A complete set of reference data will allow the customer to easily keep track in hispaperwork of reported OOS incidents. Run reference data, besides the OOS Incident Date, need tobe entered only on top of the first OOS Incident Report (worksheet: OOS Incident (1)). Subsequentreference data fields will get populated accordingly. The OOS Incident Date is the only value thathas to be filled in manually in the reference data section on every single OOS Incident Report. TheOOS Incident Date is the time when a tool or equipment OOS criterion was actually exceeded.

Data in the Reference Data section, except the OOS Incident Date,

can only be entered or changed on top of the first OOS Incident **Note**

Report (worksheet: OOS Incident (1)) but gets automaticallyduplicated to subsequent OOS Incident Reports.

**Incident Reporter:** The incident reporter should be the person who first noticed the OOS incident,triggered remedial actions, or was the most involved in mitigation efforts of conditions leading tothe reported OOS incident. During a later analysis of the OOS incident the incident reporter maybe asked to provide additional information about the incident. Either the Baker Hughes 4-3-1 orthe full name of the incident reporter has to be entered in this section.

**Out Of Specification Incident:** At the top of the Out Of Specification Incident section the OOSreason has to be selected. This is simply done by ticking the box in front of the appropriate OOSreason. It is possible to select multiple OOS reasons on a single OOS Incident Report. Operationalspecifications and their related OOS criteria can be found in Section 2.

Only if the OOS criterion of an operational specification got

**Note**

exceeded an OOS Incident Report must be completed and the

appropriate OOS reason ticked.

Into the Remarks field additional information about the OOS incident should be entered, e.g.measured downhole temperature if the OOS criterion for temperature got exceeded. Also anyobservation regarding a possible root cause should be mentioned here. For example, thedrillstring was plugged after the rig crew had switched to another mud tank (OOS reason: debris(non LCM)). Keep in mind that remarks should help in analyzing an OOS incident and to eliminatethe root cause in the future but also provide the customer with enough information tounderstand the issue.

If other is selected as OOS reason a detailed description of the**Note** OOS incident has to be entered into the Remarks field to enable an investigation of the OOS incident.

Under Recommended Action(s) all applicable actions for this case should be listed that havealready been undertaken or will/should be undertaken to stop the OOS condition. Allrecommended actions should be in accordance with Section 3. Remarks concerning the successof undertaken remedial action should be documented here as well.

**Sign-off Box:** At the very bottom of the first part of the OOS Incident Report is a sign-off box.When the OOS Incident Report is printed and used for customer notification, this box is thedesignated signature area for the Field Service Engineers and the customer's field representative.If the OOS Incident Report is not used for written customer notification (e.g. the OOS IncidentReport is used to report an OOS incident that was noticed after the run) the sign-off box is notneeded to be completed.

The second part of the OOS Incident Report is not a part of the Customer Notification Document(printout of the OOS Incident Report). This part is for Baker Hughes internal reporting only and isdiscussed in more detail below.

Generic OOS Reporting Flow

The following flowchart is a general example of how the OOS reporting process in the field maylook like.

It is the duty of the Field Service Engineer to collect evidence concerning an OOS incident, beyond Baker Hughes logs and reports, e.g. photos documenting the OOS condition (e.g. wrongly placed tongs to make up or break out Baker Hughes thread**Note** connections), parts of junk or foreign objects found in hole, mud samples, third party logs and reports etc. The knowledge gained by analyzing available evidence can help adapting procedures, eliminating the root cause or formulating a claim for damaged equipment.

|  |  |
| --- | --- |
| Drilling Services - Operations Outside of Specifications  Figure 3 |  |

OOS operation.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Yes |  | Does BHI have a  general costumer approval to  immediately react to OOS conditions  (e.g. to change drilling parameters, mud  properties etc.) without prior  costumer notification? |

No

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Implement remedial  action(s) according to  BHI policies and  Procedures. |  | Before the job,  has it been agreed upon to  never notify the costumer about  OOS operations (e.g. due to  contractual terms)? |  | Yes |  | Has an OOS criterion been  exceeded? |  | No |  | Take remedial actions  within allowed limits  and continue  monitoring situation. |

No

Yes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Has an OOS criterion been  exceeded? |  | Notify customer’s field  representative of the  OOS operation  immediately (verbally,  phone, IM etc.). |  | Take remedial actions  within allowed limits. |

Yes

No

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Continue monitoring  the situation. | | | | | | | | |  | Advise on OOS  related risks and  possible remedial  action(s) according to  BHI policies and  procedures. |
|  | | | Implement remedial  action(s) according to  BHI policies and  Procedures. |  | Yes | | |  | Did customer’s field  representative (verbally)  approve recommended  remedial action(s)? | | | |  | No | | |  | Take remedial actions  within allowed limits. |
|  | | Has an OOS criterion been  exceeded? | | | |  | No No | | | | | | | |  | Has an OOS criterion been  exceeded? | | | |

Continue monitoring

Yes Yes

the situation.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | Complete first part of  the OOS Incident  Report. | | | | | | | |  | Complete first part of  the OOS Incident  Report. |
|  | | | | | Submit two Customer  Notification Document  copies to customer’s  field representative. | | | | | | | |  | Submit two Customer  Notification Document  copies to customer’s  field representative. | | | | | | | | |  | | Complete first part of  the OOS Incident  Report. |
|  | | Yes |  | Did customer’s field  representative sign the Customer  Notification Document? | | |  | No No | | |  | Did customer’s field  representative sign the Customer  Notification Document? | | | | | | |  | Yes | |  | | Explain in the  “*Remarks*” section  why the customer did  not get notified. | |
|  | Select „*Signed off by*  *customer* ***AND***  *remedial action(s)*  *undertaken*“ in the  second part of the  OOS Incident Report. | | | | | | | |  | Select „*Not signed off*  *by customer*“ in the  second part of the  OOS Incident Report. | | | | | | |  | Select „*Signed off by*  *customer* ***BUT NO***  *remedial action(s)*  *undertaken*“ in the  second part of the  OOS Incident Report. | | |  | | Select „*Customer not*  *notified*“ in the second  part of the OOS  Incident Report. | | | |

File OOS Incident Report and submit a copy of the entireOOS Run Report file to the Operations Coordinator.

In general, the occurrence of any OOS condition during a run must be brought to the attention ofthe customer. OOS operations expose Baker Hughes equipment to a high stress environment.Immediate damage, potential failure or a significant reduction in remaining equipment lifetimecan be the result. Any equipment damage whatsoever has a financial impact on Baker Hughes.In addition, the customer's perception of the Baker Hughes reliability, performance or servicequality may get biased when the customer is not aware of operations where Baker Hughesequipment is operated beyond its operational specifications.

The OOS Incident Report is set up in a way that it can be used as customer notificationdocument. After completing the first part of the OOS Incident Report the Field Service Engineersimply needs to print out the OOS Incident Report sheet to get the Customer NotificationDocument. The print out contains only the customer relevant information entered in the OOSIncident Report.

The OOS Run Report file must not be forwarded to the customer.

**Note**

The Customer Notification Document is the only document

dedicated to be disclosed to a customer.

The Field Service Engineers (Directional Driller, MWD Engineer) need to sign the CustomerNotification Document to verify that all remedial actions – up to their allowable limits – havebeen undertaken to mitigate or resolve the OOS operation.

Regardless of the success of any mitigation effort, the customer's field representative has to bemade aware of the OOS operation, the associated risks, any adequate remedial action (alreadyundertaken or not), and that Baker Hughes reserves the right to reclaim the cost of repair of anydamage caused by an OOS operation. The customer's field representative is then asked to signtwo copies of the Customer Notification Document (customer copy, Baker Hughes copy), asevidence that proper communication was carried out and the risks were understood.

There are remedial actions that may require prior customerapproval, e.g. a change of mud properties. Such remedial actions need to be discussed with the customer in advance, listed in the

**Note**

Recommended Action(s) field of the OOS Incident Report and the customer's field representative has then to be asked for approvalby signing the Customer Notification Document before anyremedial action is undertaken.

