MANUFACTURING SPECIFICATIONS

GB DwC (Drilling with Casing) End Finishing Specifications

GB Specification No.: GB EF001.00

RELEASED FOR MANUFACTURER

April 5, 2010

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IMPORTANT NOTE: Specifications, drawings, and tables presented in this document supersede all earlier versions. You are directed to purge your system of all previous drawings, tables, specifications, etc. upon receipt (except those needed for work order archiving) and begin using this document immediately.

APPROVED BY: _____

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DATE: June 22, 2015

GBCONNECTIONS

ENGINEERING THE RIGHT CONNECTIONS

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1.0 CONFIDENTIAL INFORMATION / PROPRIETARY DOCUMENT

This document contains Confidential Information proprietary to GB Tubulars (GBT) and has been released for End Finishing Oilfield Casing with GB DwC Connections including:

- GB CD, GB WS, and GB HB.
- GB CDE, GB WSE, and GB HBE.

All of the GB DwC Connections use either GB DwC Butt (buttress), GB DwC 4P (4 Pitch), or GB DwC 3P (3 Pitch) Threads.

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2.0 SCOPE

This document provides specifications for End Finishing Oilfield Casing with any of the GB Drilling with Casing (DwC) Connections listed below and shown in Figures 1, 2 and 3.

- GB CD Butt (Casing Drilling w/GB DwC Buttress Thread)
- GB WS Butt (Wear Sleeve w/GB DwC Buttress Thread)
- GB HB Butt (Hard Band w/GB DwC Buttress Thread)
- GB CDE Butt (Casing Drilling Enhanced w/GB DwC Buttress Thread)
- GB WSE Butt (Wear Sleeve Enhanced w/GB DwC Buttress Thread)
- GB HBE Butt (Hard Band Enhanced w/GB DwC Buttress Thread)
- GB CD 4P (Casing Drilling w/GB DwC 4P Thread)
- GB CDE 4P (Casing Drilling Enhanced w/GB DwC 4P Thread)
- GB CD 3P (Casing Drilling w/GB DwC 3P Thread)
- GB WS 3P (Wear Sleeve w/GB DwC 3P Thread)
- GB HB 3P (Hard Band w/GB DwC 3P Thread)
- GB CDE 3P (Casing Drilling Enhanced w/GB DwC 3P Thread)
- GB WSE 3P (Wear Sleeve Enhanced w/GB DwC 3P Thread)
- GB HBE 3P (Hard Band Enhanced w/GB DwC 3P Thread)

The overall scope of work for end finishing includes threading casing Pin x Pin, applying thread compound, bucking on GB DwC Couplings, end drift testing, and installing thread protectors. This document is intended to provide information needed to end finishing casing with GB Tubulars proprietary connections.

CCH is allowed to end finish new, unused, or selected well returns[1] only. Under no circumstance shall CCH end finish limited service, yellow band, or mill reject casing with GBT Connections. GBT expressly denies any warranty of connections added to anything but prime casing or line pipe meeting specifications of API 5CT or API 5L.

NOTE: Separate qualification is required for end finishing with GB DwC 4P, and GB DwC 3P Threads. Separate authorization will be given to each GB Threadform (GB DwC Butt, GB DwC 4P, and GB DwC 3P).

In this document, GB DwC Butt is synonymous with GB Buttress or GB Butt, GB DwC 4P is synonymous with GB 4P, and GB DwC 3P is synonymous with GB 3P.

[1] "Selected well returns" refer to casing that has a known history is fully traceable, and not in a large quantity.

All of the GB DwC Connections with GB Butt Threads have the same pin thread profile for a given casing OD; the pin ID varies with the casing wall thickness (weight). All of the GB DwC 4P Connections have the same GB DwC 4P Pin Threads for a given casing OD with a variable ID that is corresponding to the casing wall thickness (weight). All of the GB DwC 3P Connections have the same GB DwC 3P Pin Threads for a given casing OD with a variable ID that is corresponding to the casing wall thickness (weight).

It is important to note that GB CDE Butt, GB CDE 4P, GB CDE 3P, GB WSE Butt, GB WSE 3P, GB HBE Butt, and GB HBE 3P Couplings are weight-specific, i.e. vary with specific casing weights. The internal shoulder ID at the coupling center meets the ID and Drift of the mating Casing (or Line Pipe).

The GB DwC Pin Threads (GB DwC Butt, GB DwC 4P, and GB DwC 3P) have three unique features for enhanced performance properties. These features include:

- Tighter diametric tolerances with an ovality specification.
- Specified pin nose chamfer OD with an ID Corner Break.
- Aggressive deburring specification.

Unique and proprietary to GBT, these features are required to improve connection seal-ability, field repeatability, stabbing, torque capacity, galling and fatigue resistance.

These specifications, supplemented with industry standard API documents, are intended to provide the pertinent information needed for machining, surface finishing, non-destructive testing, gauging, and documentation. All figures, tables, and drawings are included at the end in sections titled:

- Figures
- Tables
- Connection Drawings and Tables

3.0 APPLICABLE INDUSTRY DOCUMENTS

In addition to product specifications presented in this document, other aspects of the GB DwC Connections shall meet requirements stated in **the latest** API Specifications and Recommended Practices, including:

- API Specification 5CT – "Specification for Casing and Tubing".
- API Specification 5B - "Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads".
- API RP 5B1 – "Recommended Practice for Gauging and Inspection of Casing, Tubing, and Line Pipe Threads".
- API RP 5A5 – "Recommended Practice for Field Inspection of New Casing, Tubing, and Plain-End Drill Pipe".
- API RP 5C1 – "Recommended Practice for Care and Use of Casing and Tubing".
- API Specification 5L – "Specification for Line Pipe".

These industry documents shall govern all aspects of end finishing casing for provisions, specifications, and requirements not explicitly stated herein.

Where this document and the applicable industry documents have parallel but different provisions, specifications, and/or requirements, those stated herein shall have precedence.

4.0 SAFETY and TRAINING

Safety is the sole responsibility of the CCH. Under no circumstance will GBT be liable for any injuries associated with end finishing casing with GB DwC Connections.

In addition, the CCH is responsible for the implementation and use of Personal Protective Equipment (PPE) appropriate for every task associated with this specification including, but not limited to: hardhats (if needed), long sleeves (if required), gloves, safety glasses and shoes, dust masks/respirators, hearing protection, etc. All safety equipment shall be checked daily to ensure it is in good working condition and appropriate for the risks associated with the task at hand. Policies and procedures relating to safety shall be available for review by a GBT Field Representative upon request.

In addition, work areas involving the use of compressed air, e.g. for blowing out casing IDs and surface cleaning of the threads, shall be properly barricaded with appropriate warning signs. These areas shall have restricted access during ID clean out and/or operations using compressed air.

The CCH shall ensure all operational personnel have been properly trained in the aspects of the work they will perform and the corresponding specifications. Training shall be documented and records maintained. Personnel training records shall be available for review by a GBT Field Representative upon request.

5.0 PIN THREADING - DIMENSIONS AND TOLERANCES

5.1. Drawings

GB DwC Pin Threads shall be manufactured in accordance with the latest Revisions of Drawings Nos.:

- GB DWC500.0 – Parametric Machine Drawing, Pin Dimensions for Drilling with Casing Connections; and
- GB DWC601.0 - GB Threadforms GB Butt, GB 4P & GB 3P for Drilling with Casing.

Drawing No.: GB DWC500.0 is a parametric representation of the GB DwC Pins using GB DwC Butt, GB DwC 4P, and GB DwC 3P Threads. Table GBT MRP001 applies to GB DwC Pins for all sizes and casing wall thicknesses. Diameter and weight specific dimensions are provided on a series of size-specific data tables associated with GB DWC500.0. Please refer to GBT website for latest drawing and table revisions. It can either be downloaded from the website through secure login or through GBT technical support prior to production.

GBT has always specialized in Buttress and Modified Buttress, i.e. GB 4P and GB 3P, threadforms for their proprietary connections. Extensive research over the years has demonstrated that a few refinements in thread tolerances, gauging, and makeup are key contributing factors for higher performance thread seals. As such, GBT uses the MRP Gauge to control diameter and ovality to specified tolerances. GB Connections require a few more inspection steps over those commonly employed for API BC threads. Specified tolerances are shown on the Pin and Threadform Drawings that accompany this specification. Refer to Section 10.0 for Inspection Requirements.

Table 2 shows the schedule of Drawings/Tables grid for selecting the correct documents for each GB DwC Connection. A legend showing the Table numbering system is included at the bottom of Table 2.

As an example, the following package is required to produce 7” OD, 23 ppf, P-110 GB CDE Pins:

- GBT Drawing No.: GB DWC500.0 - Parametric Machine Drawing, Pin Dimensions for Drilling with Casing Connections
- Table No.: GB50007000 (Table for 7” OD GB DwC pin threads)
- GBT Drawing No.: GB DWC601.0 (GB Threadforms GB Butt, GB 4P & GB 3P for Drilling with Casing)
- Table 1: GBT MRP001 (MRP Gauge Setting Standards, GB DwC Pin Threads)
- Table 3: Inspection Requirements for GB DwC Pins

5.2. **Tolerances**

Standard API tolerances apply for those not specified on the drawing.

5.3. **GB Pin Threadforms**

The following Threadforms are used with GB DwC Connections:

- GB Butt (5-Pitch Buttress threadform on ¾" and 1" per foot tapers)
- GB 4P (4-Pitch threadform on ¾" per foot taper)
- GB 3P (3-Pitch threadform on 1" per foot taper)

5.3.1. Basic threadform dimensions are provided on GB DWC601.0. The GB DwC Butt Connections are compatible with API Buttress Pin Threads. However, the GB DwC Pin Threads have tighter diametric tolerances, ovality limits, designed pin nose, and aggressive deburr requirements. **API BC Pins will readily makeup with GB DwC Couplings and GB DwC Butt Pins will readily makeup with API BC Couplings, but connections with mixed threads cannot provide the enhanced ratings of the GB DwC Connections.**

5.3.2. The 4-Pitch and 3-Pitch threads are ARAI Iron Works and GBT's design. Dimensions for these threadforms are provided for information purposes only. Contact GBT or ARAI Iron Works for detailed threadform, chaser/insert, and overlay drawings. GB 4P Pin Threads are compatible with GB 4P and GB DwC 4P Couplings. GB 3P Pin Threads are compatible with GB 3P and GB DwC 3P Couplings.

5.3.3. When specified on the Purchase Order or requested by end user for API monogrammed buttress pin threads, the CCH shall include the API Ring Gauge in addition to other gauging requirements stipulated herein.

5.4. **GB DwC Pin Thread Compatibility**

Pin threads machined in accordance with these specifications are completely compatible and interchangeable with previous generation GB Couplings as listed below.

- GB DwC Buttress Threaded Pins are compatible with GB Butt Couplings.
- GB DwC 3P Threaded Pins are compatible with GB 3P Couplings.

These new generation threads will match fit, form, and function when assembled with any existing like-threaded GB Coupling.

6.0 GAUGING EQUIPMENT

All gauging equipment shall be in good working condition and appropriate for the task, i.e. external gauges for external threads, etc. It is also a requirement that all gauges used for threading GBT Connections be calibrated **either in accordance with the CCH's documented procedure(s) and applicable API Requirements, or at least one time per year**, although more than once per year is preferred by GBT. Calibration certificates/documents shall be available for inspection by a GBT Field Representative upon request.

The list of gauges required for GBT products are as follow:

Thread Crest Diameter Gauge:	MRP 2000
Width of contact shoe for MRP:	5/8" (GB DwC Butt & GB DwC 4P); 7/8" (GB DwC 3P)
Ring Gauge:	API (Buttress Only) per PO and/or end user request
Taper Gauge:	API External w/0.090" ball contact points
Lead Gauge:	API for 1" interval w/0.062" ball contact points API for 2" cum. interval w/0.062" ball contact points
Height Gauge:	API direct read out (or balanced dial)
Runout:	API w/0.057" contact point
Thread Profile Gauge:	Required for each threadform
Gauge Specific Setting Standards:	MRP (required), Lead and Thread Height (API for GB Butt and GB 4P, special standards required for GB 3P)

If gauges have been set up in a controlled environment, i.e. gauge lab, then the set-up shall be verified later under the actual workplace conditions after enough time has passed for the equipment to acclimate to ambient conditions, e.g. temperature, humidity, etc. Documentation of this secondary equipment setup verification is **MANDATORY** and shall be maintained with the job related QA/QC records.

Thread crest diameter measurements shall be made using an appropriate Gagemaker MRP-Gauge or equivalent device, approved by GBT in writing, in accordance with the manufacturer's instructions and industry accepted practices. Appropriate[2] setting standards, or similar equipment, with industry accepted trace-ability shall be used for gauge set-up.

Other industry accepted equipment and/or methods, for example, go/no-go gauges, may be used at the CCH's discretion provided they are used in accordance with documented internal procedures.

[2] Properly compensated for taper and threadform.

7.0 SURFACE FINISH AND DEBURRING - PIN THREADS

7.1. Surface Finish

All GB DwC Buttress, GB DwC 4P, and GB DwC 3P Pin Threads shall be **as-machined** with minimum surface finishes, as specified below, and aggressively deburred (as per Section 7.2).

Minimum Pin End Surface Finish Requirements

All machined surfaces except threads: 250 RMS (RA)
Threads (GB Butt, GB 4P, and GB 3P): 125 RMS (RA)

Under certain circumstances, abrasive blasting may be required on GB DwC Pin Threads; refer to Section 9.8 on Abrasive Blasting requirement for further information on this process.

7.2. Deburring

Important features of GB DwC Connections are long-term, low-level fatigue resistance and make/break repeatability under field conditions. These features are directly related to careful, aggressive deburring at all corners breaks, chamfers, sharp transitions, starting and exit threads, imperfect (runout) threads, etc. Therefore, this procedure is **MANDATORY** on all GB DwC Connections (Couplings and Pins).

7.2.1. Deburring shall be carefully performed to remove feather and/or sharp edges, fins, wickers, etc. on starting and imperfect threads (See Figure 4). Care shall be exercised to avoid disturbing **any perfect** pin thread.

7.2.2. If stand roller is used, the deburr wheel rotating direction should be counter to the pipe rotating direction.

7.2.3. When deburring imperfect threads, extra care must be exercised to remove fins raised above the thread crests without rolling them into the flank areas.

7.2.4. Abrasive wheels shall be used for deburring. In general, abrasive wheels should be soft and self-forming, but sufficient to remove fins at the thread crests. GBT recommends the abrasive wheels listed below that experience has shown to be operationally effective and efficient. Please note the following are recommendations and other equivalent abrasive wheels meeting these general descriptions may be used.

- 3M – 3” Dia. x ¼” wide x ¼” Arbor Hole; #15532-2A Medium
- 3M – 3” Dia. x 1/2” wide x ¼” Arbor Hole; #03732-7A Medium
- Standard Abrasives – 3” Dia. x 1” wide x 3/8” Arbor Hole; Unitized 900 Series

GBT recommends 1/2" wide abrasive wheels for starting threads and 1" wide abrasive wheels for imperfect threads.

Sandpaper, Scotchbrite, or similar abrasive materials are not acceptable to meet GBT's deburring requirements. Flapper wheels of any type are **strictly forbidden** for deburring without prior written approval by GB Tubulars.

7.2.5. In recognition of the importance of proper deburring to connection repeatability, the GBT Field Representative, at his sole discretion, shall determine the acceptability of finished parts.

7.2.6. The CCH is responsible for and shall implement appropriate safety procedures, including enforcing the use of task-appropriate Personal Protective Equipment (PPE) for all personnel performing deburring.

8.0 COLOR CODES AND MARKINGS

8.1. Color Codes

Color codes and markings shall be applied to the outside surface of casing in accordance with the provisions of API 5CT and end user requirements. GB DwC Drawings provide GB-specific marking requirements. Pipe marking shall be in accordance with API 5CT and end user requirements. Any special marking requirements shall be clearly defined on the purchase order by the end user.

8.2. Supplemental Marking Requirement for GBT

After end finishing, stenciled markings shall be applied to the outside surface of finished casing in accordance with the provisions of API 5CT, GBT (if specified), and end user requirements.