After two copies of the Customer Notification Document is submitted to the customer's fieldrepresentative and is either acknowledged or rejected, the second part of the OOS IncidentReport can be filled in. This is easily done by simply selecting one of the following four options:

**Signed off by customer AND remedial action(s) undertaken:** This option should be selected, ifthe customer's field representative had signed off the Customer Notification Document andactions to mitigate or resolve the OOS operation (with success or not) have been undertaken.This option should also be selected if the customer approved more comprehensive remedialactions by signing off the Customer Notification Document.

**Signed off by customer BUT NO remedial action(s) undertaken:** This option should be selected,if the customer's field representative had signed off the Customer Notification Document but didnot allow taking any recommended remedial action beyond the normal range of change indrilling parameters the Directional Driller can carry out.

**Not signed off by customer:** This option should be selected, if the customer's field representativehas refused to sign the Customer Notification Document. It does not matter whether remedialactions have been undertaken or not.

**Customer not notified:** There are occasions where contractual terms due to the characteristic ofa job or a separate reporting agreement between the customer and Baker Hughes do not permita customer notification on an OOS incident basis. In such a case, where the customer will not benotified, this option should be selected. If this option has been selected a detailed explanationwhy the customer was not notified needs to be given in the Remarks field of the OOS IncidentReport.

The second part of the OOS Incident Report is for Baker Hughes

**Note**

internal tracking of customer notifications. This part is for internal

use only and should not be submitted to the customer.

After completing the second part of the OOS Incident Report, the Field Service Engineer mustsubmit a copy of the entire OOS Run Report (Excel file) to the Operations Coordinator foruploading the data into MaPS. Additionally, (a copy of) the Customer Notification Document (withor without the customer's field representative's signature but signed by BHI's Field ServiceEngineers) has to be forwarded to the Operations Coordinator for further distribution to thecustomer or the account representative for this customer.

It is the responsibility of the Operations Coordinator to control the

**Note**

quality of the OOS data received from the field before it is

uploaded into the MaPS Job Center.

All Customer Notification Documents, which have been signed by the customer's fieldrepresentative, must be brought back to town and handed over to the Operations Coordinatorafter a run is completed. These documents must be retained by the Operations Coordinator tosupport a later claim for costs associated with equipment damage caused by an OOS run.

Simultaneous Violation of Multiple OOS Criteria

There will be occasions where two or more OOS criteria are exceeded almost at the same time.Such simultaneous OOS incidents are that closely spaced in time that occurrence, remedialaction(s) or reporting may overlap.

To reduce paperwork for both, Baker Hughes and its customers, simultaneous OOS incidents canbe reported with a single OOS Incident Report (ticking of several OOS reasons). However, the OOSIncident Report must be completed in a timely manner and remarks and recommended actionsmust cover all operational specifications with the violated OOS criterion. Grouping multiple OOSincidents that occurred over the period of a shift, a day or any longer period of time into one OOSIncident Report is not allowed.

Customer acknowledged OOS incidents (signed off Customer Notification Documents) supportthe reclaim process for costs associated with in OOS runs damaged Baker Hughes equipment.Therefore, it is very important that multiple simultaneous OOS incidents are only combined intoone OOS Incident Report where this will not prevent the customer from signing off the CustomerNotification Document. If necessary, each OOS incident has to be reported individually toultimately achieve the highest number of acknowledged OOS incidents possible.

The selected option in the second part of the OOS Incident Report (e.g. signed off by customer AND remedial action(s) undertaken)**Note** must apply to all OOS reasons listed in the first part of the report. If this is not the case an individual OOS Incident Report per OOS incident has to be completed.

Post-Run OOS Incident Reporting

Exceeding equipment specifications is not exclusively limited to the job execution phase whenBaker Hughes equipment is exposed to a downhole environment. An OOS incident may also notbe detected straightaway at all times while the job is being performed. Excluding monitoringservice failures as well as human errors, there are a number of reasons how Baker Hughes toolsand equipment may get exposed to an OOS environment without immediate notice of BakerHughes personnel. Three examples are: OOS while no supervision, damage-based OOS criteriaand OOS incident recorded only in the tool memory and not transmitted in real time.

In most cases Baker Hughes tools are exposed to an OOS environment while being downhole.However in some cases the tools can also be subjected to certain OOS conditions while beinghandled at the surface or during transit to or from the rig. Adequate monitoring services, e.g.impact indicators (ShockWatch), are not always in place to constantly monitor stresses andconditions that Baker Hughes tools and equipment might be subjected to between leaving aBaker Hughes facility and returning back to it. These gaps in supervision lead to "blank spots" inthe equipment's stress exposure history. Visual damage, a low hour failure or a tool that failed theincoming test at the shop but performed well at the rig site can be an indicator for an OOSincident while no supervision.

**Damage-Based OOS Criteria:** There are some operational specifications that do not have clearlydefined OOS criterion assigned to it – solids content for example. These operationalspecifications do not allow a clear real-time OOS detection. However, they need detailed analysisof the encountered damage in the workshop to prove the violation of that OOS criterion. Fluiderosion damage after a run with abnormally high solids content endorse, for example, that theequipment was run OOS for solids content. But, there exists no explicitly stated maximum solidscontent / flow velocity function for each Baker Hughes tool which would allow a real-timedetection of a solids content OOS criteria violation.

Damage-based OOS criteria only apply if damage to BakerHughes tools and equipment occurred or service quality issueswere encountered, and the characteristic of the damage clearlyidentifies an operating condition covered by one of the damagebased OOS criteria as root cause. If no damage/service qualityissue could be observed and it must not be expected that material properties (e.g. fatigue life) got negatively affected due

**Note**

to the operating environment, these operating conditions should

not be considered as an OOS incident. Damage-based OOScriteria are used at the following operational specifications:debris (non LCM), metal particle content, solids content, droppedBHA/bottom hole impact, tool mishandling on surface/duringshipment, pumping acid, pumping cement, unsupervised toolpick-up/operation/lay down, gas in mud, junk in hole, otherconditions.

Although operating, even downhole monitoring services cannot always reveal an OOS operationimmediately. For example, if the telemetry data rate does not provide a high enough real-timedata density then large time-lags between two, OOS relevant, parameter updates will beencountered. In such a case, an OOS operation may not be noticed in the first place but can onlybe observed after the fact when memory data is analyzed.

Some time may elapse between the event of exceeding an OOS criterion of an operationalspecification and the time when it is noticed and confirmed as OOS by Baker Hughes personnel.For this reason, OOS incidents can get reported by Baker Hughes personnel in different roles andat different stages of the job. Some examples (note that OOS incident reporters are not onlylimited to those listed below):

**OOS Incident Example OOS Incident Reporter OOS Category**

Drilling Applications Engineer Drilling Applications Engineer Dogleg severitydetermines exceeded rotary bending limit after examination

of memory data.

Reliability Engineer traces tool Reliability Engineer Post-run tool cleaningdamage back to solidified mud

in tool bores and pockets.

Workshop Technician finds Workshop Technician Solids contentheavily eroded alternator guide

and turbine wheel after an

operation with high solids but

low sand content.

Operations Coordinator Operations Coordinator Unsupervised tool pick-up /receives damaged mud motor operation / lay downfrom an operation without any Baker Hughes supervision.

Geoscience Applications Geoscience Applications Metal particle contentEngineer attributes poor Engineer

azimuthal FE log quality to too

high metal particle content of

mud/filter cake.

Any OOS incidents detected post run must, in addition, be reported via the OOS Run Report. Thecompleted OOS Run Report should be submitted to the Operations Coordinator or local MaPSAdministrator to be uploaded into the MaPS Job Center and therewith update the OOS status ofthe appropriate run.

In the post-run phase customer notification may not be relevant and therefore does not need tobe completed.

In case a post-run data analysis cannot confirm a reported OOSincident, the Operations Coordinator and the local MaPS Administrator must be informed. The Operations Coordinator will

**Note**

ensure proper customer communication. The MaPS Administratorwill make sure that the OOS status of the run in the MaPS JobCenter is changed accordingly.

Operational Specifications

This section provides additional specifications and information on the application, operation, andhandling of Baker Hughes tools. It is intended to supplement the tool specific technicalspecifications and the *Supplemental Technical Specifications* TDS. Baker Hughes personnelshould be consulted relative to any procedures, calculations, or detailed specificationsreferenced here. Due to the effects third party BHA components might have on the performanceand specifications of the BHA, Baker Hughes should be consulted in the BHA design process.

Any application which results in physical damage beyond what is considered normal wear andtear is considered to be the result of an OOS operation. When out of specification operationsoccur, additional charges for tool usage, maintenance, or replacement up to the LIH value willapply. The Baker Hughes Price Book should be consulted to determine how associated pricing willapply to all operational parameters.

As to any single drilling parameter, the lowest specifications of any component in a BHA are thepredominant specification. Operation of the BHA outside the parameters of the predominantspecification is an OOS operation. Generally industry accepted good drilling/operating practicesmust be followed at all times. For example, rotating inside casing is not a good drilling practiceand is considered to be an OOS operation. However, rotation inside casing for the purposes ofdrilling cement and shoe tracks shall not be considered an OOS operation. It should be notedthat such operations routinely cause damage to equipment that may require compensationfrom the customer. In these operations, it is recommended that the customer discuss theprocedures and operating practices with Baker Hughes personnel, as such practices may assistin minimizing or preventing damage.

Baker Hughes specifications are based on proper and appropriate operation for any givenapplication. Baker Hughes field personnel must be given advanced notice of changes inoperational parameters including circulatory changes (pumping pills or slugs, mud weight, LCM,acid, etc.) so that they can implement proper procedures. Failure to provide adequate advancednotice will result in an OOS operation.

Drilling Fluids

**Chloride Content:** All drilling fluids contain corrosive species such as chlorides. The damage thatthis can incur to downhole tools varies with chloride concentration, equipment material,temperature, pH, and other factors.

Typically, fluids with chloride levels of <20,000 mg/liter have minimal effects on the tools duringdownhole operation. Fluids with chloride levels between 20,000 – 56,000 mg/liter have mediumeffect and care must be taken when coming back out of the hole (flushing tools as describedfurther below). When the chloride levels exceed 56,000 mg/liter, corrosion of common equipmentmaterial can be severe, even in the downhole environment. It is therefore advised to runcorrosion inhibitors and put special attention to the pH-control of the drilling fluid to maintain thepH between 10 and 12 when chloride levels are expected to exceed 56,000 mg/liter. Downholeequipment made of Nickel-based alloys according to Baker Hughes Drilling Services specifications (NIXX) can withstand higher chloride concentrations, up to 120,000 mg/liter when the pH of the drilling fluid is maintained in the range recommended below.

When combinations of different equipment materials are used, the material with the lowest corrosion

resistance determines the tolerable concentration. For oil-based fluids, the chloride levels relate to thewater content of the fluid. As additional factors such as temperature and pH affect corrosion,OOS operation will be stipulated regardless of the measured actual chloride content if excessivecorrosion or equipment damage is observed that can be related to elevated corrosive propertiesof the operating environment.

As most damage to downhole tools actually occurs at the surface, where oxygen is more readilyavailable to support the reaction, all tools must be thoroughly flushed and washed, externallyand internally, after use in either OBM or WBM systems. The cleaning fluid should have a lowchloride content – on the order of fresh water (<500 mg/liter). The customer is required toprovide facilities and clean water as well as the required rig time to perform these procedures.Failure to do so must be handled as an out of specification operation and can result in additionalcharges for tool usage, maintenance, or replacement costs up to LIH value as per Price Book.

**Lost Circulation Material (LCM):** Use of other than granular fine to medium LCM materials or theincorrect preparation or application of LCM is considered an out of specification operation.Always visually inspect the LCM being used. All granular LCM material should be fine or mediumin size. Coarse and fibrous LCM is considered out of specification and must be avoided.

Concentration should start at 3 lb/bbl (8.6 kg/m3) with good mixing. Always premix, it is badpractice to put LCM directly into the active system. The maximum concentration should be

40 lb/bbl (114 kg/m3). Certain tool designs can handle higher concentrations; information isavailable on their individual Technical Data Summaries.

Detailed specifications for materials and procedures are available i[n ~~Operational Procedures~~.](#br23)

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**pH:** In water based mud, pH must be maintained between a pH of 9.0 and 12.5. The operation oftools in water based mud below pH 9.0 or above pH 12.5 is considered an OOS operation. Forfreshwater mud systems, a pH between 8.0 and 9.0 is acceptable. As pH typically decreases withincreasing temperature, it needs to be ensured that pH remains in the acceptable range duringthe entire operation, e.g. by introducing sufficient margin when adjusting pH at roomtemperature. The use of some drilling fluids, such as Sodium Silicate and Lamium, is known to bedestructive to downhole tools. The use of such fluids is considered an OOS operation and willrequire, prior to such use, an agreement between Baker Hughes and the operator with respect to(1) increased wear and tear on downhole tools and (2) the OOS cost for the resulting wear andtear.

If aluminum material is used in tools (e.g. aluminum inner tubes for coring), see tools’ specifictechnical data summaries regarding detailed information about the pH value and mudproperties.

**Debris (Non-LCM):** Non-LCM debris can consist of anything that finds its way into mud system.Cloth, broken bolts, rust from old pipes and lost hand tools are a few examples. Debris in mudcan cause problems such as blocking the pulser, damaging rubber lining in motors or damagingturbine blades.

**Metal Particle Content:** Metal particles present a special case of solids in mud. These can resultfrom casing wear, drill pipe wear, result of window milling and several other operations. Theireffect on Baker Hughes tools is twofold. Metal particles can get stuck in magnetic parts in toolsand can cause premature failure of pulser and turbine components. Also magnetic interferencedue to ferrous materials in drilling fluids can result in degraded directional or Azimuthalorientation accuracy. This most commonly occurs in oil based muds. Although Baker Hughesspecifically disclaims any warranty as to any interpretations and data quality, the integrity of anydata will be negatively impacted under such circumstances.

**Sand Content:** If the sand content is measured to be above 1% in one sample taken according toMud Contractor's Standard sand content procedures the operation is considered out ofspecifications. Baker Hughes recommends a sand content of less that 0.5%.

In cases where rig contractors cannot provide accurate

**Note**

information, Baker Hughes should provide its own sand content

measurement kit.

**Solids Content:** Excessive and abrasive solids cause extensive damage to the downhole tool.With increasing mud weights, the total solids concentration in the mud system increasessignificantly. Erosion damage to the internal parts of the tools is a function of flow-rate and solidscontent. Usually the low gravity solids are the more abrasive ones, the operator should thereforerun proper fluid cleaning systems to overcome this problem. Mud screens (uphole and downhole) will be a good indicator of tool erosion on the MWD/LWD tools. When after strip down in thelocal workshop more than normal erosion is noted, an OOS claim will be submitted.

Use of hematite as weighting material is considered non-standard and will require additionalagreement between Baker Hughes and the operator with respect to increased wear and tear ondownhole tools and the diminished accuracy of directional measurements.

**Low Gravity Solids—Drilling Motors**: Low gravity solids as bentonite, polymers, and drill solids in awater-based mud, should be less than 7% by volume, otherwise it can cause the fluid paths inbearing assembly to block off and starve the bearing assembly of any fluid, resulting in bearingassembly failure.

Operating Parameters

**Bit Pressure Drop:** Bit pressure drop is primarily a concern when it comes to hydraulicsoptimization for hole cleaning, ROP or hydraulically activated BHA components (e.g. holeopeners). Nevertheless, improper bit pressure drop can also become an issue with regard to OOSas bit pressure drop affects the operating conditions of Navi-Drill motors.

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Navi-Drill motors incorporate bearing assemblies that are not sealed. These bearings require acertain mud flow across them for proper cooling and lubrication. To achieve sufficient mud flowacross the bearing assembly the total flow area at the bit (TFA) needs to be adjustedadequately. The TFA is a function of number and size(s) of bit nozzles. A large TFA can lead to avery small pressure drop across the bearing assembly and thus to little or no mud flow acrossthe bearing. This can result in excessive wear or frictional heat damage in the bearing section. Onthe other hand, a too small TFA causes too much mud flowing through the bearing which canlead to wash-outs and erosion damage.