The following information shall be applied in addition to all other markings on all orders processed for GBT:

- A GBT PO Number (yyPxxxx or yySxxxx)
- GBT Connection Name
- The End-finisher's Work Order or Router Number
- The Process Date[3] (mm/dd/yyyy or mm/yyyy)
- End Drifted (mill end only)
- The Joint Number[4]. The actual Joint No. can be applied with a paint stick or other means as long as the marking is at least 2-in height and legible.

5 1/2" OD, 23.00 ppf, P-110 GB CD Butt 6.200

GB yyPxxxx, WO#xxxx, mm/dd/yyyy, END DRIFTED, JT #

All stencils, except for end drift, shall be placed adjacent to both threads (2 places) and located consistently on all joints. CCH's stencils shall not cover, block, or obstruct original mill markings in any way. A clear lacquer or equivalent paint shall be sprayed over all applied stencils; this extra protective coating preserves markings when finished parts remain in inventory for extended time periods.

Additionally, an end drift marking is required at the mill end of the casing after coupling buck on. See Section 9.16 on End Drift Requirements for further information on this requirement.

[3] Date of threading
[4] Joint numbers to be unique, sequential numbers

9.0 OTHER REQUIREMENTS

This section provides information and specifications addressing other requirements for End Finishing Casing with GB DwC Connections. Unless otherwise specified here, please follow API Specification 5B, "Thread Dimensions and Tolerances" section, for all other gauging requirements for GB DwC Pins.

9.1. Runout Threads and Perfect Thread Length

It should be noted that the GB Butt, GB 4P, and GB 3P threads are **full** runout threads. The runout is defined as the intersection of pipe OD and thread cone; it is a location on the pipe OD where the thread root vanishes.

GBT recommends that pin threads be machined so that the tool passes the pipe OD on taper until it no longer touches the metal. **At a minimum, the last forming thread of the insert/chaser shall remain engaged along the taper cone for an axial distance equal to A1 plus 0.625".** CCH should demonstrate the thread pull out position is more than A1 plus 0.625" upon request. However, provisions of API Specifications pertaining to the definition, measurement, and acceptance of external API BC threads shall apply to GB DwC Butt, GB DwC 4P, and GB DwC 3P Threads in all respects as the absolute minimum requirement. For worst case tolerance stack up, the runout location of the connection was evaluated at minimum pitch diameter, slow taper, shortest A1 stamp location, and maximum OD tolerance per API. It's noted that smaller diameter products (i.e. 4 1/2", 5", and 5 1/2") should not have run-out threads pass the tip of A1 stamp. For 7" and above, the run-out length can be over the tip of the A1 stamp.

Note that for sizes 13 3/8" and smaller and GB Connections with GB 4P and GB 3P Threads on 10 3/4" to 20" OD Casing, the runout gauge indicator shall be set to zero using a flat, machined metal surface as a setting standard in accordance with API 5B "Thread Inspection" section for all GB Connections. It is acceptable to use perfect thread roots or the pipe OD as a setting standard for GB Connections with Buttress Threads on 10 3/4" to 20" OD (per API 5B "Thread Inspection" section). The perfect thread roots shall be checked and determined to have acceptable taper prior to use for runout gauge setup.

If the last thread root is less than or equal to distance from the end of the pipe to the apex of the makeup triangle (A1 + 0.375"), the thread must be a true runout thread. The thread runout shall be measured where it terminates or at the apex of the makeup triangle, whichever is the shortest length, by placing the runout gauge contact point at 90 degrees prior to the thread termination or the apex of the triangle, and rotating the runout gauge clockwise until the contact point is out of the thread groove or beyond the triangle apex. If the dial indicator reads +0.005" or less, the runout is acceptable. For detailed inspection criteria, please refer to API 5B Section 5.

Within the specified Lc length, as many as 2 threads showing the original outside surface of the pipe on the crests for a circumferential distance not exceeding 25% of the pipe circumference is permissible. A single thread showing the original outside surface of the pipe for more than 25% of the circumference is cause for rejection. The remaining threads shall be full crested.

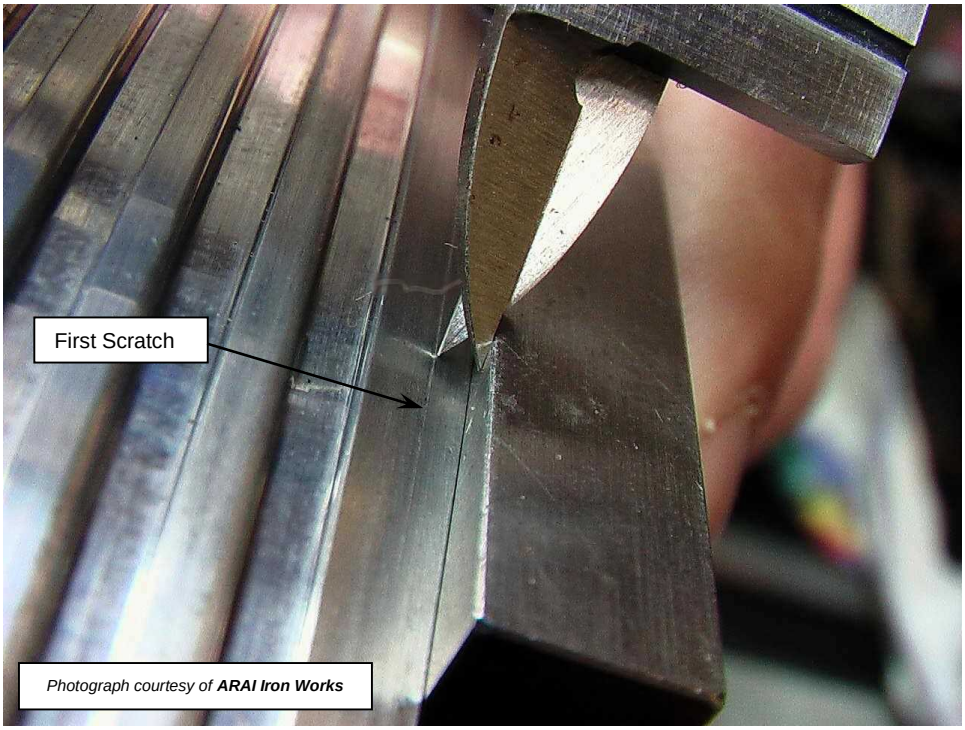
9.2. Pin Nose Bearing Face

The Pin Nose OD/ID specifications have been designed for maximizing the bearing face to provide an increased torque rating as the pin nose bearing area is usually the limiting factor for torque rating. With respect to the pin nose, the OD chamfer diameter (dch) has been designed so the root of the threadform enters on the chamfer and not on the face. A minimal ID Corner Break has been specified for the pin noses to maximize the bearing face.

Photograph showing too aggressive ID corner break using a button tool

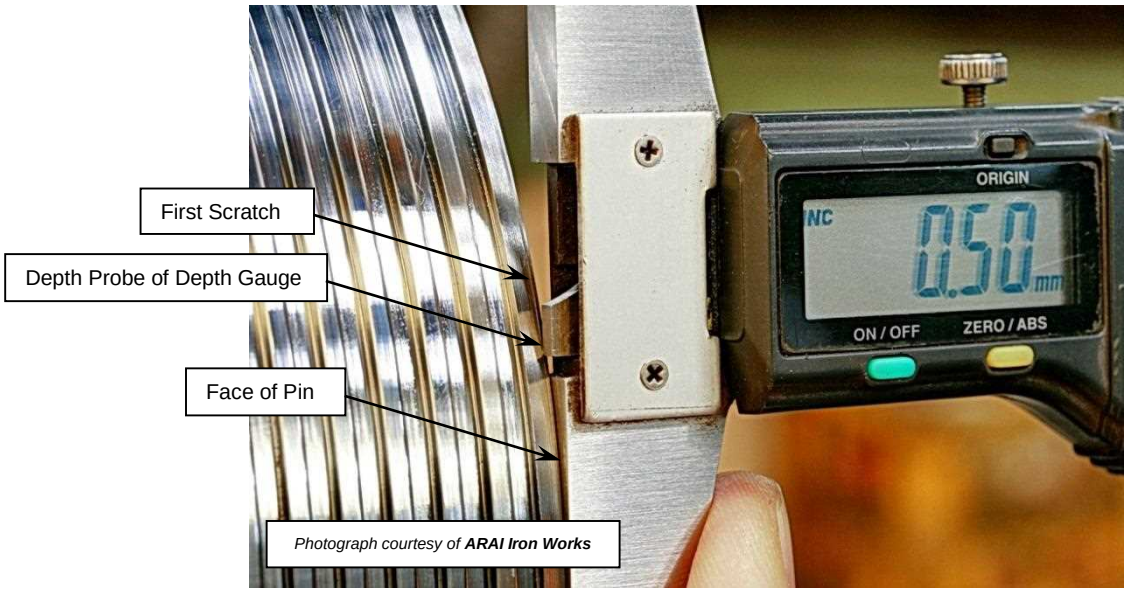
Pin Nose OD Chamfer Gauging. Recognizing the difficulty in precise gauging of the Pin Nose Chamfer OD (dch) on finished parts, two alternate methods of gauging have been devised. The first method employs a machined, flat metal gauge-block and a set of calipers, which can be seen in the photograph below.

The inspector shall turn the pipe to locate the first scratch of the pin thread root that enters on the Pin Nose OD chamfer. Gauging shall consist of measuring the distance (Ldch) between the first scratch and pin face using the gauge block as shown in the picture.



Photograph showing precise measurement of Ldch as described above

The second method for measuring Ldch employs the depth probe of a standard depth gauge as shown below.



Photograph showing precise measurement of Ldch using depth probe of a depth gauge

Of these two methods, the first is considered more precise and therefore preferred. Regardless of the measurement method, tolerances for Ldch are given on Drawing GB DWC500.0; any out-of-tolerance part shall be rejected.

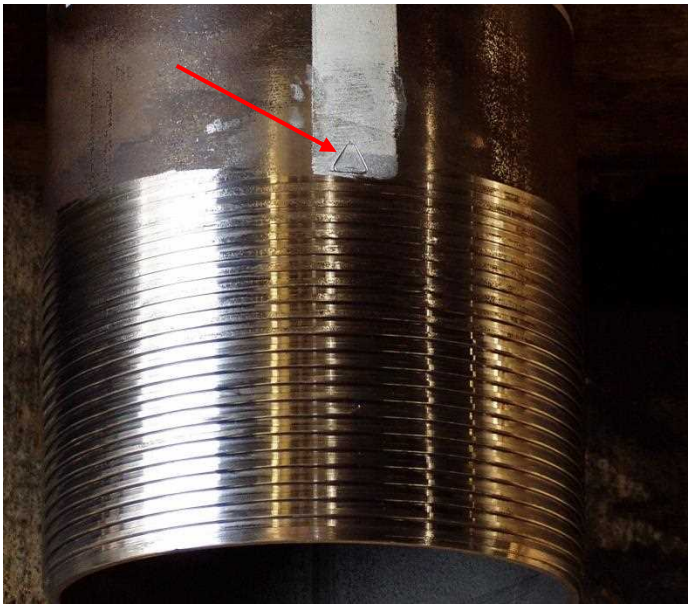
Tables GB500XXXXX provide size-specific pin threading dimensions and lists the Pin Nose Bearing Face (*bf*) as a reference dimension. Due to pipe wall eccentricity, there may be a portion of the pin nose that is relatively thin. This is acceptable as long as the thin portion is equal to or greater than the specified *min. bf,* and thin nose portion does not exceed 1/3 (120º) of the Pin Nose Facial Circumference. Any pin with a bearing face equal to *bf, min* that extends over more than 1/3 of Pin Nose Facial Circumference shall be reject.

9.3. Corner Breaks

The GB DwC Connections Specifications call for minimal corner breaks on the Pin Nose ID for all GB DwC Connections; corner break machining is not necessary for this requirement. The following detailed specifications shall also apply to all specified corner breaks:

- Minimal Corner Break shall extend 360º and an aggressive deburr is required.
- The ID corner break should be produced to maintain the maximum bearing face.
- Pin nose corners shall have no sharp edges.
- Specified Pin nose Chamfer OD (dch) is a reference dimension. The maximum Chamfer OD shall be such that: 1) the pin thread root enters on the pin nose chamfer and not on the face of the pipe, and 2) shall not produce a feather edge.

9.4. **Triangle Stamp**



All GB DwC Pins shall be stamped with the API Triangle Stamp per API Specifications. In addition to, and in accordance with, industry standard specifications, each end shall be marked with a white locator stripe to help field personnel quickly locate the API Triangle Stamp; see photo. It is imperative that all GB pin threads include the API Triangle Stamp as well as the white locator stripe consistent with the specified width and length by API Requirements. The white locator stripe shall be placed on top of all other paint finishes. The API Triangle Stamp shall be applied after, or on top of, the white locator stripe. After stamping on top of the white locator stripe, the API Triangle Stamp shall be sprayed with clear lacquer or equivalent paint for extra protection during storage, transportation, and handling.

The white locator stripes and API Triangle Stamp are **MANDATORY** on all pin threads for GBT, including those cut on pups, subs, and other accessory equipment. There are no exceptions to this requirement.

API Triangle Stamps shall be located as specified by API within the designated tolerance. Any API Triangle Stamp located out of the specified location tolerance shall be rejected. API Triangle Stamps on GB Pins (GB Butt, GB 4P, and GB 3P) shall be located in the same position and tolerance as specified for API BC pin threads.

Gauging and QA/QC procedures shall include verification that the API Triangle Stamp is located within the specified tolerance and visually inspected to verify the entire stamp is **full formed**. No duplicate or partial stamps are allowed within the specified marker stripe except as discussed and illustrated below. Any stamp that is outside of the locator stripe should be carefully removed.

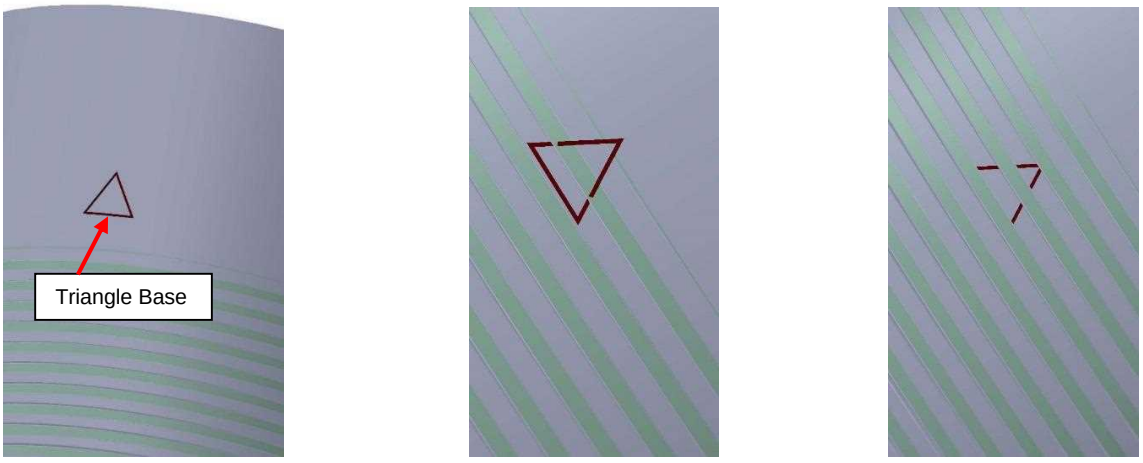
The following outlines the requirements for **full formed** triangles in the context of this specification. A **full formed** API Triangle Stamp is one that is placed on the original pipe surface (if possible) where the base, both sides, and the apex are all readily visible. It should be recognized that with allowable pipe OD tolerances, it may not be possible to locate the API Triangle Stamp on the original pipe surface where there

are not any threads. In these cases, the API Triangle Stamp shall be located such that the base and apex are located on a thread crest. If this is the case, it should be recognized that only partial sides of the triangle may be present. The pipe shall be rotated to determine the optimum spot for the API Triangle Stamp within the parameters described below. Without a readily visible base, verification that the API Triangle Stamp has been applied in the correct location is not possible. Any applied API Triangle Stamp that does not meet these requirements shall be rejected.