TFA and flow rate vary greatly depending on hole size and application. A fraction of 5 to 10 % ofthe total mud flow diverted through the bearing assembly is a good rule of thumb to ensureproper bearing cooling and lubrication.

During the pre-job planning phase a hydraulics analysis has to be done. The analysis needs tofactor in expected mud properties and drilling parameters to make sure the TFA is suitablyselected for the entire planned interval. Usually, the mud flow across the motor bearing assembly(special case of split flow) cannot be calculated with hydraulics software packages. However,the pressure drop at the bit can easily be determined. For this reason, a bit pressure dropbetween 217 to 1,160 psi (15 and 80 bar) should be maintained while on bottom drilling. This resultsin a 5 to 10% mud flow across the bearing as mentioned above.

An OOS incident for bit pressure drop occurs if a Navi-Drill motor is deployed and continuouslyoperated (on bottom drilling) with a bit pressure drop out of the range of 217 to 1,160 psi (15 to 80bar). In case there is no Navi-Drill motor in the BHA the operational specification bit pressure dropis irrelevant for OOS and hence cannot be an OOS reason.

**Pressure:** Unless otherwise stated, standard tools are limited to 20,000 PSI (hydrostatic plusstandpipe pressure). Certain tools rated for higher pressures are available on request but requireadditional time for mobilization.

**Torque:** Torques specified in Technical Data Summaries are right handed (clockwise, lookingdownhole) torques. The max torque specification is for continued operation and is typically equalto 80% of the nominal specified makeup torque, although other components may be the limitingelement. For Baker Hughes proprietary, field-serviceable thread connections, the allowabletolerance for actual makeup torque is -0%...+15% of the nominal value, unless specified otherwise.The tolerance in Makeup torque does not extend the limit of allowable operating torque.

**Flow Rates:** Flow rate limits are specified in the Technical Data Summary of each tool.

**Rotational Speed (rpm):** RPM is the rotational speed of the sub in revolutions per minute. Thisspecification is dependent upon tool application. In the case of downhole mud motors, it is afunction of AKO setting. The maximum rotation level stated is for drilling ahead in formation. TheRPM limit of a tool is specified in its Technical Data Summary.

**Weight on Bit (WOB):** Weight on bit limits are specified in the TDS for basic configurations ofdrilling systems (AutoTrak G3, AutoTrak eXpress, VertiTrak, TruTrak) and for downhole motors.However for individual downhole tools, WOB may not be specified in the TDS. For a BHA whichincludes more modules than a basic configuration of a drilling system, the WOB limit has to bedetermined by BHASysPro, Advantage Engineering or by a relevant Finite Element analysis.

It should also be noted that the WOB specified in the TDS refers to the downhole WOB. In theabsence of downhole WOB measurements, the surface value should be used and excessiveweight on bit must be avoided by adopting a conservative estimate of borehole drag.

**Motor Differential Pressure:** Motor differential pressure is an indication of motor load. Constantlyoperating with high differential pressure can lead to stator lining damage, drive shaft damage orstick slip condition. High motor differential pressure can be caused by an over aggressive bit, toomuch WOB or indicate a motor not fit-for-purpose. The operation limit for differential pressureshould not be exceeded.

Motor stalls represent an out of specification operation, as the stall torque is above theoperational differential pressure limitation for motors with nominal power sections. Decreasedlife and increased wear should be expected if the motor is run at these parameters for any lengthof time.

**Temperature (MWD/LWD):** Temperature limits are specified in the Technical Data Summary of

each tool. Certain tools can be ordered with higher than standard temperature ratings.

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*HTHP Operating Procedure* (HTHP-20-04-001) must be applied when static downholetemperatures equal or exceed 257°F (125°C). The maximum downhole temperature will bedetermined from tool measurements, transmitted or recorded, or the temperature-stickerslocated inside the tool-mounted on hatch covers.

**Hole Enlargement with Expandable Underreamer Tools:** When running expandableunderreamer tools (GaugePro XPR, GaugePro Echo, competitor reamers) above the modular BHAwith less than 66 ft (20 m) spacing between the stop sub and the reamer, rotating faster than 60rpm with bit and reamer being off bottom is an outside of specification operation. Therecommended off bottom rotation speed is 40 rpm. When formation is cut by the reamer only(bit off bottom), rotating faster than the BHA back-off threshold RPM is an outside of specificationoperation. The BHA back-of[f threshold RPM is calcul](https://dms.bakerhughes.com/sites/operations/publishedDocuments/OPS-GLB-ECHO-103451.pdf)ated according the *GaugePro Echo and XPR—all Series—Prejob Planning* [(~~OPS-GLB-ECHO-103451~~).](https://dms.bakerhughes.com/sites/operations/publishedDocuments/OPS-GLB-ECHO-103451.pdf)

Drilling Dynamics

Using equipment beyond its design purpose and specification can lead to damage. The repair ofthis damage requires additional measures compared to a standard maintenance and will havea cost associated.

The Baker Hughes model is aimed at the recovery of non-visible fatigue damages of all BHAcomponents, with individual measures to reset the tools for further use without degradation ofspecification, i.e. downgrading of tools as done for drill pipe is not an option.

The stepwise and transparent progression of the compensation model as defined here andsupported in the Baker Hughes Price Book is both an incentive for reducing the number of OOSincidents as well as an effort to limit the OOS Level during drilling even if a certain abuse isunavoidable.

In drilling, reaming, and back reaming operation vibration levels must be closely moni[tored andmaintaine](https://dms.bakerhughes.com/sites/operations/publishedDocuments/OPS-GLB-En-103188.pdf)d within specifications as per the Baker Hughes *Common Drilling Guidelines* [(~~OPS-GLB-En-103188~~)](https://dms.bakerhughes.com/sites/operations/publishedDocuments/OPS-GLB-En-103188.pdf); specifically the reaming and back reaming can easily lead to an OOS ope[ration.](https://dms.bakerhughes.com/sites/operations/publishedDocuments/OPS-GLB-En-103188.pdf)

Due to the constant evolution of downhole sensor and signal processing capabilities, vibrationmeasurements can vary between different tool types, even when they are exposed to the samephysical conditions. Consequently, vibration limits applied to the entire BHA are definedaccording to the measurement tool deployed.

If multiple vibration measurements are deployed in one BHA, the reading with the highestcriticality will be applied to the entire BHA. The general vibration limits may be detailed furtheraccording to the technical specifications of particular tools, as stated in the respective TechnicalData Summaries.

The following values are intended to provide cumulative values ofvibration; i.e., the values accumulated over an entire run. Forexample: 12 minutes of axial vibration level 5 from 12:01 to 12:13,and then 10 minutes of axial vibration level 5 from 13:00 to 13:10 inthe same run. The cumulative vibration time is now 22 minutes. According to the charts this will be out of specification. It is not

**Note**

acceptable to have 19 minutes of axial vibration level 6, and thenno vibration for 60 minutes and then a further 19 minutes of axialvibration, in the same run. 19 minutes is under the 20 minute limit,but the cumulative time for the run is now 38 minutes, which isout of specification. This cumulative concept applies to thespecifications set out for axial and lateral vibrations.

**Axial Vibration:** Vibration of drill string along tool axis can cause damage to seal faces ofmodular connections, damage to stabilizers and in severe cases can lead to buckling fatigue.Axial and Lateral vibration limits are described in the table below.

**Lateral Vibration:** Vibrations transverse to the tool axis are known as lateral vibrations. These arethought to be the most destructive type of vibrations and constant exposure to lateral vibrationscan cause damage to tool electronics. Constant lateral shocks will damage the tool body, as wellas greatly reduce drilling efficiency.

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Table 2: All MWD/LWD/RSS and positive displacement motor systems

**Axial and Lateral Vibration**

**Unit Time Limit**

**No Limit 3 hours 20 minutesMeasurement Source Tool Size**

**Severity**

**Level L3 L4 > L4**

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|  | NaviTrak MWD  TeleTrak MWD  OnTrak MWD  CoPilot 2 Sensor Sub  CoilTrak  Advanced Slim MWD System |  | All sizes gRMS x < 3 3 ≤ x ≤ 5 x > 5 |

CoPilot UHD Sensor Sub 9-1/2 in. gRMS x < 8 8 ≤ x ≤ 12 x > 12 AutoTrak eXact Steering Unit

CoPilot UHD Sensor Sub 6-3/4 in. gRMS x < 8 8 ≤ x ≤ 12 x > 12

**Severity**

**Level L4 L5 > L5**

AutoTrak eXact Steering Unit

Lucida Steering Unit

4-3/4 in. gRMS x < 12 12 ≤ x ≤ 15 x > 15

Lucida Directional Sub

CoPilot UHD Sensor Sub

Table 3: AutoTrak Curve – Axial, Lateral, and Tangential Vibration **Axial, Lateral, and Tangential Vibration Time Limit**

**30 hoursUnit**

**No Limit 10 hoursMeasurement Source Tool Size**

**1 hour Severity**

**Level <L3 L3 L4 toL5 >L5**

AutoTrak Curve 6-3/4 in. gRMS x < 5 5 ≤ x ≤ 8 8 ≤ x ≤ 15 x > 15

**Note** For AutoTrak Curve, the time limits indicated are accumulated

over several runs.

**Stick-Slip – General:**

Stick-slip dynamics can cause adverse effects on drilling performance and service deliverables.The following points should be considered:

• Special attention must be given to the avoidance of backward rotation, as this can lead to

backing off of BHA or drillstring connections.

• Stick-Slip can lead to erroneous borehole images or tool face measurement caused by rapid

change of sensor position.

• BHA-induced stick-slip can be a symptom of other drilling dysfunctions or adverse borehole conditions (e.g. hole spiraling, ledges or other undesirable borehole patterns) that can lead to excessive tool OD wear, or to the back off of connections due to a sudden release of stored

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torsional energy in the drill string.

Table 4: All MWD/LWD/RSS and positive displacement motor systems **Severity**

**Level 0 1 2 3 4 5 6 7**

**S1; S2** S10<.00≤.2 S10<.20≤.4 S10<.40≤.6 S10<.60≤.8 S01 .<81≤.0 S11.0< 1≤.2 1.2 ≤ S1 S2 > 0.1

**Time**

**Limit** No limit 5 hr 1 hr

S1 = (max RPM – min RPM) / (2× average RPM)

S2 is a measure of negative RPM time in percent (1.0 meaning 100%)

**Tangential Acceleration:** Tangential acceleration can be an effect of stick-slip dynamics, butcan also occur at much higher frequencies and with higher energy than stick-slip. Highfrequency torsional oscillation (HFTO) causes only small angular motion of the tools. However,this occurs at high rotational acceleration amplitudes that can be very damaging.

Table 5: All MWD/LWD/RSS and positive displacement motor systems

**Tangential Acceleration**

**Unit Time Limit**

**No Limit 3 hours 20 minutesMeasurement Source Tool Size**

**Severity**

**Level L3 L4 > L4**

CoPilot 2 Sensor Sub all sizes gRMS x < 3 3 ≤ x ≤ 5 x > 5CoPilot UHD Sensor Sub 9-1/2 in. gRMS x < 57 57 ≤ x ≤ 86 x > 86

AutoTrak eXact Steering Unit gRMS x < 8 8 ≤ x ≤ 12 x > 12

6-3/4 in.

CoPilot UHD Sensor Sub gRMS x < 44 44 ≤ x ≤ 66 x > 66

**Severity Level L4 L5 > L5** AutoTrak eXact Steering Unit

Lucida Steering Unit gRMS x < 12 12 ≤ x ≤ 15 x > 15

Lucida Directional Sub 4-3/4 in.

CoPilot UHD Sensor Sub gRMS x < 45 45 ≤ x ≤ 57 x > 57

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|  | **Note** |  | When limits are exceeded, the associated logs need to be  analyzed carefully. Checks will be made if the limits were  exceeded in an on bottom/off bottom situation, and if no  damage is seen to bit/bottomhole assembly/ stabilizers, etc.  specifications might not have been exceeded. |

**Note** All earlier documents stating vibration levels and limits are

superseded by this document.

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|  | **Note** |  | The values for CoPilot 3 were derived with a limited amount of  data. These values will be reviewed as more data becomes  available (e.g. in one year). |

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Operating Practices

**Dropped BHA/ Bottom hole Impact:** A BHA can be dropped downhole due to many reasons e.g. atwist off, wrong Slip size or placement, connection failure or wrong elevator sub or thread. Such adrop can cause mechanical damage to any of the BHA components. A similar effect can happenwhen BHA hits bottom of hole during a running-in procedure (referred to as accidental spuddingin some locations). This can also be caused by wrong pipe tally, wrong cement calculations ordepth sensor problems. All such incidents are considered out of specifications operation and willusually result in some kind of damage to Baker Hughes equipment. Even if no apparent damageis observed, sensor malfunction can happen and result in wrong measurements.

**Post-Run Tool Cleaning:** The wellbore environment can consist of corrosive fluids under extremeconditions of temperature and pressure. When the tools come out of hole these corrosive fluidscan interact with air and start a chemical reaction on the metal surface. If left unchecked thisreaction can cause damage to the tool body and in worst case can result in the tool beingrendered unusable. It is therefore required to thoroughly clean the tools before laying them downor racking back for further use. It is important to perform this operation as soon as tools comeback to surface.

After the tool has been pulled out of the well, the ID and OD must be cleaned of all of the mud byusing a pressure washer (with a cleaning solution applied, if possible). The rig should alreadyhave this established for cleaning the rig floor and surrounding areas. Special considerationneeds to be taken in assuring all areas around antennas and hatch covers are free from anyremaining mud. This should not entail removing each cover, simply verifying that the areasaround them are clean. Thoroughly clean and dry all accessible threads and protect them withWD–40 Spray. Ensure thread protectors are clean and dry prior to being screwed onto thethreads.

Failure to follow this procedure should be considered an out of specification operation and mustbe reported for corrective action.

**Tool Mishandling on Surface/During Shipment:** Proper care of tools during shipment, movingand make up is essential to their successful functioning. Any mishandling or damage duringshipping, handling on the rig site or during make up on rig floor is considered an OOS operation.All such incidents should be reported.

**Rotation without circulation:** Rotating the drill string without circulation is deemed as an OOSsituation. Several operational needs may cause that the flow would not reach the BHAcomponents, e.g. packoffs, use of circulation subs above the BHA, failures in the circulatingequipment, etc.

The most critical variant is rotating the string without circulation during stuck pipe incidents(mainly due to packoffs). Rotating the string in such condition causes high torsional loads andexcessive friction of the tools against the borehole or bed of cuttings. The high torsional loadscould cause over torqueing connections and/or twist offs, while the high friction would causeoverheating and (potentially) heat check on drill string components.

**Jarring:** A drilling jar is a downhole tool that allows the on purpose generation of axial shocks in

downhole or uphole direction to help freeing a stuck drillstring.

Jarring shocks can be very destructive to BHA components such as MWD and LWD tools. If ajarring shock of critical magnitude actually hits the BHA is influenced by many parameters, suchas: spacing between jar and BHA, relative position of the stuck point to BHA and jar, type of jar,wellbore profile, use of an accelerator, movable mass for shock generation, etc.

Currently, the magnitude of the impact force that reaches the BHA cannot accurately bepredicted nor measured. Amplitude and effective direction of any caused tool deflection canhardly be determined either. Due to the high damaging potential of jarring, its occurrence isalways considered an OOS operation in the first place and the customer must be advised of thehigh possibility of damage to Baker Hughes equipment, the elevated risk of failure, and the voidstatus of any performance warranty. However, as it is not known if a critical jarring shock hasactually reached the BHA, the OOS condition must eventually be confirmed.

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A confirmation for an OOS jarring incident can either be a related failure that is experiencedshortly after the jarring event or any tool damage discovered after the run by Baker Hughes AMOor Reliability Engineering personnel which can be attributed to jarring. If jarred-on tools flawlesslycomplete a run and also during subsequent inspections no related tool damage is found it canbe assumed that no critical jarring shock(s) reached the BHA. In such an event the run was notOOS for jarring. This conclusion must also be communicated to the customer.