The following sections illustrate the triangle stamp locations. They are provided as examples only and are not intended to imply the actual stamp location on the part. **The green shade represents the thread root.**

9.4.1. Triangle stamp on connection with GB Butt thread form

With smaller casing sizes, i.e. 4 1/2", 5", and 5 1/2", it is difficult to get a **full formed** API Triangle Stamp. With these casing sizes, the API Triangle Stamp base and part of the two sides will be visible on one thread crest and the apex will be visible on the next thread crest. Partial sides of the API Triangle Stamp will be present on both crests. It is GBT's recommendation that the CCH use special curved triangle stamping equipment manufactured for the smaller casing sizes, such as 5 1/2" OD and smaller. The figure below gives a visual indication of accept and reject criteria for the triangle stamp of GB Butt thread form.

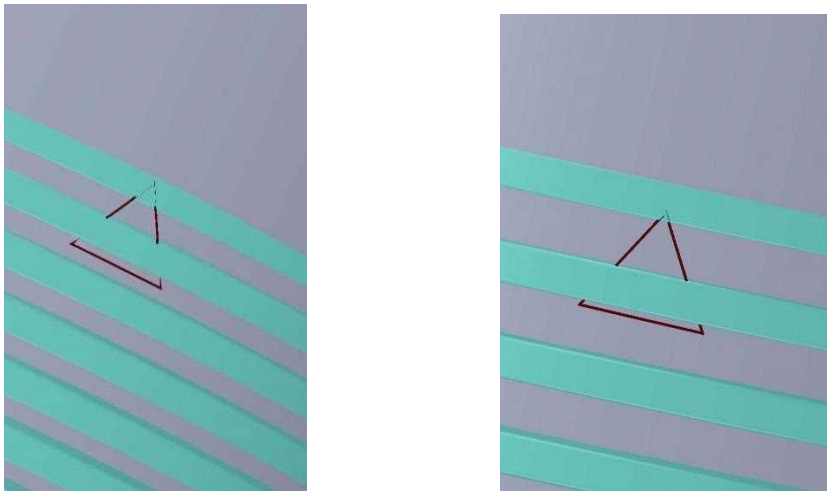


Accept: Triangle on pipe OD or Triangle tip and base on the crest. Reject: Triangle base and tip on the root.

9.4.2. Triangle stamp on connection with GB 4P or GB 3P thread form

For GB 4P and GB 3P thread forms, due to the nature of thread pitch and size of the triangle stamp, it is acceptable if only the base of the triangle stamp is visible on the crest of **GB 4P and/or GB 3P**

threads. The figure below gives a visual indication of acceptance criteria for the triangle stamp of GB 4P and GB 3P thread forms.



Accept: Triangle stamp base on the thread crest and tip on the thread root.

GBT recommends a jig, holder, or other device when applying API Triangle Stamps to aid location consistency among pins during production end finishing runs. Vibro-Etched stamps that clearly show the API Triangle stamp base and apex in pin thread roots are acceptable. When using this equipment, the triangle base and apex shall be readily detected by visual observation otherwise the stamp is a reject. Laser stamping is **strictly prohibited**.

9.5. Thread Compounds

GB DwC Connections are designed for use with industry standard thread and storage compounds as detailed below:

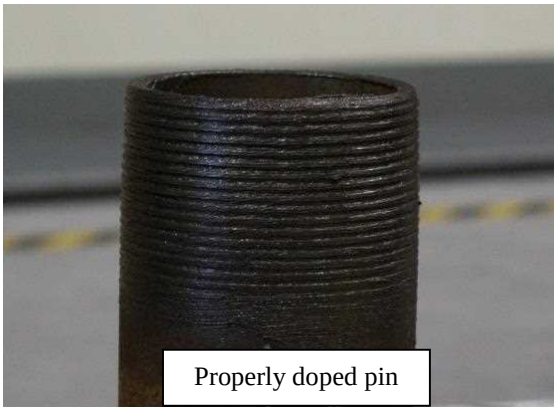
Thread Compounds: Best-O-Life 2000, API Modified, or equivalent.

Storage Compounds: Kendex or equivalent.

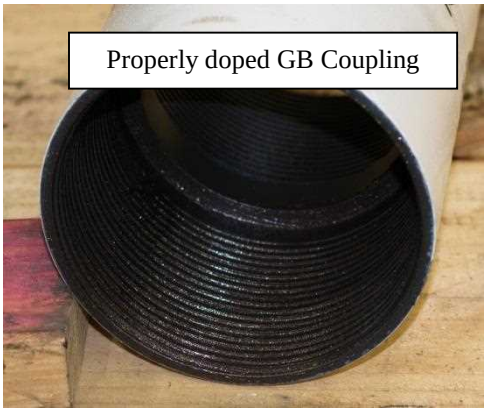
It is imperative that the CCH understands that under no circumstance shall a coupling be bucked on to a pin with a storage compound.

Proper application of thread compound is an important factor for performance of GB DwC Connections with respect to storage, makeup torque, and field performance. Thread compound shall be applied in a light, even coat over all threads and shoulders, mill side of the pin nose for GB CD type, and internal shoulder on the field side of the coupling for GB CDE type. Sufficient thread compound has been applied when the threadform is completely and uniformly covered (with no bare spots) and threads are visually discernible

under the compound. In general, GB DwC Connections are thread compound "friendly", so generous application of thread compound is acceptable provided compounds are not applied excessively.



Properly doped pin



Properly doped GB Coupling

9.6. **Storage Compound**

End Finished Casing with GB DwC Connections pulled from inventory may have a storage compound under the thread protectors. All storage compound shall be removed from connection threads and thread protectors prior to application of thread compound and re-installation of thread protectors. Threads and protectors shall be completely cleaned and dried before application of new thread compound.

Under no circumstance shall a pipe be shipped to a rig with a storage compound under the thread protectors unless specified in writing by the end user, in which case both ends shall have 2-in wide yellow tape bands that clearly state "Storage Compound".

9.7. **ID Bore-Out of Pins**

On certain casing diameters and weights, usually casing with a special or alternate drift diameter, i.e. "no-drifts", may occur under couplings after buck on. When encountered, the following specification shall be employed to eliminate this problem:

9.7.1. Bore out pin ID on **both** ends of all "no-drift" joints. The ID shall be bored to the nominal pipe ID dimension (see appropriate pin thread table, Table GB500XXXXX) with a tolerance of +0.030"/-0.000". ID Boring shall be performed on a taper on diameter and shall extend until the tool **no longer removes metal**. The ID Bore taper should be between 0.008 in./in. to 0.020 in./in. on diameter. The maximum bore out length shall be no more than 5-in from the pin nose. Contact a GBT representative immediately for troubleshooting if bore-out lengths extend more than 5-in. from the pin nose. Figure 5 shows the Pin Nose ID Bore Detail.

9.7.2. For each pin ID bore, the following measurements shall be made and recorded:

ID Measurements: Two ID Measurements (0° and 90°) under the pin nose.

ID Bore Length: Record maximum ID bore length.

If a small amount of no-drifts are experienced, manual grinding to remove the no-drifts is allowed. Manual grinding of the ID should be performed on both the mill end and the field end. Mill end ID under the pin nose should be measured and recorded at 0° and 90° before and after manual grinding. The amount removed should be used as a reference for field end no-drifts repair. A similar amount of material (diameter change and bore length) should be removed on the field end to avoid no-drift during field deployment.

If during processing a high number of no-drifts under the couplings are experienced, it is acceptable to pre-bore pins during threading operations to avoid the extra handling. This is at the CCH's sole discretion based on experience with the pipe being processed and economics of the order.

This specification shall also apply when ID Bore is included with pin threading. **Recorded information shall be maintained along with other gauging information for the order.**

9.8. **Abrasive Blasting**

When specified on the Purchase Order, abrasive blasting **shall** be performed when pins are machined on C-90, T-95, all chrome-moly (≥1% Cr and ≥ 0.15% Mo), and specialty steels designated as "high toughness"; for example, Shell's CYP-110 Grade. In addition, abrasive blasting may be required on Q-125 Grade Casing.

When abrasive blasting is not specified on the Purchase Order, machined threads on any material with 110 ksi yield strength or higher shall be carefully inspected using a minimum 10X magnifying glass for any tiny hair-like threads, fins, and wickers. This visual inspection shall be performed on the first 10 joints (both ends).

If no tiny hair-like threads, fins, or wickers are found, threaded parts shall be periodically inspected thereafter on no less than 10% of the ends within a thread lot, batch, or production order. If any tiny hair-like threads, fins, or wickers are observed at any time during inspection, check tooling and/or CNC program. If machine, program, and tooling checks do not eliminate the problem, abrasive blasting shall be performed on all machined threads.

Abrasive blasting shall be performed **after** the mandatory deburring as discussed previously in this specification. Abrasive blasting is **not** a substitute for deburring; if required, abrasive blasting follows an acceptable deburr operation.

The purpose of abrasive blasting is to remove hair-like threads, fins, wickers, burrs, etc. that can break free of the threads or roll into the flanks during connection assembly. If left alone or rolled into the flanks, these machining remnants may reduce fatigue resistance and/or contribute to thread galling during connection assembly.

9.8.1. Parts to be blasted shall be clean and dry. Blasting shall be performed over the entire threaded surface with abrasive grit, glass beads, or equivalent media. The appropriate media should be equivalent in size to Black Beauty #6, WA-46, WA-60, or other equivalent products.

9.8.2. While blasting, parts shall be rotated while steadily moving the blast nozzle to yield a uniform, consistent finish. After blasting, each part shall be thoroughly cleaned to remove all blast media residue and grit. Connections and casing should be blown out to completely remove all debris from the ID.

9.8.3. After blasting, each part shall undergo thorough visual inspection. For acceptance, each part shall have a uniform surface finish appearance over 100% of the treated surface area with no shiny areas and/or bare spots.

9.9. ID Clean Out

After threading is complete, the through-bore of pipe and accessories shall be blown out to remove coolant(s), saw filings, shavings, scale, abrasive blasting media (if used), and all other debris that may be present. **This requirement is mandatory**. The ID should be checked carefully to be sure nothing has been left in the pipe, such as pipe plugs used during the threading process. Most facilities blow the pipe out with high pressure compressed air. It is strongly recommended by GBT that the pipe be blown out from the box end toward the pin end. Blow out in this direction avoids depositing debris on the box threads which would require additional cleaning of the box threads prior to application of thread compounds.

The end-finisher is required to implement appropriate safety procedures including the use of Personal Protective Equipment (PPE) for all personnel performing ID clean out. In addition, barricades and warning signs are needed near the exit end to avoid injury to other plant personnel that may be in, or inadvertently pass through, the area.

9.10. Final Cleanup

All exposed threads shall be thoroughly cleaned and dried before any storage or thread compound is applied. Appropriate cleaning methods include the use of compressed air, soft bristle brushes, clean rags, or other method(s) the CCH deems suitable to achieve the desired result. **In general, cleaning as described here using only rags is inefficient and generally not sufficient to achieve the desired results**. A last visual inspection is highly recommended before application of any storage or thread compound to catch any thread damage that might have occurred during material movement in the process.

9.11. **Jaw Marks**

Makeup equipment chucks shall have sufficient bearing area to minimize localized marks on external pipe and coupling surfaces. Low stress, so called soft jaws, shall be used during makeup. API Specifications regarding permissible depths with respect to sharp/round bottom jaw marks shall govern all aspects of external surface imperfections on couplings and casing. Refer to API Specification 5CT, Permissible Depth of External Imperfections on Coupling for details. Jaw marks on casing and/or connection external surfaces exceeding API allowances shall be cause for reject, and thus require repair and, if necessary, cut-off and replacement.

The bucking unit shall be checked for proper leveling and alignment. To avoid jaw mark problems when they occur, connections can be wrapped with sandpaper in addition to soft jaws, to further reduce jaw marks. Jaw marks shall be measured and recorded at the start of, and periodically during, each production run. Appropriate corrective measures shall be implemented to minimize jaw marks on coupling ODs.

The pictures above provide a visual example of uneven jaw marks on the left and better distributed jaw marks on the right side. The jaw marks on the left show the uneven loading on the coupling OD favors one end of the coupling; on the other hand, the right side show more evenly distributed jaw marks on the coupling OD that implies better alignment and uniform gripping force. Jaw marks shall also be consistent around the circumference of the coupling OD.

9.11.1. Couplings rejected for jaw marks shall be repaired in accordance with API requirements. If the coupling is not repairable, it shall be rejected. The corresponding pin may be re-used provided it passes visual inspection.

9.12. **OD Cylinder Turn Requirements**

In some cases, GB DwC Connections may be specified on 9-7/8", 11-7/8", and 13-5/8" OD Casing. These less common casing sizes commonly use standard 9-5/8", 11-3/4", and 13-3/8" OD buttress pin threads respectively, and the corresponding standard sized couplings. As such, 9-7/8", 11-7/8", and 13-5/8" OD casing require an OD cylinder turn prior to pin threading. See GBT Drawing No. GB DWC500.0 which illustrates the detail for this feature.

9.12.1. After machining, each joint shall be inspected by measuring OD and wall thickness in accordance with the drawing. OD shall be checked with an OD micrometer following industry-accepted practices in accordance with the internally documented procedures. If the measured OD is less than the value specified on the drawing, the part is a reject, and there are no exceptions to this requirement.

9.12.2. Wall thickness shall be checked by taking 4 readings (one per quadrant) with a "D" meter, OD and ID micrometers, or deep throat micrometers and calculating the average. When OD and ID readings are used, measurements shall be taken in 4 places around the circumference for use in determining the average and minimum wall thickness. The average must exceed the given value with no single reading less than the specified minimum wall thickness as shown on Drawing No. GB DWC500.0.

9.12.3. Reject parts may be re-cut after programming the appropriate offset to increase the cylinder turn OD to increase remaining wall thickness.

9.12.4. When threads extend into the API Triangle Stamp area, accurate readings may not be possible with a "D" meter. In these cases, OD and ID readings shall be taken in 4 places around the circumference using OD and ID micrometers, or deep throat micrometers, for use in calculating wall thickness. Calculate the average and minimum reading and assess compliance with the above specifications.

9.13. **Thread Protectors**

GBT recommends new or reconditioned thread protectors. Unless otherwise specified, thread protectors shall be Closed End Liftable (CEL) and vented. DRILLTEC Protector Products are preferred. Regardless of manufacturer, CCH shall follow the manufacturer's recommendations for installation of thread protectors and subsequent handling.

Because GB DwC Connections have pin nose to pin nose (GB CD type) or pin nose to torque shoulder (GB CDE type) engagement at power tight, some standard API Box thread protectors may be too long. When this happens, these protectors will not adequately seal against the bearing face of the coupling. To avoid this condition, see Table 6 for Maximum Allowable Box Thread Protector Lengths.

9.13.1. Reconditioned Thread Protectors

GB Tubulars allows the use of reconditioned thread protectors provided they are clean, free of all debris, and replicate the fit, form and function of new thread protectors. Any reconditioned thread protector that is visibly damaged, cracked, and/or does not fit properly shall be reject. It shall be the CCH's responsibility to scrap or return rejected protectors to the supplier for replacement or credit.

9.13.2. Installation of Thread Protectors

Prior to installing thread protectors, the connection threads shall have storage or thread compound, whichever is specified. Sufficient compound has been applied when the threadform and all other internal bare surfaces are completely and uniformly covered (with no bare spots) and threads are visually discernible under the compound.

Thread protectors shall be installed in strict accordance with the thread protector manufacturer's recommended procedures. These devices are intended to isolate thread compound on machined areas of the connection for efficient protection against corrosion. They must also provide an effective seal against moisture intrusion. GBT acceptance criteria for thread protector installation are:

- Box Thread Protectors: Thread protector face shall fully engage and seal against the coupling bearing face. Please refer to Table 6 for Maximum allowable box thread protector length for GB DwC connections.
- Pin Thread Protectors: Thread protector shall be installed using strap wrenches or similar device that will not damage exterior surfaces of the thread protector.

9.14. **Rig Prepping Casing**

Casing in the yard may have either storage or thread compounds under the protectors.

9.14.1. **Pipe stored with a storage compound:** Remove thread protectors from **all** pins and boxes. All threads and pulled thread protectors shall be thoroughly cleaned and dried, and undergo a visual thread inspection. Cleaned parts shall be protected from dust and debris contamination. New thread compound, as specified in Section 9.5, shall be applied in a light, even coat over all threads and shoulders, mill side of the pin nose for GB CD type and internal shoulder on the field side of the coupling for GB CDE type. Sufficient thread compound has been applied when the threadform is completely and uniformly covered, with no bare spots, and threads are visually discernible under the compound. In general, GB DwC Connections are thread compound "friendly", so generous application of thread compound is acceptable provided compounds are not applied excessively. Re-apply thread protectors in accordance with the manufacturer's recommendations for continued

storage and/or shipment. Any threads that do not pass visual inspection shall be repaired before they are returned to storage or loaded out.