**Bottom line:** Jarring must always be highlighted to the customer as an OOS operation bycompleting an OOS Incident Report (once per run is enough in case of multiple jarring events)but eventually a related damage or failure must confirm that a destructive jarring shock hasactually reached the BHA and thus caused an OOS incident.

**Pumping Acid:** Baker Hughes tools are not designed to withstand an acid environment. All suchevents must be considered OOS operations. In such an event, the customer must be advised ofthe possibility of damage to Baker Hughes equipment, the elevated risk of failure, and the voidstatus of any performance warranty. The actual damage will be assessed by Baker HughesRepair and Maintenance and Reliability Engineering personnel.

Tripping Practice: Tripping speed must be adjusted based on hole conditions, well profile, andBHA configuration. For example, when passing through high dogleg areas, changes in hole size,whipstocks, casing shoes, etc. trip speed must be reduced to a maximum of 150 ft/hr (45 m/h).For rib steering devices it is recommended that operators consult with Baker Hughes personnelfor further detailed information.

**Overpull until failure:** Stated specifications are according to the API definition of tensile yield.

Usually, this concerns the weakest thread of the tool.

**Pumping Cement:** Pumping of cement slurry through tool can damage pulser, turbine and othermoving components. Hardened cement may not be removable and might render the toolcompletely unusable.

**Unsupervised Tool Pick-up/ Operation/ Lay Down:** Only trained Baker Hughes personnel are fullyaware of all specifications, limitations, and handling and operating procedures of Baker Hughestools and equipment. Hence, any operation without adequate supervision by trained BakerHughes personnel can result in injury and/or damage to Baker Hughes tools and equipment.

Apart from the substantial HS&E hazard, which has to be dealt upon separately, any damageencountered during an unsupervised Baker Hughes tool and equipment manipulation representsan OOS incident. In this respect the type of damage does not matter as long as its severity isbeyond what is considered as normal wear and tear. If Baker Hughes tools or equipment did notget damaged then an unsupervised operation should not be considered as an OOS operation.

An OOS incident due to unsupervised tool pick-up/operation/lay down has to be reported—asalways—by submitting a completed *OOS Run Report Form* (GOP-20-10-0000-00-02) to theresponsible Baker Hughes Operations Coordinator who will trigger further steps and actions.

**Whipstock/ Window Passing Practice:** For a BHA, whipstocks and casing exits (casing windows)represent highly critical spots in a well path as they can easily cause damage to the bit and BHA,if not passed carefully.

A whipstock always causes a local dogleg, usually of considerable severity. The actual doglegseverity across a whipstock dependents on whipstock design, hole size, and quality of the millingrun. Some manufacturers protect their whipstocks against accidentally being milled or drilledwith a special hard facing. Some whipstock models incorporate an accelerator ramp. The mostdamage prone scenario is immediately after a milling / drill-out run, when the area around awhipstock / casing window contains metal shavings, cement and rock fragments, sharp edges,and the created dogleg is highest (this will be reduced with every subsequent run across).Rotation of stabilizers, standoffs and sensors on the face of a whipstock is not permitted as thiscan lead to tool damage, whipstock damage, stuck drill string, and loss of the well.

All these risks lead to the general statement that rotating or reaming across a whipstock orcasing exit with Baker Hughes services other than motors and slick probe MWD tools is notpermitted. Any violation of that represents an OOS incident and is required to be reported assuch.

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It must be noted here, that whipstocks can cause such high local doglegs that the sliding limit ofa BHA might get exceeded when tools are run across it. If this is expected the customer must bemade aware of the situation and the consequence of a possible claim for repair costs if theypersist to proceed without any changes.

Wellbore Environment

**Dogleg Severity (DLS):** The DLS limit is applicable to continuous curvature. The allowable DLS islimited by mechanical stress on the tool components. Areas with high localized DLS, which maynot be visible in the wellbore survey using standard measurement techniques, may exceed thespecified limits and cause excessive mechanical stress. Certain services of Baker Hughes useadditional measurement devices monitoring inclination and bending moments continuously.These measurements will also be used to determine out of spec conditions. A DLS limit in theTechnical Data Summary refers to the maximum rate that can be tolerated for that specific BHAconfiguration. Any deviations in BHA design including the addition of measurement componentsor the rearrangement to enhance certain drilling characteristics may change the stated DLSvalues and must be calculated using Baker Hughes proprietary FEA software. These calculationsshould be done in the planning stages and, in all cases, prior to running in hole.

From recent material tests, it is known that the limits for alternating bending under corrosiveattack are extremely lower than anticipated; therefore published bending moments are onlyvalid for non-corrosive environments and will be reduced if tools are exposed to corrosiveenvironments (fluids, gasses, etc.).

**Gas In Mud:** A high concentration of gas in the drilling fluid (free or dissolved) can harmdownhole tools in many different ways. Gases can chemically and physically attack materialsused for downhole tools (steels and polymers). They might be corrosive, affect mechanicalmaterial properties (e.g. embrittlement), break through seals, get trapped in tool internal voids orcause parts and materials to burst when pulled out of hole (exposed to lower than downholepressures). The actual damage potential of gas in mud is dependent on factors such as:material, type of gas, molecule size, concentration, absolute/partial pressure, temperature, typeand properties of drilling fluid, use of scavengers and corrosion inhibitors, time of exposure,stress, etc.

The enormous number of influencing factors makes the definition of a universally applicablethreshold for tolerable quantities of gases in mud impossible. However, with regard to OOS thefollowing two statements can be made:

1. Exposing Baker Hughes tools and equipment to a sour environment is always considered an OOS operation. Sour conditions are characterized by the presence of sour gas. Sour gas contains hydrogen sulphide (H2S) and carbon dioxide (CO2) at various partial pressures and ratios. In most cases sour gas originates from a sour gas bearing formation. In some cases, however, bacterial activity in the drilling fluid can be the source of a sour environment.

Sour gas makes any aqueous environment acidic and potentially corrosive. In addition,the presence of H2S may make materials susceptible to environmental embrittlementmechanisms such as Sulphide Stress Cracking (SSC) and Hydrogen-Induced Cracking(HIC). Under adverse conditions, damage due to sour gas may occur very quickly(minutes to hours).

Industry standard sour drilling practices reduce the risk of exposing Baker Hughes toolsand equipment to critical concentrations of sour gas (high enough hydraulic head toprevent inflow of formation fluids at all times (overbalanced), high alkalinity (water-based drilling fluids: pH >11) to suppress the solubility of small amounts of sour gas, use ofscavengers to neutralize small amounts of sour gas, use of inhibitors to coat tubulars toprovide some protection against short term exposure). However, accurate andcontinuous real-time measurements of the level of exposure downhole are not available,and as a result it is difficult to quantify the level of damage for any given concentration ofsour gas.

Bottom line: Baker Hughes tools and equipment are generally not designed for sourdrilling applications. Moreover, sour gas exposure and damage cannot be accuratelyquantified. Therefore, sour drilling operations in general are considered OOS.

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2. Exposing Baker Hughes tools and equipment to any other type of gas, e.g. nitrogen (N2), is considered OOS if the exposure causes any observable damage to Baker Hughes tools and equipment.

**Junk In Hole:** Junk in hole left from milling operation, a dropped object or any other fish canpotentially damage the downhole tools. Tool components such as the TesTrak Pad, StarTrakscanning electrode or AutoTrak Rib can be damaged by such Junk. In case of damage observeddue to junk in hole an OOS report should be filed and the matter should be brought to theattention of customer representative and operations coordinator.

Other Conditions

Any operation not mentioned above but outside the normal drilling practices and which canaffect the working of Baker Hughes tool or cause extra maintenance will also be considered anOOS incident.