9.14.2. **Pipe stored less than 6 months with thread compound:** Pipe can be shipped without visual thread inspection provided new thread compound was applied in a light, even coat over all threads after end finishing in accordance with provisions in these specifications. Assuming the thread compound around the protectors does not appear dried out or show visible signs of deterioration, the pipe can be shipped as-is without further investigation.

9.14.3. **Pipe stored more than 6 months but less than 12 months with thread compound:** Pin and box protectors from approximately 10% of joints to be shipped shall be removed for visual thread inspection. All threads and pulled thread protectors from selected joints should be thoroughly cleaned and dried, and a visual thread inspection shall be performed. Cleaned parts shall be protected from dust and debris contamination. New thread compound, as specified in Section 9.5, shall be applied in a light, even coat over all threads and shoulders, mill side of the pin nose for GB CD type and internal shoulder on the field side of the coupling for GB CDE type. Sufficient thread compound has been applied when the threadform is completely and uniformly covered, with no bare spots, and threads are visually discernible under the compound. In general, GB DwC Connections are thread compound “friendly”, so generous application of thread compound is acceptable provided compounds are not applied excessively. Assuming that the thread compound has not dried out and doesn’t show visible signs of deterioration and the threads pass a visual inspection (on all selected joints), the pipe can be shipped as-is without further investigation.

If any threads on the selected joints do not pass visual inspection, then every joint shall have protectors removed. After removal, all thread protectors and threads shall be thoroughly cleaned, dried, and visually inspected. Any threads that do not pass visual inspection shall be repaired before they are returned to storage or loaded out.

Visual inspection shall be performed to distinguish between discoloration, staining, and pitting. Discoloration and staining are not cause for reject/repair. Light pitting in the run out threads can be touched up by hand. Field repairs may be acceptable with minor pitting; otherwise the connections shall be cut-off and re-threaded and, if applicable, have new couplings installed. Pitting in the perfect threaded area of pin threads, i.e. within the specified Lc dimension, or within mating section of box threads, i.e. box threads that engage perfect pin threads, is cause for reject. A GBT Field Representative shall be consulted for disposition of questionable thread condition(s).

9.14.4. **Pipe stored longer than 12 months with thread compound:** Remove thread protectors from all pins and boxes. All threads and pulled thread protectors shall be thoroughly cleaned and dried and undergo a visual thread inspection. Cleaned parts shall be protected from dust and debris contamination. New thread compound, as specified in Section 9.5, shall be applied in a light, even coat over all threads and shoulders, mill side of the pin nose for GB CD type and internal shoulder on the field side of the coupling for GB CDE type. Sufficient thread compound has been applied when the threadform is completely and uniformly covered, with no bare spots, and threads are visually discernible under the compound. In general, GB DwC Connections are thread compound "friendly", so generous application of thread compound is acceptable provided compounds are not applied excessively. Re-apply thread protectors in accordance with the manufacturer's recommendations for continued storage and/or shipment. Any threads that do not pass visual inspection shall be repaired before they are returned to storage or loaded out.

Visual inspection shall be performed to distinguish between discoloration, staining, and pitting. Discoloration and staining are not cause for reject/repair. Light pitting in runout threads can be touched up by hand. Field repairs may be acceptable with minor pitting, otherwise the connections shall be cut-off and re-threaded and, if applicable, have new couplings installed. Pitting in the perfect threaded area of pin threads, i.e. within the specified Lc dimension, or within mating section of box threads, i.e. box threads that engage perfect pin threads, is cause for reject. A GBT Field Representative shall be consulted for disposition of questionable thread condition(s).

9.15. **Threadlocked Connections**

Any **pin** thread identified for assembly with a threadlocking compound into a GB DwC Coupling shall be machined to the following special threadlock tolerances:

Thread Crest Dia. Tolerance (by MRP): -0.010", -0.015"

When threadlock connections are: (1) not identified during processing, or (2) ordered after threading is complete, it is acceptable to threadlock connections not machined to the special tolerance shown above. In these instances, the end finisher and all third party inspectors shall recognize that higher torques will be required to complete such an assembly. Time is of the essence to complete the makeup of threadlock assemblies with pin threads machined to standard thread crest diameter tolerances. Please refer to the Appendix for detailed threadlocking procedure and acceptance criteria.

9.15.1. Threadlock compounds shall be mixed and applied in strict accordance with the manufacturer's written instructions, paying close attention to specified temperature recommendations.

9.15.2. In addition, the joint shall be stenciled with the word "**THREADLOCK**", along with a minimum 24-inch long arrow(s) pointing to the appropriate pin thread(s). This stencil SHALL be applied **immediately after pin threading.**

It is important for the CCH to keep track of Threadlock tolerance pin threads and ensure these parts are properly marked as specified. A Threadlock tolerance pin assembled with thread compound **will not meet** downhole performance requirements and may result in a downhole failure. **The CCH shall be solely liable for any and all damages associated with assembling any part machined to threadlock tolerances that are not properly marked as specified here.** GBT shall not be liable for any damages resulting from this mistake.

9.15.3. Stenciled letters shall have a 2" letter height on Range 3 joints and at least a 1" letter height on accessory items, such as pup joints. Stencils and arrows shall be placed close to the appropriate end or at both ends of joints where both pins have been cut to threadlock tolerances. It is **not necessary** to stencil actual threadlock tolerances on the part.

9.15.4. Threadlock stenciling shall be in bright yellow paint or in accordance with customer instructions or specifications.

9.15.5. Prior to applying threadlocking compounds, dry molylube (Molycoat or equivalent) may be applied on pin threads only; as a reminder GB Pin threads are always as-machined with no other surface treatment except abrasive blasting or phosphate when required. Molylube products should be applied in accordance with the manufacturer's instructions. Note: Dry molylube **shall not** be applied to any pin or box threads that have been treated with any type of phosphate coating.

9.15.6. Threadlocking compounds set up relatively quickly. When assembling connections that will be threadlocked, the threadlocking compound shall be mixed and evenly applied to **all perfect pin threads** just before stabbing. Makeup should immediately follow application of the threadlocking compound. Pin threads with applied threadlocking compounds shall not be allowed to sit more than 5 to 7 minutes prior to makeup. **Note:** Threadlocking compounds shall be applied to pin threads, in a light, uniform coat over the **perfect threaded length only**.

9.16. **End Drift Requirements**

9.16.1. End drifting is required on every joint after buck on of GB DwC Couplings. During end drift testing, the drift mandrel shall be advanced through the coupling a minimum distance of 2 ft. in accordance with API Specification 5CT "Drift Requirement" section. There are no exceptions to this requirement.

9.16.2. End drift testing shall be performed with a drift mandrel that meets API Specifications for the appropriate casing size and wall thickness.

9.16.3. Prior to performing the drift test, the end drift mandrel shall be dimensionally verified, i.e. gauged, in accordance with API Specifications (refer to API 5CT and API 5A5, Drift Testing Section). Drift mandrel gauging measurements shall be recorded and maintained with the QA/QC package.

The processor shall apply a stencil confirming end drift testing at coupled end of each joint. Example: End Drift: 12.250. This requirement is **mandatory**. The end drift shall also be recorded on the buck-on sheet as part of the QA/QC package.

10.0 INSPECTION REQUIREMENTS

Inspections shall meet all end user and all applicable API requirements. In addition, GBT and/or the end user will specify one of the following two inspection levels.

Level 1: Full Inspection to include First and Last Article and Production Inspection Requirements listed in Paragraphs 10.1 and 10.2 or other GBT and end user approved procedures. Requires First Article approval by a GBT Field Representative and an end user representative (if required) prior to starting production.

Level 2: Full Inspection to include First and Last Article and Production Inspection Requirements listed in Paragraphs 10.1 and 10.2 or other GBT and end user approved procedures. Level 2 requires First Article approval by the CCH's QA/QC department prior to starting production. First Article approval by a GBT Field Representative is **not required** for Level 2. However, First Article gauging reports shall be available for review by a GBT Field Representative at any time.

If Level 1 Inspection is required it will be specified on the Purchase Order. If not specified, the CCH shall assume Level 2 Inspection Requirements apply. Inspection requirements are shown on Table 3 - Inspection Requirements for GB DwC Pins.

Upon job completion, all inspection records shall be sent to GBT; electronic format is acceptable. Hard copies of the inspection package shall be kept for at least three years.

PERSONNEL: All personnel involved in the threading and assembly of GB Connections shall have appropriate training and knowledge about the equipment and processes inherent in said activity. Each CCH shall maintain documentation of training and experience of all operators involved in processing GB Connections. This documentation shall detail the time and content of the training.

DEFINITION OF FIRST ARTICLE: First Article generally applies to machine setup, cold start, shift change, or other significant events, such as machine maintenance, that sufficiently interrupt normal production and can potentially affect the quality of finished parts. Additionally, First Article means one part that has: (1) all measured thread elements within specified tolerances, (2) all threadform radii are fully formed and within the tolerance band based on the thread comparator overlay issued by GBT, via a threadform trace or other acceptable method, and (3) specified ***thread crest diameter***, ***lead, and tapers*** that are within **the special tolerance** range shown below (using standard measurement locations and procedures):

Special Tolerances for a Qualified and/or Approved First Article

Thread Crest Diameter (MRP)

13 5/8" OD and smaller	0.000 to +0.0025"
16" OD and larger	0.000 to +0.004"

Lead

13 5/8" OD and smaller	±0.0015"
16" OD and larger	±0.002"
Cumulative Lead	±0.0025"

Taper

0.062 to 0.064 in./in. (3/4 in./ft. Taper)

0.083 to 0.085 in./in. (1 in./ft. Taper)

First Article **taper** measurements shall not be "erratic". The definition of "erratic" for First Article is where taper measurements are: (1) not within the acceptable range shown above and (2) exceed ±0.001 in./in. between adjacent measurements.

If a First Article meeting the preceding definition has not been achieved after 10 threads, the machine setup, program, tooling, etc. shall be thoroughly evaluated and appropriate corrective measures implemented. A First Article must be achieved prior to starting all accessory threading.

GBT realizes that several parts may be machined on startup that fall within allowable tolerances and still not meet the criteria for a First Article as defined here. These parts should be set aside and classified as good parts once a First Article in all respects is complete.

10.1. **First and Last Article Inspection Requirements**

This section outlines requirements for verification and documentation of First and Last Article Inspection when manufacturing GB DwC Connections.

10.1.1. Objective of First Article Inspection - The purpose of the First Article Inspection is to demonstrate that the machine "setup" generates a finished part in compliance with the dimensions and tolerances shown on the GB Connection Drawing and **the Special Tolerances** as stated above. For a specified Inspection Level 1 order, production machining shall not begin until the GB Connection specifications have been satisfied, and the part has been approved in writing by a GBT Field Representative and an end user representative if required.

10.1.2. Objective of Last Article Inspection - Inspection of the Last Article shall be performed to show that the specified dimensions and tolerances have been met throughout the production run by the initial machine setup.

10.1.3. Requirements - First Article Inspection shall include: (1) careful visual inspection, (2) complete gauging of product dimensions, and (3) geometric verification of the threadform. See Table 3 for a complete listing of First/Last Article Inspection requirements.

10.1.4. Equipment - The First Article shall be visually inspected and gauged using standard API Gauges, where appropriate, in accordance with the latest API calibration, setup, methods, and procedural specifications. Additionally, all equipment shall meet API traceability standards. See Section 6.0 for Gauge and Setting Standards information.

Thread crest diameter measurements shall be made using an MRP-2000 Gauge in accordance with the manufacturer's instructions and industry accepted practices. Appropriate[5] setting standards, or similar equipment, with industry accepted traceability shall be used for gauge setup. Other industry accepted equipment and/or methods, i.e. go/no-go gauges, may be used at the CCH's discretion provided they are used in accordance with documented internal procedures.

Geometric verification shall be performed using thread contour tracing equipment, castings (molds), cross-sectional sampling, or other industry accepted methods in conjunction with appropriately compensated overlays. Regardless of method used, geometric verification **shall be performed in a timely manner** by appointed QA/QC personnel. Under no circumstance shall production threading commence until this critical part of the initial inspection(s) is complete unless otherwise agreed upon between CCH and GBT in writing. The selected geometric verification equipment shall be used in accordance with documented internal procedures detailing the method, process, equipment, qualified personnel, overlay specifications, and pass/reject criteria.

10.1.5. Documentation - Documentation of the First/Last Article Inspection shall include numerical results, i.e. measurement or deviation from nominal, or check marks from all gauged elements and "accept or reject" notation for visual and comparative observations. Inspection results shall be documented on the inspection report forms downloadable from GBT website, or CCH's standard inspection reporting forms that are approved by GBT. Download/request should be immediately prior to starting of the production order.

[5] Properly compensated for taper and threadform.

As a reminder, under Level 1 Inspection, production machining shall not begin until a GBT Field Representative and an end user representative (if appropriate for the order) have approved the First Article.

10.2. **Production Inspection Requirements**

This section outlines requirements for inspection during production of GB DwC Connections. Production Inspection Requirements include the First and Last Article Inspection Provisions detailed in Section 10.1. Under Level 2 Inspection Requirements, First Article **approval in writing** by CCH's QA/QC department is mandatory; approval of First Article by a GBT Field Representative prior to production processing is waived.

10.2.1. Objective - Inspection during production of GB DwC Connections shall be performed to verify and document compliance with all specified dimensions and tolerances.

10.2.2. Equipment - All inspection shall be performed using standard API Gauges (where appropriate) in accordance with the latest API calibration, setup, methods, and procedural specifications. Additionally, all equipment shall meet API traceability standards.

Thread crest diameter measurements shall be made using an MRP-2000 Gauge, or similar device, in accordance with the manufacturer's instructions and industry accepted practices. Appropriate[6] setting standards, or similar equipment, with industry accepted traceability shall be used for initial gauge setup.

Other industry accepted equipment and/or methods, i.e. go/no-go gauges, may be used at the CCH's discretion provided they are used in accordance with documented internal procedures.

10.2.3. Inspection Frequency - Once a First Article has been achieved and approved by a GBT Field Representative (Level 1 Inspection Criteria) or CCH's QA/QC Personnel (Level 2 Inspection Criteria), the order is effectively released for production machining.

The next 2 pins, designated as FPV1 (First Production Verification) and FPV2, (or more at CCH's option or recommendation by a GBT Field Representative) shall receive 100% inspection to verify all specified dimensions, threadforms, and other elements (including visual inspection requirements) have been met. The only inspection process not required with these initial pins are the geometric verification (by mold or other means). After these initial 2 (or more) pins have passed inspection, production inspection may begin with the rotation so as to allow inspection of fewer elements to assist with production efficiency.

[6] Properly compensated for taper and threadform.

Table 3 lists the elements, inspection type, frequency, and rotation required during production of GB DwC Connections. Two inspection matrices are provided for manufacturing facilities with different levels of GBT product proficiency. Inspection Matrix A requires more inspection on a 10 parts rotation basis than Inspection Matrix B. Facilities are expected to start from Inspection Matrix A and migrate to Inspection Matrix B once the process is well established and production proficiency is proved by past inspection record statistics. GBT reserves the right to revert back to Inspection Matrix A requirement if the facility cannot maintain the integrity of Inspection Matrix B.

Appropriate adjustments, offsets, etc. shall be made to bring any out-of-compliance element within the specified tolerances. This element shall then be re-gauged on the next two parts before re-entering the normal inspection rotation. If this extra measurement confirms successful adjustment, the normal inspection rotation for this element may be implemented. If additional out-of-tolerance elements are found, further corrective action(s) shall be taken and a restart of the Inspection Rotation at FPV1 shall be expected.

If during production rotation, an out-of-tolerance element is spotted, the same element on the previous parts needs to be checked to find the first out-of-tolerance part. Inspection results shall be documented properly to verify compliance.

Additionally, the inspection rotation shall restart from “Piece No. 1” with each operator, shift change, and/or cold start.

The required inspection rotation relies on “reasonable” thread element consistency from part-to-part. Individual elements demonstrating erratic measurements shall be checked more often as directed by internally documented QA/QC procedures or as directed by a GBT Field Representative, if present.

10.2.4. Mold Frequency – For the purpose of this specification, “molds” using elastomeric compounds (preferred method) may include contour tracing or casting using other materials as alternates with approval by GBT. Molds shall be taken as needed on the threadform. Molds are required at the beginning of each shift, machine cold start, tool and/or tool holder adjustments, and other times as recommended by GBT Field Representative or CCH’s QA/QC personnel to verify compliance with the threadform. **Molds are not required with routine insert and/or chaser replacement.**

10.2.5. Documentation - Inspection documentation shall include numerical results, i.e. measurement or deviation from the nominal, or check marks from all gauged elements and “accept or reject” notation for visual observations. Inspection results shall be documented on the inspection report forms downloadable from GBT website, or CCH’s standard inspection reporting forms that are

approved by GBT. Download/request should be immediately prior to starting of the production order.

10.3. **Inspection Notes**

10.3.1. All visual inspection shall include critical observation of areas requiring aggressive deburr as discussed in Section 7.2. Any evidence of insufficient deburring in the starting threads, black crest (imperfect) threads, chamfers, breaks, and/or feather-edges shall be cause for reject requiring correction. In general, sandpaper, Scotchbrite, or similar abrasive materials are not acceptable to meet GBT's deburring requirements. Flapper wheels are expressly forbidden for deburring purposes. The GBT Field Representative, if present, or CCH's QA/QC Inspector shall have the final word on acceptability of finished work with respect to deburring.

11.0 MILL MAKEUP PROCEDURE FOR GB CD, GB WS, AND GB HB CONNECTIONS

11.1. Discussion

The GB Drilling with Casing Connections are refined Buttress Threaded Connections (GB DwC Buttress), GB 4P Threaded Connections (GB DwC 4P), or GB 3P Threaded Connections (GB DwC 3P). Refinements include tighter tolerances, better diametric control with MRP Gauges, multiple tapers in the coupling, and additional dimensional specifications on the pins. These design refinements have been implemented for a variety of reasons including, but not limited to, enhanced resistance to long-term, low-level cyclic loading, increased torque capacity, improved galling resistance, and reliable field make/break repeatability.

It should be noted that API does not publish recommended or reference torque values, mill makeup or field makeup for API BC Connections due to numerous variables that affect makeup. Some of these variables include pipe properties (OD, straightness, ovality, eccentricity and material grades), connection tolerances, surface finishes, amount and distribution of thread compound, thread compound friction factor, bucking unit alignment, chuck[7], equipment condition, makeup speed, mechanical/electrical/hydraulic inefficiencies of the equipment, temperature, and others.

While the GB DwC Connections will make up more consistently than API BC due to tighter tolerances and diametric controls, GBT cannot provide or specify pass/reject torque values for makeup of GB Drilling with Casing Connections. **The primary pass/reject makeup criterion is based on final position defined by the connection specific makeup gauge as described in Section 11.2.**

Table 4 presents the **Anticipated Torque** for GB CD (GB WS and GB HB) Connections. "**Anticipated Torque**" is a range intended to cover all casing weights and grades. It is for informational purposes only and is **NOT** a specified torque value. Requirements for recording torque are also for informational purposes only. Occasionally joints in a run will make up slightly outside of this range. If this happens, these occasional outliers shall be noted in the production records. A few, one or two, are not necessarily cause for concern. However, if measured torque values exceed or fall below the “anticipated” values by > ± 20% on a large number of connections (more than about 5%) during mill makeup, equipment setup, alignment, doping practices, makeup speed, and other possible factors should be evaluated to determine a root cause and corresponding adjustments/corrective actions should be implemented. If recorded values continue to fall outside those limits after corrective actions, contact GB Tubulars for further evaluation and assistance.

[7] No. of chucks, gripping location on the coupling, conditions of dies, chuck pressure, and grip footprints.

11.2. **GB DwC Connection Mill Makeup Gauges**

GBT designed gauges to assist mill makeup of GB CD, GB WS, and GB HB Connections with GB Butt, GB 4P, and GB 3P Threads to the proper makeup position. Makeup gauges are indicator gauges.

Mill Makeup Gauge Type MG1 is shown in Figure 6. Type MG1 is designed for making up the mill side within the specified position window.

11.3. **Mill Makeup Procedure for GB CD, GB WS, and GB HB Connections with GB Butt, GB 4P, and GB 3P Threads**

11.3.1. Pin and box threads are completely clean and dry.

11.3.2. Apply an even coat of thread compound to both pin and box threads. GBT recommends BOL 2000, API Modified, or equivalent products. Thread compound shall be applied in a light, even coat over all threads and shoulders, mill side of the pin nose for GB CD type, and internal shoulder on the field side of the coupling for GB CDE type. Sufficient thread compound has been applied when the threadform is completely and uniformly covered (with no bare spots) and threads are visually discernible under the compound. In general, GB DwC Connections are thread compound "friendly", so generous application of thread compound is acceptable provided compounds are not applied excessively.

11.3.3. Assemble the coupling onto the mating pin and manually turn to the hand-tight position. Strap wrenches may be used to assist hand-tight makeup.

11.3.4. Move the connection into the bucking unit and chuck it up by gripping about the center. This step requires proper bucking unit alignment and prior verification of proper alignment.

11.3.5. Insert the makeup gauge so the tapered surface rests against the coupling threads and the notched face engages the coupling face. See Figure 7.

11.3.6. Begin power tight makeup noting that GB CD, GB WS, and GB HB mill makeup is to a specific position window defined by the makeup gauge. Initial makeup can be performed in high gear then switched to low gear. However, the final makeup shall be performed in low gear at less than 6 rpm. It will be extremely difficult to stop within the specified makeup position window at higher makeup speeds.

11.3.7. Minimum makeup position is achieved when the pin nose engages the face of the makeup gauge and causes slight standoff, i.e. the gauge is pushed away from the face of the coupling. See Figure 7A for a diagram of the proper minimum makeup position.

11.3.8. Nominal makeup is achieved when half of the indicator groove is exposed. See Figure 7B.

11.3.9. Maximum makeup is achieved when the full indicator groove is exposed. See Figure 7C.

11.3.10. Makeup shall be continuous from initiation of torque until a position between the minimum and maximum positions is achieved. It is permissible to shift from high gear used at the beginning of makeup to low gear to finish the makeup as needed for the job specific equipment.

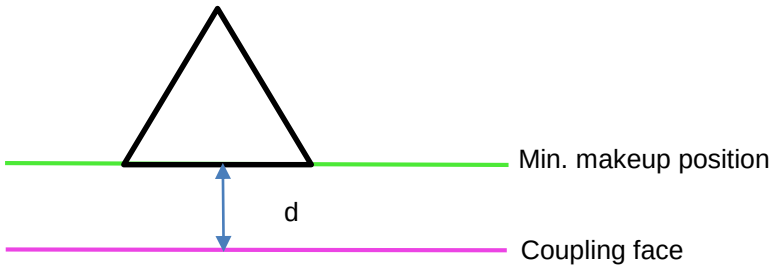
11.3.11. The end finisher shall record makeup torque for each connection and accept/reject records. Electronic torque monitoring records are also acceptable records provided they are annotated with "accept" or "reject". Torque turn monitoring equipment may be used but is not a mandatory requirement.

11.3.12. Any makeup that does not fall within the limits of the indicator groove, i.e. slight gauge standoff from coupling face to the limits of the indicator groove, shall be rejected.

11.4. **Comments**

11.4.1. Makeup of GB CD, GB WS, and GB HB Connections **shall start and continue without stopping** until the desired position is achieved as indicated by the makeup gauge.

Occasionally the operator may inadvertently stop short of the minimum makeup position. If the position d, as illustrated in the figure below, is 1/8" shy of the minimum makeup position (d < 1/8") additional torque may be added to complete the makeup. If the position d, is more than 1/8" from the minimum position (d > 1/8"), the coupling must be bucked off, threads cleaned, and visually inspected. If both pin and box threads pass the visual inspection, the connection can be used for one additional makeup attempt. If any threads do not pass a visual inspection, those threads are to be considered as reject and a new pin and/or coupling must be used.



Occasionally the operator may inadvertently exceed the maximum makeup position. If the position is less than 0.100" by caliper measurement past the maximum makeup position, reverse torque may be applied to bring the connection into compliance with the specified makeup position determined by the makeup gauge. If the position is more than 0.100" past the maximum makeup position, the coupling must be bucked off and is a reject. The pin thread may be cleaned and

visually inspected. If the pin thread passes visual inspection, it may be used for one additional makeup attempt. If any threads do not pass a visual inspection, those threads are reject and a new pin must be used. **Replacement for reject couplings from over-makeup will be at the CCH's cost.**

11.4.2. Higher anticipated torque values than those listed in Table 4 should be expected when making up connections with threadlocking compounds. Makeup shall be initiated as quickly as possible after application of threadlocking compounds. GBT cannot provide anticipated torque values for makeup of threadlocked connections.

11.4.3. See Section 9.11 for discussion on Jaw Marks.

11.4.4. **GBT requires gauges on all bucking equipment to be direct read "torque" gauges.** Gauges that read hydraulic pressure in pounds per square inch (psi) and require conversion to determine torque are not acceptable.

12.0 MILL MAKEUP PROCEDURE FOR GB CDE, GB WSE, AND GB HBE CONNECTIONS

12.1. Discussion

GB CDE, GB WSE, and GB HBE Connections with GB Butt (GB DwC Buttress), GB 4P (GB DwC 4P), and GB 3P (GB DwC 3P) Threads are refined Buttress Connections that feature a centrally reinforced coupling with tighter tolerances, better diametric control with MRP Gauges, multiple tapers in the coupling, and additional dimensional specifications on the pins. These design refinements have been implemented for a variety of reasons including, but not limited to, enhanced resistance to long-term, low-level cyclic loading, increased torque capacity, improved galling resistance, and reliable field make/break repeatability.

It should be noted that API does not publish recommended or reference torque values, mill makeup or field makeup for API BC Connections due to numerous variables that affect makeup. Some of these variables include pipe properties (OD, straightness, ovality, eccentricity, and material grades), connection tolerances, surface finishes, amount and distribution of thread compound, thread compound friction factor, bucking unit alignment, chuck[8], equipment condition, makeup speed, mechanical/electrical/hydraulic inefficiencies of the equipment, temperature, and others.

While the GB DwC Connections will make up more consistently than API BC due to tighter tolerances and diametric controls, GBT cannot provide or specify pass/reject torque values for makeup of GB Drilling with Casing Connections. Since the pin noses engage internal torque shoulders, all makeups require pin nose/shoulder engagement final power tight makeup. **The primary pass/reject makeup criterion for these connections is shoulder engagement + at least 10% delta torque[9] using the torque established at the start of the job.**

Table 5 lists **Anticipated Shoulder Torque** ranges for GB CDE, GB WSE, and GB HBE Connections. "**Anticipated Shoulder Torque**" is a range intended to cover all casing weights and grades. It is for informational purposes only and is **NOT** a specified torque value. Requirements for recording torque are also for information only. Occasionally joints in a run will make up slightly outside of this range. If this happens, these occasional outliers shall be noted in the production records. A few, one or two, are not necessarily cause for concern. However, if measured torque values exceed or fall below the "anticipated" values by > ± 20% on a large number of connections (more than about 5%) during mill makeup, equipment setup,

[8] No. of chucks, gripping location on the coupling, conditions of dies, chuck pressure, and grip footprints.
[9] Delta torque is final torque minus shoulder torque. Note that 10% is the minimum delta torque. Using the makeup torque established at the beginning of the job. A small-pin/big-box tolerance combination will have lower shoulder torque and higher delta torque. Conversely, a large-pin/small-box tolerance combination will have a higher shoulder torque and a lower delta torque.

alignment, doping practices, makeup speed, and other possible factors should be evaluated to determine a root cause and corresponding adjustments/corrective actions should be implemented. If recorded values continue to fall outside those limits after corrective actions, contact GB Tubulars for further evaluation and assistance.

12.2. **Mill Makeup Procedure for GB CDE, GB WSE, and GB HBE Connections with GB Butt, GB 4P, and GB 3P Threads**

12.2.1. Pin and box threads are completely clean and dry.

12.2.2. Apply an even coat of thread compound to pin nose, pin and box threads, and box internal shoulder. GBT recommends BOL 2000, API Modified, or equivalent products. Sufficient thread compound has been applied when the threadform is completely and uniformly covered (with no bare spots) and threads are visually discernible under the compound. In general, GB DwC Connections are thread compound "friendly", so generous application of thread compound is acceptable provided compounds are not applied excessively.

12.2.3. Assemble the coupling onto the mating pin and manually turn to the hand-tight position. Strap wrenches may be used to assist hand-tight makeup.

12.2.4. Move the connection into the bucking unit and chuck it up. This step requires proper bucking unit alignment and prior verification of proper alignment.

12.2.5. Grip the coupling at the center and makeup without stopping to shoulder engagement. Makeup should start in high gear and then be shifted into low gear (3 to 5 rpm is recommended) for completion of makeup. A spike on the torque gauge indicates shoulder engagement. As a secondary verification, any connection where the 0.005" thick feeler gauge can be inserted between the pin nose and internal shoulder for more than 25% of the shoulder circumference shall be rejected. Contact GBT for handling of reject parts.

12.2.6. Makeup the first ten connections to shoulder engagement, and record both shoulder torques and final torques. In general, the Maximum Makeup Torque **at the beginning** of the run should be limited to 2X the **Minimum Anticipated Shoulder Torque** shown on Table 5. This rule-of-thumb is given as a practical limit for avoidance of thread galling and possible tube damage due to excessive jaw pressure that can occur with excessive makeup torque. The CCH should makeup connections until shoulder engagement with the minimum torque value shown in Table 5, plus enough additional delta torque for project-specific requirements. Contact GBT if more than the maximum torque value listed in Table 5 is required for the intended service.

12.2.7. After ten makeups, use the maximum shoulder torque recorded in Section 12.2.6 + 10% for the remainder of the production run. This calculated value should be less than the Maximum Torque shown in Table 5. If available, set up a dump valve for this calculated value so each connection will be made up to the same torque. Watch for the spike on the torque gauge during each makeup to verify shouldering and check with a 0.005" thick feeler gauge as a secondary verification.

12.2.8. For small quantities of less than 10 joints, watch each connection carefully for shoulder torque and take care to stop as close as possible to the **Maximum Anticipated Shoulder Torque** shown in Table 5. A dump valve, if available, should be used to avoid exceeding the maximum shoulder torque listed in Table 5. With each additional connection, the operator should attempt to adjust the final makeup torque to a lower value based on experience with previous makeups. The previously stated objective shall govern when making up fewer than 10 joints: **"shoulder engagement + at least 10% of shoulder torque".**

12.2.9. The end finisher shall record shoulder and final torque for each connection, as well as accept/reject records. Electronic torque monitoring records are also acceptable records provided they are annotated with "accept" or "reject". Torque turn monitoring equipment may be used but is not a mandatory requirement.

12.3. **Comments**

12.3.1. Makeup of GB CDE, GB WSE, and GB HBE Connections (GB Butt, GB 4P, and GB 3P) **shall start and continue without stopping** until shoulder engagement. Shifting to low gear during makeup is acceptable.

12.3.2. Using the constant torque established in Section 12.2.7, the connections will achieve shoulder engagement. Occasionally, a connection will not shoulder at the established torque. This can occur due to allowable thread tolerances and other variables. If shouldering was not clearly indicated on the torque gauge during makeup, or if available, a torque vs. turn plot, shouldering can be verified with a feeler gauge as described in Section 12.3.7 and with a visual observation of the coupling face position relative to the API Triangle Stamp.

12.3.3. If the position is shy of the triangle base, the coupling must be bucked off, threads cleaned and visually inspected. If both pin and box threads pass the visual inspection, the connection can be used for one additional makeup attempt. If any threads do not pass a visual inspection, those threads are reject and a new pin and/or coupling must be used.

12.3.4. If the position is at or covering the triangle base, add torque continuously until the torque gauge spikes and the connection shoulders. It is common to see the torque gauge spike to initiate further

makeup and drop off (it's OK if spike exceeds listed maximum torque at this point). Makeup should continue until shouldering is verified.