Following are some example of such situations:

• Counterclockwise Rotation

• Excessive Wear

• Rubber / elastomer degradation due to drilling fluid

Table 6: Internal References

**OOS Category**

Drilling Services - Drillstring, BHA, and Operating Parameter Design

Procedure OPS-GLB-DS-103320 Effective DLS Whipface calc.xlsSupplemental Technical Specifications TDS-20-60-0000-00Common Drilling Guidelines OPS-GLB-En-103188Whipstock Milling & Drilling operations ATK-20-70-0000-04-21HTHP Operating Procedure HTHP-20-04-001Correct Usage of Ditch Magnets on Rigsite GOP-20-70-0000-00-06

Operational Procedures Jarring

In the event drilling jars are activated with a particular MWD tool in the BHA, then the followingprocedures should be followed (ZDR1):

• Record the time(s) at which jarring occurred. It needs to be noted that in any case of jarring (whether it be 6s, 6 min., or 6 hrs.) the tools may suffer damage that can lead to a tool failure at a later stage if not immediately. Therefore, in all cases a handwritten log of events needs to be made and attached to the tools when returned to the workshop, also MaPS Job center requires to be updated. In case the tool was powered-up (circulated above minimum flow rate) during the jarring occurrence, the axial and lateral memory files should be dumped on the next trip out of hole (assuming the tool has VSS capability and rig-site accessible memory).

• If the dumped axial or lateral data recorded at the time of the jar activation shows no change

then in all probability the drillstring was stuck above the MWD tool and no shocks reached thetool.

• If axial or lateral data show abnormal events recorded then the tool should be laid down

unless otherwise directed by your local office.

• In cases where the tool was not powered up, or the tool does not have the appropriate VSS/ Memory capability then the tool should be laid down, on the next trip out of the hole and returned to the local Assembly, Maintenance and Overhaul (AMO) facility for internal component inspection.

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• In the event a tool is laid down, the tool should be returned to the local AMO facility for internal component inspection. The tool should not be kept on location as a back-up. The local support office must also be contacted to coordinate shipment of a replacement tool should it be required.

• Where memory is available, stored vibration data should be examined at the AMO facility as above in order to corroborate or identify any damage. Abnormal vibration data or lack of it should be documented in the tool history/failure report.

• When a customer decides to continue drilling with a jarred tool, the customer needs to be made aware (verbally and in writing) that Baker Hughes will assume no responsibility for the performance of that tool.

Lost Circulating Material (LCM)

Improper use of LCM is considered an out of specification application. In the event that lostcirculation occurs and necessitates pumping LCM through Baker Hughes tools the followingprocedure must be reviewed and followed:

• Always visually inspect the LCM being used: All granular LCM material should be fine or medium in size. Coarse and fibrous LCM is considered out of specification and must be avoided.

• Concentration should start at 3 lb/bbl (8.6 kg/m3) with good mixing. Always premix, it is bad practice to put LCM directly into the active system. The maximum concentration should be 40 lb/bbl (114 kg/m3). Some tools have higher specifications, as designated in their individual documentation. A detailed LCM mixing procedure can be found in *OPS-GLB-DS-102416*. A customer handout is available as well (*OPS-GLB-DS-103805*).

• Increase the concentration of the LCM as needed. The MWD mud pulse signal should be monitored carefully during this process. If the tool starts to skip pulses or pulses increase in size, concentrations of LCM should not be increased.

• If pills with higher concentration are to be pumped, make sure an *Out of Specification Report*

(GOP-20-10-0000-00-02) is filled out.

• Pills with higher concentration (40 lbs/bbl (>114 kg/m3)) have been pumped with success, but this is outside of specification. Examples are available in the AutoTrak-OnTrak Operations Manual. Contact your local technical support for further details.

• Calculate the displacement / strokes for the pill to reach 500 ft (150 m) above the top of the first turbine-driven tool of the BHA (e.g. BHA with MTK, FAS and BCPM) and reduce flow when the pill reaches this point.

• Avoid slugging. Reduce pump flow to below 25% of the turbine-driven tool upper flow limit,

before pill reaches the tool. The flow should be kept low.

• Flow should be kept below tool turn on threshold until all LCM has passed through the bit.

• Notes on Particle Size: Conventional LCMs can be classified by the particle shape into three types: fibers, flakes, and granules. It is particularly important to note that although most conventional LCMs are labeled as being fine, medium, or coarse, there are no standards. Each individual material will have a different particle size and each manufacturer will use a different particle size for their LCM materials.

Pulser Considerations: Any contamination of the mud with a certain size can influence theperformance of the downhole tool. The most sensitive component is the pulser system. Theparticles and grains range in size from 0.028–0.05 in. (0.7–1.3 mm) and are likely to plug flowchannels and ultimately lead to pulser blockage.

Procedure for Pumping Fine Granular LCM Materials

**Operation:** Set tool transmission to max (highest) adjustable data rate to avoid plug buildingand to increase the differential pressure over the MVA/CVA (regardless if decoding is ok or not;send downlink for lower data rate after the pill has been pumped and losses cured successfully).

Start below maximum flow (<25% of the turbine-driven tool upper flow limit)

Frequently start-up the tool at minimum flow rate (power on), do this as often as possible- toavoid Bell sedimentation.

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Table 7: Pulser Consideration

**LCM Size Recommended Flow Potential Risk if not followed**

0.020–0.05 in.

(0.5–1.3 mm) <25% of tool upper flow limit Pulser plugging

0.05–0.126 in.

(1.3–3.2 mm) <25% of tool upper flow limit Turbine blockage

>0.126 in.

(>3.2 mm) <25% of tool upper flow limit Bit plugging

**Turbine Considerations:** The tool turbine is the second most likely component to be blocked;however, the turbine can develop considerable torque and momentum depending on flow rateand mud weight. Coarse LCM might be able to bridge the gap between turbine OD and collar IDthereby braking or even halting the turbine, hence LCM size above 0.059 in. (1.5 mm) should bepumped through the tool at high flow rates to ensure maximum momentum at the turbine as therisk of plugging the pulser is less with coarse material (it will be filtered away by the pulser mesh).

In general, any ground, shredded or manufactured LCM that has an average componentdimension greater than one-third the diameter of the bit nozzles might plug these. The followingtable provides a guideline for the maximum diameter fiber lengths to a particular nozzle size. It isto remind that coarse and fiber LCM represent a general out of specification situation for MWDtools.

Table 8: LCM Specification

**Nozzle Size Maximum Fiber Length** 12 0.125 in. 3.17 mm 14 0.146 in. 3.70 mm 16 0.167 in. 4.23 mm 18 0.187 in. 4.76 mm

For the AutoTrak and OnTrak standard pulser, a minimumnominal LCM length of 0.039 in. (1 mm) is recommended, hencethe window between the risks of plugging the bit and pulser should be used as effectively as possible. The turbine will

**Note**

potentially free itself after partial plugging and should be considered far less susceptible to failure after pumping LCM. Iffine LCM in the size range of 0.020–0.05 in. (0.5–1.3 mm) is to beused this should be pumped through at flow rates below 25% oftool upper flow limit.

Any other flow restrictions (e.g. bit nozzles, additional downhole tools in the BHA) might or mightnot conflict with these recommendations and should be considered prior to pumping any LCM.

Pumping High/Low Viscosity Pills

In the event that high or low viscosity pills are planned, the following procedure should bereviewed prior to and during MWD/ LWD/ Rotary steerable operations:

• Calculate the displacement/ strokes for the pill to reach 150 m (500 ft) above the top of the

first turbine-driven tool of the BHA and reduce flow when the pill reaches this point.

• Reduce flow to at least 50% of start-flow for current tool (dependent on turbine setup), e.g. maximum of 302 gpm for a 9-1/2-in. BCPM (605 [725] – 1,090 gpm).

• When the pill has gone through the last turbine-driven tool of the BHA (e.g. BHA with MTK, FAS

and BCPM) the flow can be increased to operating flow (refer to note below).

• Return to operational flow after the pill has passed the tool.

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For turbine-driven tools: The flow while pumping the pill throughthe tool should be maximum 80% of the upper flow limit (toprevent over speed of turbine). Do not rely 100% on the flow being reported by the rig. Always monitor Turbine RPM in order to know

**Note**

if the flow going through the tool is compatible with the flow reported. If there is discrepancy, notify the rig representatives inorder to check the correct pump efficiency and guide them forthe limits of pumping the pill based on the real flow goingthrough the tool.