12.3.5. If a connection does not shoulder after one additional application of torque, the connection is a reject. Buck-off and set the coupling aside for evaluation and disposition by a GBT Field Representative. If the pin thread passes visual inspection, it may be re-used one time for makeup with a new coupling.

12.3.6. The recommended makeup speed for GB Connections is 3 to 5 rpm after shifting to low gear. Makeup speeds outside of the recommended rpm range, faster or slower, will affect makeup torque. Should this be the case, contact GBT for a Field Representative to establish makeup parameters at the time of fabrication with the job-specific equipment. It should be noted that recommended makeup speeds are given for guidance only and shall not be cause for rejection.

12.3.7. Any connection where the 0.005" thick feeler gauge can be inserted between the pin nose and internal shoulder for more than 25% of the shoulder circumference shall be rejected. Contact GBT for handling of reject parts.

12.3.8. Higher "anticipated" shoulder torque values than those listed in Table 5 should be expected when making up connections with threadlocking compounds. Makeup shall be initiated as quickly as possible after application of threadlocking compounds. GBT cannot provide anticipated torque values for makeup of threadlocked connections.

12.3.9. See Section 9.11 for discussion on Jaw Marks.

12.3.10. **GBT requires gauges on all bucking equipment to be direct-read "torque" gauges.** Gauges that read hydraulic pressure in pounds per square inch (psi) and require conversion to determine torque **are not acceptable**.

FIGURES

Figure 1

GB DwC Connections with GB Butt Threads

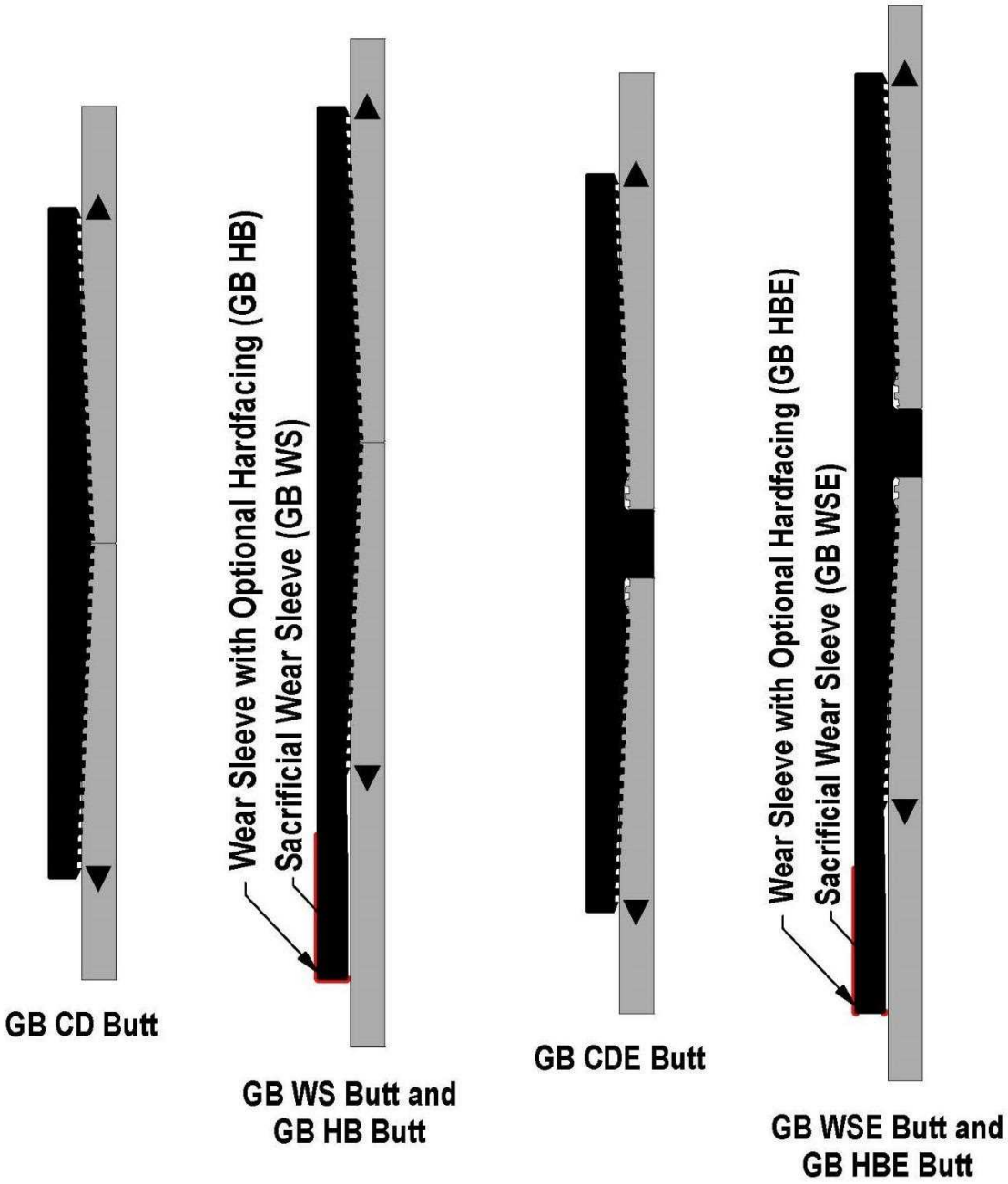
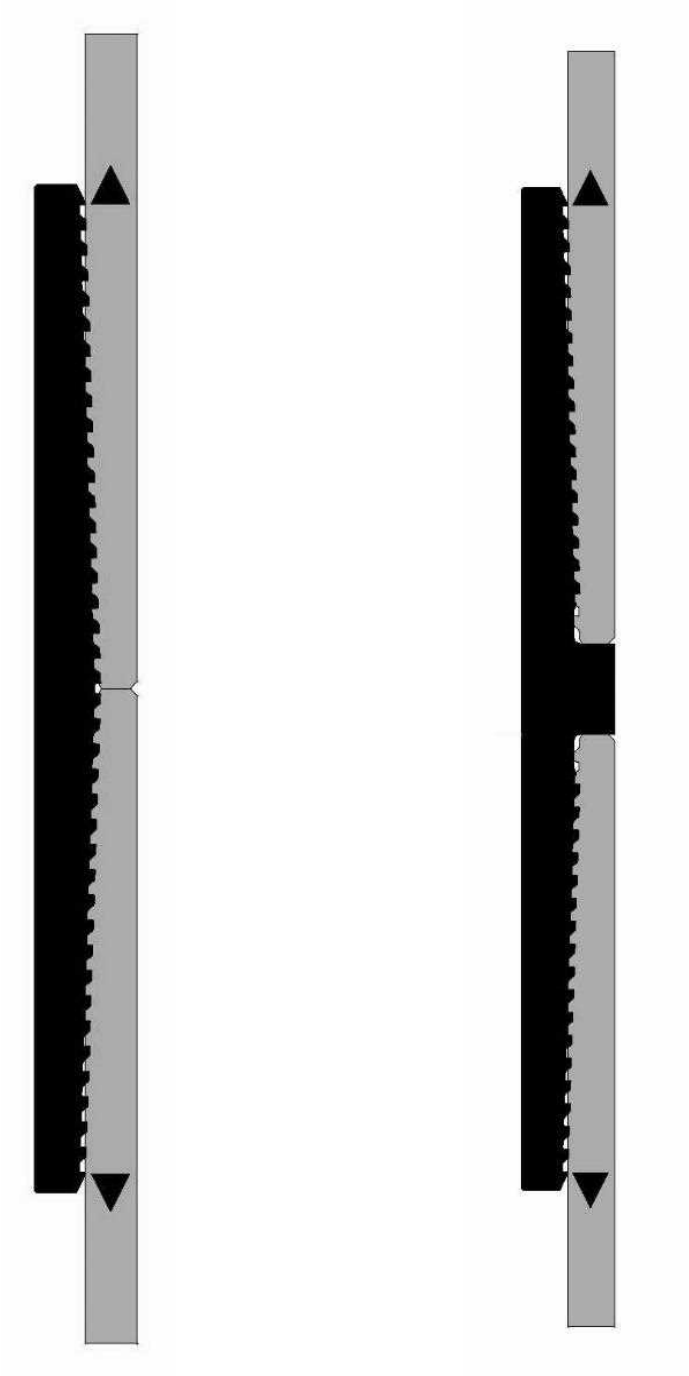


Figure 2

GB DwC Connections with GB 4P Threads



GB CD 4P **GB CDE 4P**

Figure 3

GB DwC Connections with GB 3P Threads

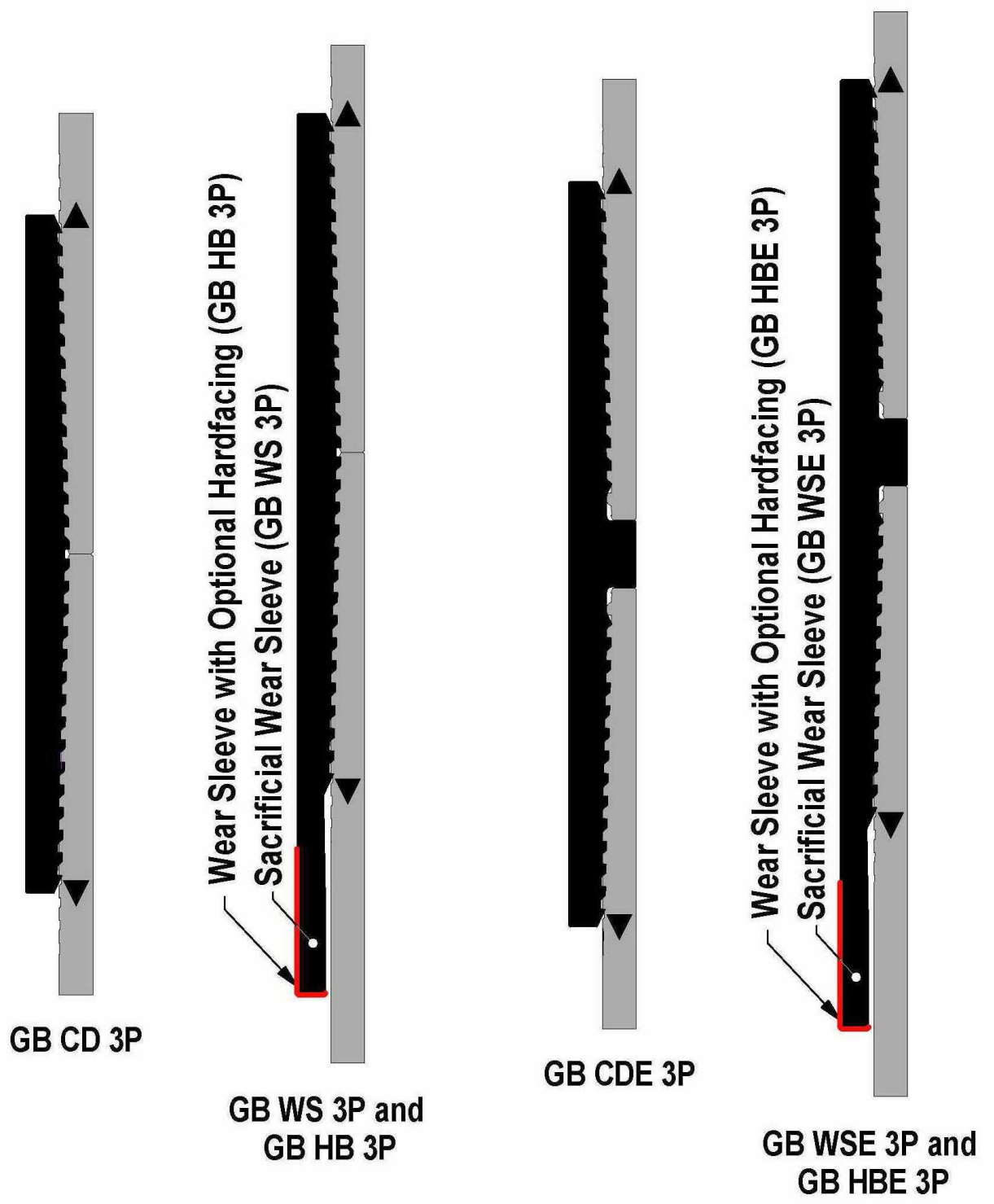
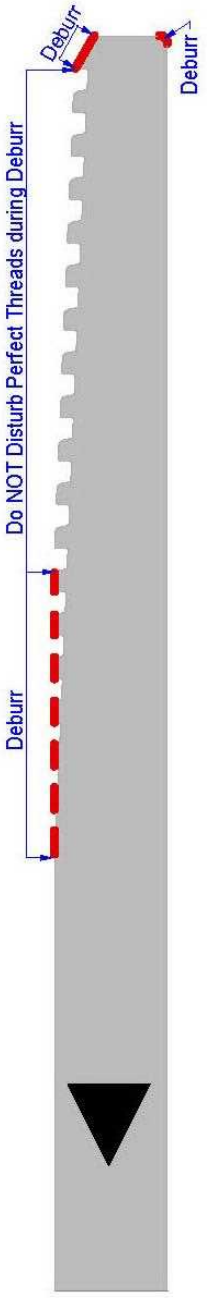