These recommendations should be presented as the Baker Hughes requirements for pumpingpills through Baker Hughes MWD/ LWD/ Rotary steerable tools. However, the operator will alwayshave the final say in this matter and their first priority will be to save the well. If the operator finalcall exposes the tools to OOS conditions, the customer representative will be asked to sign theCustomer Notification Document of the Out of Specification Run Report form.

**Turbine Speed Considerations:** The mud viscosity has an impact on the effectiveness of the toolturbine. When pumping high viscosity pills one might cause over-spinning of the turbine if usingoperation flow, this again might cause a current peak and might lead to an electronic short.

**Slugging Considerations:** All pills introduced into the system must be properly mixed beforepumped through our MWD tool. It is important to lower the flow rate. Failing to do so might causedamage to the tool.

Pumping Cement or Acid

In the event that the pumping of cement or acid through MWD/ LWD/ Rotary Steerable tools isbeing considered the following procedures should be reviewed and followed prior to and duringoperations:

• Calculate the displacement/strokes to 500 ft (150 m) from the top of the tool and reduce flow

when the pill reaches this point.

• Reduce flow to 30–50% of recommended start-up flow for the current tool (dependent upon turbine set-up). In the case of a battery powered tool you will have to further reduce flow to prevent the tool from starting-up.

• For cement slurries, continue to pump at low flow to prevent the tool from starting-up. Once the cement has been pumped from the bit, the string should be raised 90 ft (30 m) and rotated, to clean any cement from the external surfaces of the tool. If flow can be increased without incurring losses, it should be raised to operating flow rate.

• In case an acid pill has to be pumped, it is recommended to include an inhibitor in the spacer pill preceding the acid pill. Once the spacer is laid around the tool, the acid pill should be pumped at a flow that is below the operating limit of the tool (to prevent pulser action). The acid pill should be followed by fresh mud or water. Once the pill is pumped through the tool, flow should be increased to normal operating flow. Once the tool starts operating, the flow should be increased to maximum. Flow can be further increased for a short period of time to 10% above the maximum flow for the specific tool configuration. This will create internal and external turbulent flow patterns, where possible, and assist in cleaning the tool. After an acid pill has been pumped, the tool should be POOH and laid down.

• Following any cementing operation with nuclear tools in the hole, circulating clean drilling fluid above the cement is required to clean the exterior of the tool and to avoid hardened cement blocking access to the nuclear source ports. In the event that hardened cement does block access to the nuclear source ports, potential exposure of personnel to radiation is increased, and would be against regulatory and Baker Hughes requirements to keep radiation exposures As Low As Reasonable Achievable (ALARA). In addition, shielding equipment may be required to safely transport the sources to a Baker Hughes maintenance facility for removal, all of which is incremental to Radiological/HS&E risk.

Corrosive Drilling Fluids

Some mud types cause chemical corrosion to downhole equipment. These fall into twocategories:

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• Metal corrosion can take place when acid and or alkaline levels create a chemical reaction between the drilling fluid and the tool metal. This typically occurs in the downhole high oxide environment but can also be experienced on the surface if the tool is not flushed with fresh water or an anticorrosion agent. Corrosion damage cannot be seen on the rig since it is usually found in the tool bore or on exposed internal components. Corrosion damage does not always result in a tool failure. However, severe corrosion will lead to components of the tool being scrapped prematurely. Tools should be washed down and flushed with fresh water as soon as possible upon reaching the surface. Anti-corrosion agents may be used depending on Baker Hughes recommendation and the customer consent. In the case where drilling fluids which are known to cause metal corrosion are to be used, with the agreement of the customer, Baker Hughes will include a corrosion ring in the BHA to monitor corrosiveness.

• Rubber/elastomer degradation resulting from organic chemicals in the drilling fluid e.g. diesel. This primarily affects positive displacement motor stators and is more severe at higher temperatures but may also affect any seals exposed on MWD, LWD, or rotary steerable systems. Another organic chemical group known to cause elastomer degradation is esters.

The client should provide a sample of the oil/diesel based mud to Baker Hughes during theoperation planning phase. During operations, the time and place a sample was captured mustbe documented. Baker Hughes will test the mud versus any rubber or elastomer components inthe tool which may be exposed to the fluid. Note that these samples are to be shipped accordingto hazardous materials shipment guidelines. Baker Hughes has two facilities worldwide wherethese tests can be conducted: Celle Technology Center, Celle, Germany and MTC-Oklahoma;special transport containers are available upon request, (1 l mud sample plastic bottle,NITL50043).

Baker Hughes will advise the client of any required changes in tool specifications or commercialadjustments needed in order to maintain reliable operations. If damaging mud additives areused without Baker Hughes being informed, any resulting damages should be re-billed to thecustomer. Drilling tools are manufactured from materials which should not experience corrosionunder normal drilling conditions. But when high levels of corrosion are observed this is indicativeof abnormal mud rheology and represents conditions which are out of tool operatingspecifications. In such cases the resulting damage and scrapping of tool components will be re-billable to the customer. Evidence of abnormal levels of chemical corrosion will be madeavailable for customer inspection. The customer damage reclaim report will need to include thefollowing supporting documentation: pre-job condition of the equipment, description of theadverse operational conditions to which the tool was subjected, description of the resultingdamage, and the cost of replacement itemized by equipment cost and labor.

Maximum Bit Differential Pressure Drop (Motors)

It is generally accepted practice to allow 5 % flow through the bearing section for sufficientcooling. To calculate the maximum bit TFA which will achieve the 5% flow, one need to know mudweight, fluid properties, and flow rates.

As a general rule of thumb, the bit pressure drop should not exceed 1,160 psi (80 bar).

Bending Moment, Dogleg Severity

Stated maximum dogleg severity (DLS) for Baker Hughes Drilling Services equipment assumescontinuous curvature. The allowable DLS is limited by mechanical stress resulting from thebending moment imposed on the tool components. Allowable stresses are based on theassumption of nominal drilling conditions. The technical endurance limit for alternating bendingin corrosive environments is extremely reduced vs. operation in non-corrosive environments.Therefore published DLS limits have to be reduced if tools are exposed to corrosive environments(fluids, gasses, etc.).

Stated maximum DLS in Technical Data Summaries only refers to the specific BHA configurationsreferenced in the respective documents. Any changes in BHA design, including the addition ofmeasurement components, rearrangement of components to enhance certain drillingcharacteristics, or the use of third party BHA components, may change the stated DLS limits andmust be evaluated using Baker Hughes Drilling Services proprietary Finite Element Analysis (FEA)software. Failure to take changes in BHA design into consideration, and to properly re-evaluateDLS limits, may result in OOS operation.

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Borehole intervals with high localized DLS may exceed the specified DLS limits and causeexcessive mechanical stress. Local effective DLS (including local DLS across whipstocks) must becalculated to verify that specifications for the BHA being utilized are not exceeded for anyoperation mode Rotation or reaming across any interval of high local effective DLS, exceedingthe maximum specified DLS constitutes OOS operation.

As high localized DLS may not be visible in the wellbore survey using standard measurementtechniques, Baker Hughes Drilling Services offers solutions to help mitigate the risk of DLS OOS. Atthe same time these services allow optimization of drilling performance.

BHA left hanging downhole for an extended period of time

In some situations, the operator may decide to leave the BHA/drill string at a particular depthinside the wellbore for a considerable amount of time, i.e. several days.

Leaving the BHA in static mud conditions increases the risk that solids in the fluid would settleand cause plugging in some parts of the BHA. The main concern are tools with restrictions tomud flow, e.g. pulser in BCPM/UPA, turbine in the ATK GT/GT4, MagTrak and FASTrak or the clocksection in SeismicTrak. Although, this doesn’t constitute an OOS condition as per se, customermust be informed in writing of the potential damaging consequences of this condition. Thiscondition could result in, but not be limited to: NPT, due to downhole equipment malfunctionand/or operational and HSE risks, due to the inability to circulate through the BHA. Damagedequipment would be charged as per contract.

Contracts, Terms of Service and Reimbursement

The detailed content of this chapter can be found in the document:

• Contract wording for DBR-LIH-OOS and Claim Process (*GS-GLB-En-100423*)

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