Figure 4

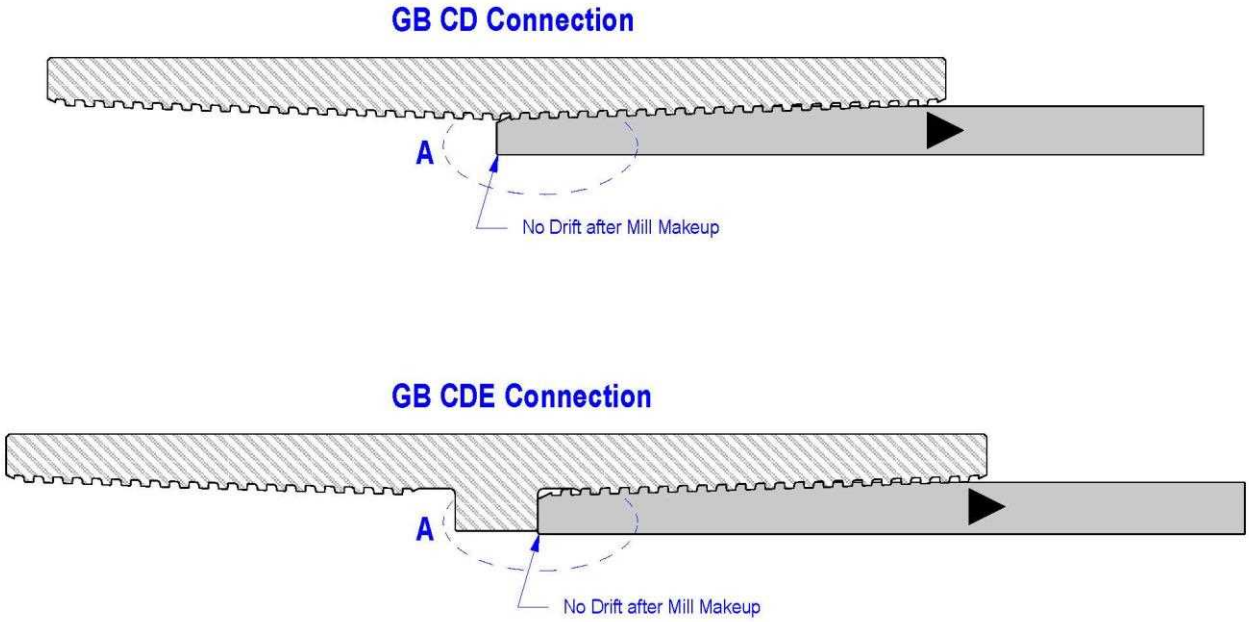
Areas of Pin Thread Requiring Deburring



*** Applies to all threadforms**

Figure 5

ID Bore Detail



DETAIL A

Figure 6

Mill Makeup Gauge Type MG1

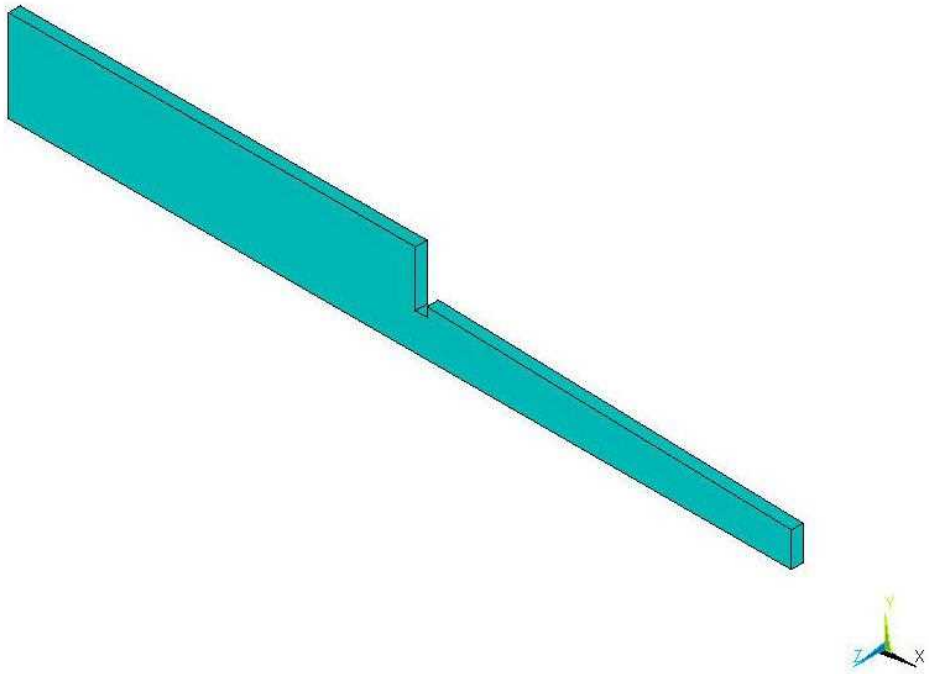
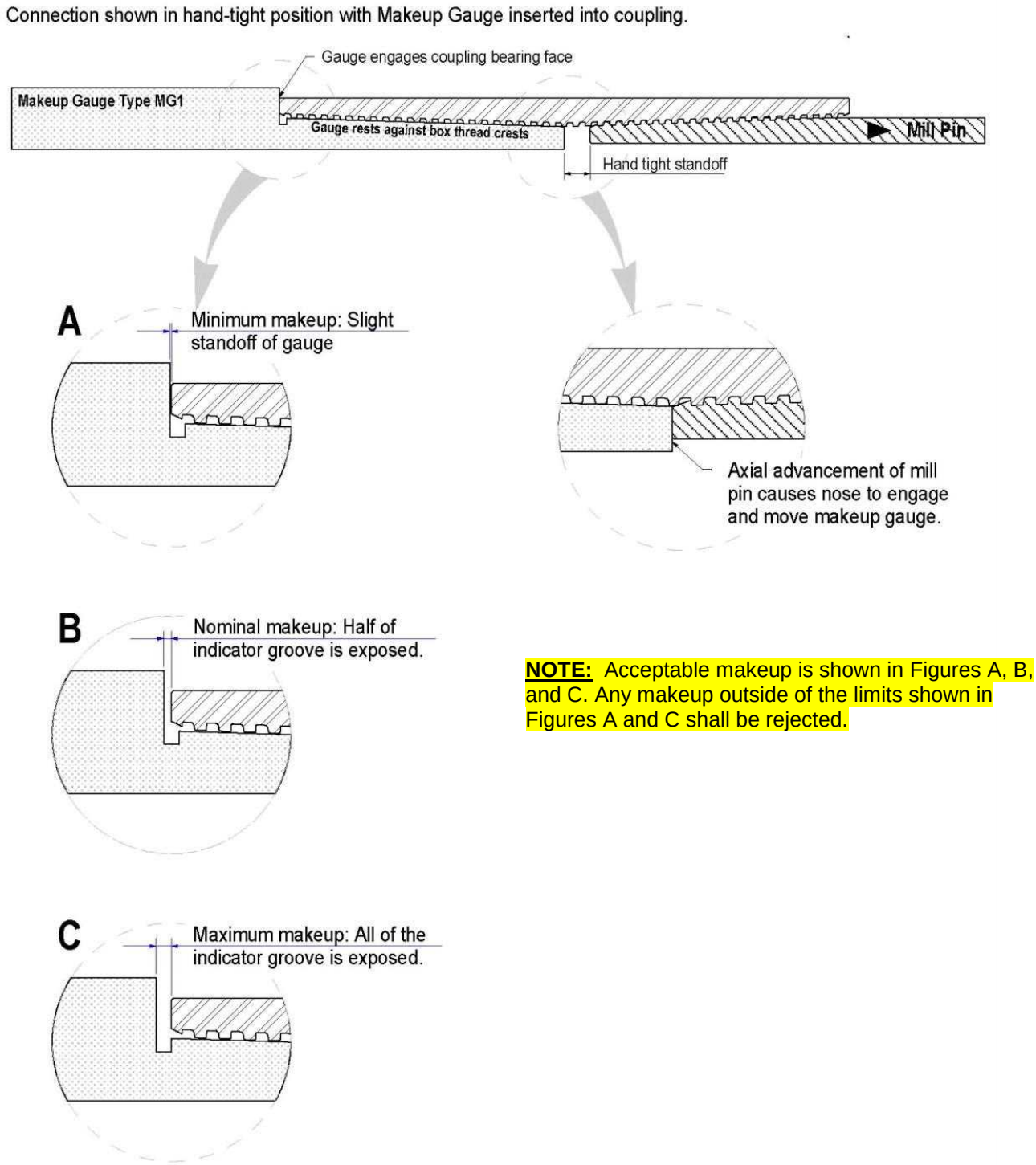


Figure 7

Mill Makeup using Makeup Gauge



NOTE: Acceptable makeup is shown in Figures A, B, and C. Any makeup outside of the limits shown in Figures A and C shall be rejected.

TABLES

Table 1 GBT MRP001
MRP Gauge Setting Standards
GB DwC Pin Threads

Table applies to GB CD, GB WS, GB HB, GB CDE, GB WSE, and GB HBE pin threads with GB Butt, GB 4P and GB 3P Threadforms.

Rev. 4 (03/25/2015)

Pipe OD (in.)	Thread	MRP Gauge	Width of Contact Shoe (in.)	Pin Standards*	
				Compensated A (in.)	B (in.)
Standard GB Connections					
4 1/2	GB DwC Butt	MRP-2000**	5/8	4.4850	0.8415
5	GB DwC Butt	MRP-2000**	5/8	4.9850	0.9665
5 1/2	GB DwC Butt	MRP-2000**	5/8	5.4850	1.0290
7	GB DwC Butt	MRP-2000**	5/8	6.9850	1.4040
7 5/8	GB DwC Butt	MRP-2000**	5/8	7.6100	1.5915
8 5/8	GB DwC Butt	MRP-2000**	5/8	8.6100	1.7165
9 5/8	GB DwC Butt	MRP-2000**	5/8	9.6100	1.7165
10 3/4	GB DwC Butt	MRP-2000**	5/8	10.7350	1.7165
11 3/4	GB DwC Butt	MRP-2000**	5/8	11.7350	1.7165
13 3/8	GB DwC Butt	MRP-2000**	5/8	13.3600	1.7165
16	GB DwC Butt	MRP-2000**	5/8	15.9625	2.3435
18 5/8	GB DwC Butt	MRP-2000**	5/8	18.5875	2.3435
20	GB DwC Butt	MRP-2000**	5/8	19.9625	2.3435
GB 4P Connections					
10 3/4	GB DwC 4P	MRP-2000**	5/8	10.7340	1.7165
11 3/4	GB DwC 4P	MRP-2000**	5/8	11.7340	1.7165
13 3/8	GB DwC 4P	MRP-2000**	5/8	13.3590	1.7165
GB 3P Connections					
16	GB DwC 3P	MRP-2000**	7/8	15.9325	1.7870
18 5/8	GB DwC 3P	MRP-2000**	7/8	18.5575	1.7870
20	GB DwC 3P	MRP-2000**	7/8	19.9325	1.7870

*** "A" dimension compensated for Contact Shoe Rotation**
**** R = 0.250 (Radius from pin to contact shoe edge)**

Table 2

Schedule of Drawings and Tables

Drawings and Tables		***Revision 4.0 (03/25/2015)***
Pipe OD (in)	**Pin**	**Threadform Drawing**
DRAWINGS	GB DWC500.0	GB DWC601
TABLES for GB DwC with Buttress Threads		**Thread Taper (in./ft)**
4 1/2	GB50004500	3/4
5	GB50005000	3/4
5 1/2	GB50005500	3/4
7	GB50007000	3/4
7 5/8	GB50007625	3/4
8 5/8	GB50008625	3/4
9 5/8	GB50009625	3/4
10 3/4	GB50010750	3/4
11 3/4	GB50011750	3/4
13 3/8	GB50013375	3/4
16	GB50016000	1
18 5/8	GB50018625	1
20	GB50020000	1
TABLES for GB DwC 4P Threads		**Thread Taper (in./ft)**
10 3/4	GB500107504**P**	3/4
11 3/4	GB500117504**P**	3/4
13 3/8	GB500133754**P**	3/4
TABLES for GB DwC 3P Threads		**Thread Taper (in./ft)**
16	GB500160003**P**	1
18 5/8	GB500186253**P**	1
20	GB500200003**P**	1
TABLE of MRP Setting Standards for GB Butt and GB 4P and GB 3P Threads		Table: GBT MRP001

Connection Drawings and Tables are presented following the text of this document.

To determine the proper table for use with each connection size and weight use the following legend.

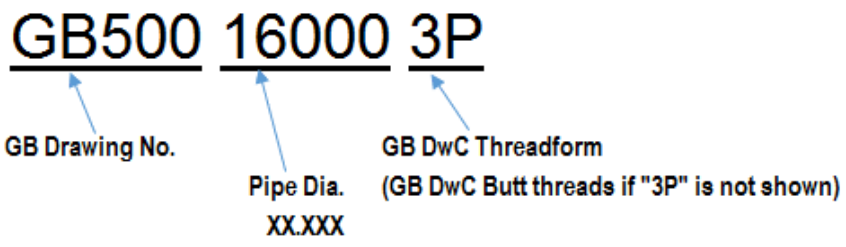


Table 3

Inspection Requirements for GB DwC Pins

Inspection Matrix A

Revision 0 Mar. 25th, 2015

	DESCRIPTION	SYMBOL	INSPECTION TYPE	RECORD	START UP			PIECE NO. (Repeat 1 thru 10 for Production Inspection Rotation)										
					FA	FPV1	FPV2	1	2	3	4	5	6	7	8	9	10	LA
PIN	**GEOMETRY**																	
	End of Pipe to Triangle Stamp	A1	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Min. Length Full Crested Threads	Lc	M	N	√	√	√	√			√			√			√	√
	Visual Thread Inspection	Vis	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PIN	**THREADFORM**																	
	Thread Crest Diameter	MRP	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Ovality	Oval	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Lead	Ld	M	N	√	√	√	√	√					√				√
	Cumulative Lead	Cld	M	N	√	√	√	√	√					√				√
	Thread Height	T-HT	M	N	√	√	√	√		√					√			√
	Taper	Taper	M	N	√	√	√	√			√					√		√
	Profile	Prof	V, PG	A	√	√	√	√				√					√	√
	Runout	R/O	M	N	√	√	√	√					√					√
	Geometric Verification	Geo.	V (4)	A	√													√
PIN	**FINISH - Deburr Inspection**																	
	Starting Thread	Vst	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Run Out Threads	Vro	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PIN	**NOSE**																	√
	Bearing Face	Bf	M	~N	√	√	√	√	√		√				√			√
	OD Chamfer	Ldch	M, PC	N	√	√	√	√		√			√			√		√
	ID Break	Bid	V	A	√	√	√	√			√			√			√	√

Inspection Matrix B

Revision 0 Mar. 25th, 2015

	DESCRIPTION	SYMBOL	INSPECTION TYPE	RECORD	START UP			PIECE NO. (Repeat 1 thru 10 for Production Inspection Rotation)										
					FA	FPV1	FPV2	1	2	3	4	5	6	7	8	9	10	LA
PIN	**GEOMETRY**																	
	End of Pipe to Triangle Stamp	A1	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Min. Length Full Crested Threads	Lc	M	N	√	√	√	√					√					√
	Visual Thread Inspection	Vis	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PIN	**THREADFORM**																	
	Thread Crest Diameter	MRP	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Ovality	Oval	M	N	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Lead	Ld	M	N	√	√	√	√					√					√
	Cumulative Lead	Cld	M	N	√	√	√	√					√					√
	Thread Height	T-HT	M	N	√	√	√	√					√					√
	Taper	Taper	M	N	√	√	√	√					√					√
	Profile	Prof	V, PG	A	√	√	√	√					√					√
	Runout	R/O	M	N	√	√	√	√					√					√
	Geometric Verification	Geo.	V (4)	A	√													√
PIN	**FINISH - Deburr Inspection**																	
	Starting Thread	Vst	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	Run Out Threads	Vro	V	A	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PIN	**NOSE**																	√
	Bearing Face	Bf	M	~N	√	√	√	√					√					√
	OD Chamfer	Ldch	M, PC	N	√	√	√	√										√
	ID Break	Bid	V	A	√	√	√	√										√

LEGEND

FA First Article - See First/Last Article Inspection Requirements
LA Last Article - See First/Last Article Inspection Requirements
FPV First production verification
M Measurements
V Visual
N Numerical; Measurement or Deviation from Nominal
A "Accept" or "Reject"
~ Approximate Measurement w/Caliper or other approved device
PG Use Profile Gauge to Confirm Full Threads
PC Program Check at Start Up

NOTES

1. Appropriate adjustments, offsets, etc. shall be made to bring any out-of compliance element within the specified tolerances.
2. Upon discovery of an out-of-compliance element in the rotation, previously produced parts shall be regauged to find the last part with a good measurement for that element. All out-of-compliance parts discovered with the back check shall be recut.
3. Inspection Rotation shall be re-started at Part No. 1 with each cold start, operator change, and shift change. Geometric verification shall be performed at the start of each shift.
4. Verify on First Article with mold, trace or similar comparative method.
5. This Inspection Rotation relies on reasonably consistent measurements part-to-part. Individual elements exhibiting erratic or "out-of-character" measurements relative to those previously recorded shall be checked more often and corrective measures implemented to achieve part-to-part measurement consistency.

Table 4

Anticipated Torque Range for GB CD, GB WS, and GB HB Connections with GB Butt, GB 4P and GB 3P Threads

Casing OD (in)	**Anticipated Torque Range** (ft-lbs)
4 ½	3,000 to 8,000
5	3,000 to 8,000
5 ½	4,000 to 10,000
7	5,000 to 10,000
7 5/8	5,000 to 10,000
9 5/8; 9 7/8	6,000 to 10,000
10 ¾ (Butt and 4P)	6,000 to 10,000
11 ¾; 11 7/8 (Butt and 4P)	8,000 to 12,000
13 3/8; 13 5/8 (Butt and 4P)	8,000 to 14,000
16 (Butt and 3P)	10,000 to 16,000
18 5/8 (Butt and 3P)	12,000 to 20,000
20 (Butt and 3P)	12,000 to 20,000

These anticipated torque values do not apply for connections assembled with threadlocking compounds, refer to Section 11.4.2.

If the makeup torque of more than a few joints fall outside the anticipated torque range, please contact GBT for assistance.

Table 5

Anticipated Shoulder Torque Range for GB CDE, GB WSE, and GB HBE Connections with GB Butt, GB 4P, and GB 3P Threads

Casing OD (in.)	ANTICIPATED SHOULDER TORQUE (ft-lbs.)
4 ½	3,000 to 8,000
5	3,000 to 8,000
5 ½	5,000 to 9,000
7	5,000 to 8,000
7 5/8	5,000 to 8,000
9 5/8; 9 7/8	6,000 to 10,000
10 ¾ (Butt and 4P)	6,000 to 10,000
11 ¾; 11 7/8 (Butt and 4P)	8,000 to 12,000
13 3/8; 13 5/8 (Butt and 4P)	8,000 to 14,000
16 (Butt and 3P)	10,000 to 16,000
18 5/8 (Butt and 3P)	12,000 to 20,000
20 (Butt and 3P)	12,000 to 20,000

These anticipated torque values do not apply for connections assembled with threadlocking compounds, refer to Section 12.3.8.

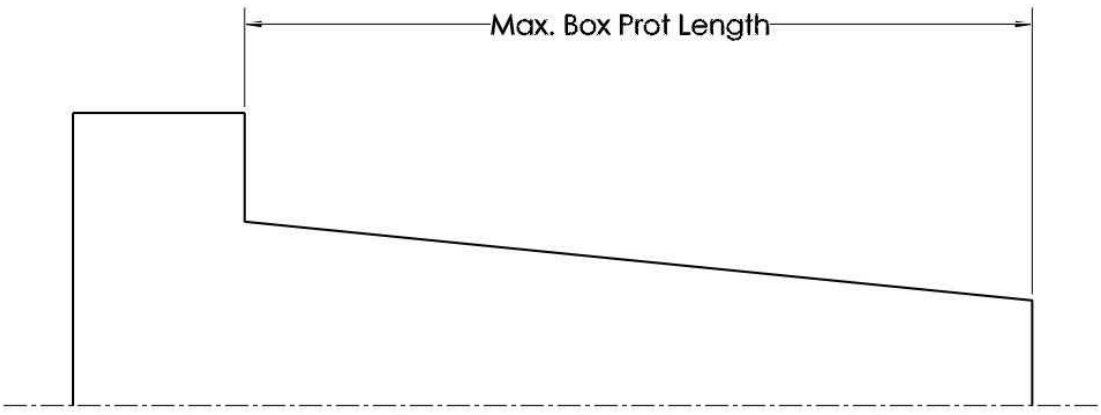
If the makeup torque of more than a few joints fall outside the anticipated torque range, please contact GBT for assistance.

For grade specific minimum and maximum makeup torque, please refer to inspection package or performance property sheet published on GB Tubulars website for details.

Table 6

Max. Allowable Box Thread Protector Length for GB DwC Connections

Casing Diameter (in.)	Clearance (in.)	Max. Box Prot Length (in.)
4 1/2	0.1200	3.8125
5	0.1200	3.9375
5 1/2	0.1200	4.0000
7	0.1200	4.3750
7 5/8	0.1200	4.5625
8 5/8	0.1200	4.7500
9 5/8	0.1200	4.7500
10 3/4	0.1200	4.7500
11 3/4	0.1200	4.7500
13 3/8	0.1200	4.7500
16	0.1200	4.7500
18 5/8	0.1200	4.7500
20	0.1200	4.7500



APPENDIX MAKEUP GBT CONNECTIONS WITH THREADLOCK COMPOUND

GBT Connections with Threadlock Compound

OVERVIEW

This procedure has been developed to provide practical instructions for assembling GB Connections with Threadlocking compounds. It provides general information and is intended to be supplemented by professional judgment of qualified personnel based on observation, actual equipment, and conditions that exist at the time of connection assembly.

KEY INFORMATION

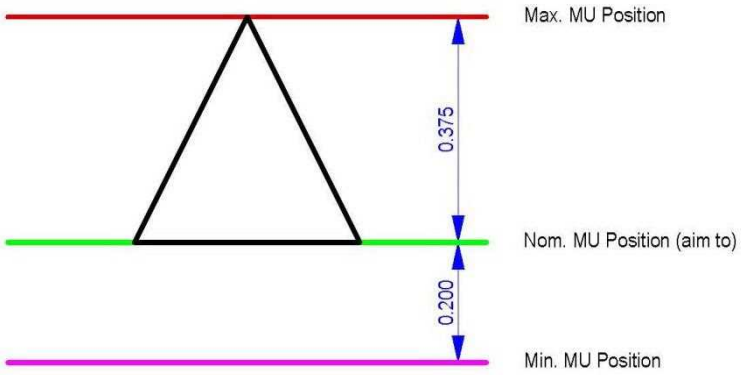
Compound: Threadlock Compound.

Torque Values: See individual GB Connection Performance Property Sheets that provide general torque information for assembly with common thread compounds such as Best-O-Life 2000 or API Modified. High torque may be required to achieve shoulder engagement when threadlock compounds are applied. Due to many variables including temperature, time, etc. torque ranges with threadlock compounds cannot be anticipated.

Continuous Makeup: Makeup of GB Connections **SHALL START AND CONTINUE WITHOUT STOPPING** until full power tight makeup is achieved.

Makeup Speed: Use of high gear at no more than 20 RPMs is permissible once proper starting thread engagement has been verified. The final two (2) turns at a minimum should be completed in low gear at less than 6 RPMs.

Acceptance Criteria: Pin nose engagement (i.e. shouldering) with small amount of delta torque. Shouldering is not required for GB pins or boxes mated with API BC boxes or pins, respectively. When GB and API BC parts are mixed, the acceptance criteria is 0.200” shy of the API Triangle Stamp base (Min. position) to the apex of the API Triangle Stamp (Max. position). However, all makeups should aim to a minimum position at the base of the API Triangle Stamp.



0.200" = 1 Turns for API and GB Butt, 5 threads per inch (TPI),
= 0.8 Turns for GB 4P (4TPI), and
= 0.6 Turns for GB 3P (3 TPI).

Note: GB 4P and GB 3P will **NOT** makeup with API BC.

Makeup Procedure - Threadlock Connections

1. Make sure that all pin and coupling threads are completely clean and dry in preparation for application of Threadlock compound.
2. When assembling connections with Threadlocking compounds, parts should be aligned and ready to stab prior to mixing the Threadlocking compound.
3. Threadlock compounds shall be mixed and applied in strict accordance with the manufacturer's written instructions paying close attention to specified temperature recommendations.
4. The Threadlocking compound should be mixed and evenly applied to all perfect pin threads just before stabbing. It is ***not*** necessary to apply Threadlocking compound to the imperfect pin threads or the coupling threads. The proper amount of threadlocking compound has been applied when all perfect threads (those with fully formed crests) are uniformly covered with no shiny or bare spots. The thread valleys should be about half full of thread locking compound.
5. It should be noted that Threadlocking compounds set up relatively quickly, so it is imperative that the connection be stabbed and made up immediately after application of the Threadlocking Compound. This work should be performed quickly and efficiently so that the whole operation between mixing and final assembly occurs within 7 minutes. If the operation takes longer, the operator should expect high torque and the possibility of not achieving the full power tight makeup condition.

   Time is critical after mixing threadlock compounds and temperature can have a significant impact on threadlock set up time.
6. Set a dump torque at the maximum torque of bucking unit, if necessary.
7. Grip the parts taking care not to set the grips over the threads.

8. Makeup without stopping to shoulder engagement or the minimum makeup position is achieved. Makeup should start in high gear and then be shifted into low gear (recommended makeup speed 3 to 6 rpm in low gear) for completion of makeup. The final two (2) full turns as a minimum should be made in low gear. A spike on the torque gauge indicates shoulder engagement.
9. Carefully monitor the analog torque gauge or torque vs. turn plot during the assembly. When the spike occurs indicating that pin nose engagement), immediately stop the makeup. The operator should be prepared and immediately manually stop makeup when shouldering occurs.
10. Record Shoulder torque, Makeup Torque (Final Torque) and makeup position.

Jaw Marks

Makeup equipment chucks shall have sufficient bearing area to minimize localized marks on pipe and coupling OD's. Connections with jaw marks exceeding the depths listed per API 5CT Table Permissible depth of external imperfections on coupling shall be rejected. Pipe Body imperfection shall not exceed Maximum permissible imperfection per API 5CT Specifications.

To avoid jaw mark problems when they occur, low stress soft jaws should be used during makeup. Connections can be wrapped with sandpaper as an alternative, or in addition to, low stress soft jaws if needed to further reduce jaw marks. The bucking unit shall be checked for proper leveling and alignment. Jaw marks shall be measured and recorded at the start of and periodically during each production run. Appropriate corrective measures shall be implemented to minimize jaw marks on coupling ODs.

Couplings reject for jaw marks shall be repaired in accordance with API requirements. If not repairable, the coupling shall be rejected. The corresponding pin may be re-used provided it passes visual inspection.

CONNECTION DRAWINGS

CONFIDENTIAL

TOLERANCES

1. Taper (in./in.):
   Perfect Threads:-0.0015, +0.0035
   Imperfect Threads:-0.0015, +0.0045
2. Runout: +0.005 Max.
3. Lead (per in):
   13 5/8" OD and smaller: +/- 0.002
   16" OD and larger: +/- 0.003
   Cumulative: +/- 0.004
4. Thread Height (in.): +/- 0.001 (GB CD Butt, GB 4P & GB 3P)
5. Thread Crest Dia. by MRP (in.):
   13 5/8" OD and smaller: -0, +0.004
   16" OD and larger: -0, +0.006
6. Pin Nose Chamfer: (dch): Ref. Dimension
   Ldch - See Section 9.2 for measurement information and detailed view
7. Ovality of Thread Crest Dia. (by MRP): OD x 0.003 Max.
8. Bearing face (bf): See Table for bf and bf min. Due to pipe wall eccentricity, there may be a portion of the pin nose that is relatively thin. This is acceptable as long as the thin portion is equal to or greater than the specified min. bf and thin nose portion does not exceed 120% of the circumference. Any pin with bearing face equal to min. bf that extends more than 120% of pin nose facial circumference shall be rejected.
9. Lc (per API). Within the specified Lc length, as many as 2 threads showing the original outside surface of the pipe on the crest for a circumferential distance not to exceed 25% of the pipe circumference is permissible. The remaining threads shall be full crested.

THREAD TAPER

GB CD & CDE uses standard API taper given below:
13 5/8" OD and smaller: 3/4" per foot
16" OD and larger: 1" per foot

NOTES

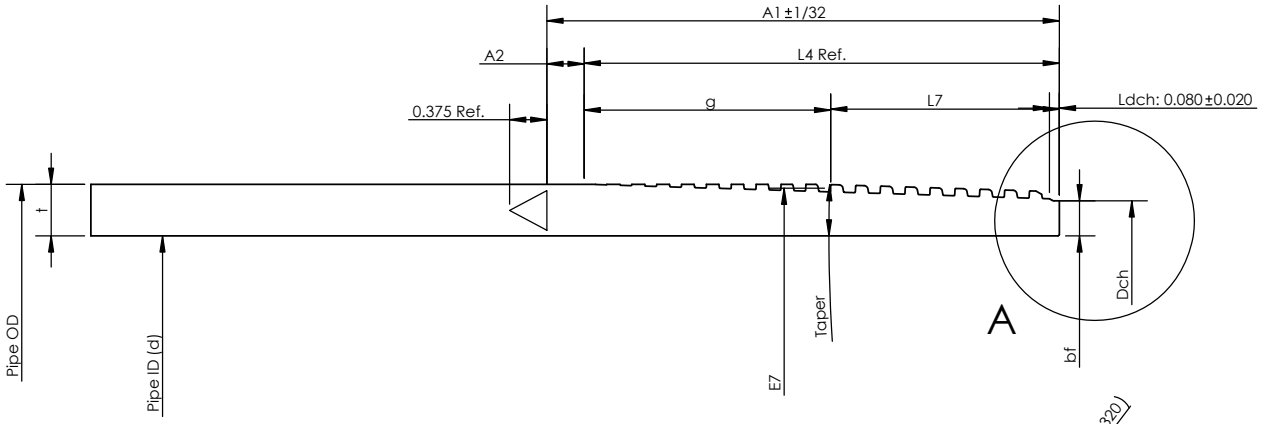
1. Refer to DWG No. GB DWC601.0 for GB threadforms.
2. Reference tables for size-specific dimensions.
2. It should be noted that GB Butt, GB 4P & GB 3P threads are FULL runout threads. The blanking and threading tools should advance up the taper until they no longer touch metal. Refer to GB Specification EF.001.00 for more information.

DE-BURRING REQ'TS

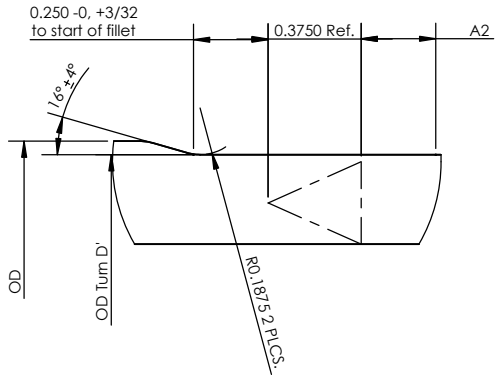
De-burr at all corner breaks, chamfers, run out threads and grooves
De-burring shall be carefully performed to remove feather and/or sharp edges, fins, wickers, etc.

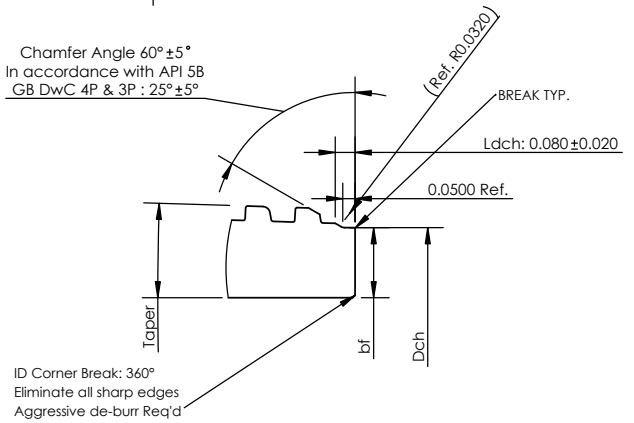
MARKING

Apply the following marking:
OD, Weight, Grade, Connection Type, Threadform
Connection Types are: GB CD/CDE, GB WS/WSE, GB HB/HBE, GB RDB/RDB WS
Threadforms are: GB Butt, GB 4P and GB 3P
Work Order #, GB Connection order number, Date, Drift
Example: 5 1/2", 23ppf P110HC GB CD BUTT
WO# XXXX, GBC XXXXSXXXX, 04/23, End Drift 4.545



OD CYLINDER TURN DETAIL for 9 7/8, 11 7/8 and 13 5/8 Casing





DETAIL A

SCALE 2 : 1

Casing OD (in)	D' Min. (in)	Wall Thickness Average (in)*	Min. Wall Thickness (in)**
9 7/8	9.641	0.422	0.400
11 7/8	11.766	0.447	0.417
13 5/8	13.391	0.422	0.400

*Average of 4 wall thickness readings, one per quarter
** Reject if any single wall thickness reading is less than given value

	NAME	DATE
DRAWN	GB CD & CDE Pin	03/30/2023
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
Size specific dimensions provided in table as part of the inspection package

GBCONNECTIONS
ENGINEERING THE RIGHT CONNECTIONS

TITLE:
PARAMETRIC MACHINING DRAWING
Pin Dimensions for Drilling with Casing Connection

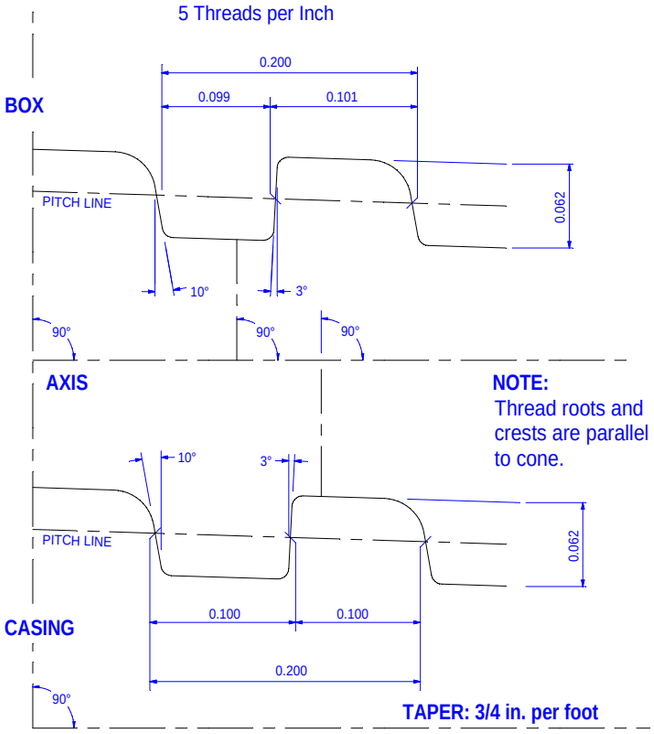
SIZE	DWG. NO.	REV
B	GB DWC500.0	10

SCALE: 1:1 | WEIGHT: per table | SHEET 1 OF 1

GB BUTT

13-5/8" OD and Smaller

5 Threads per Inch

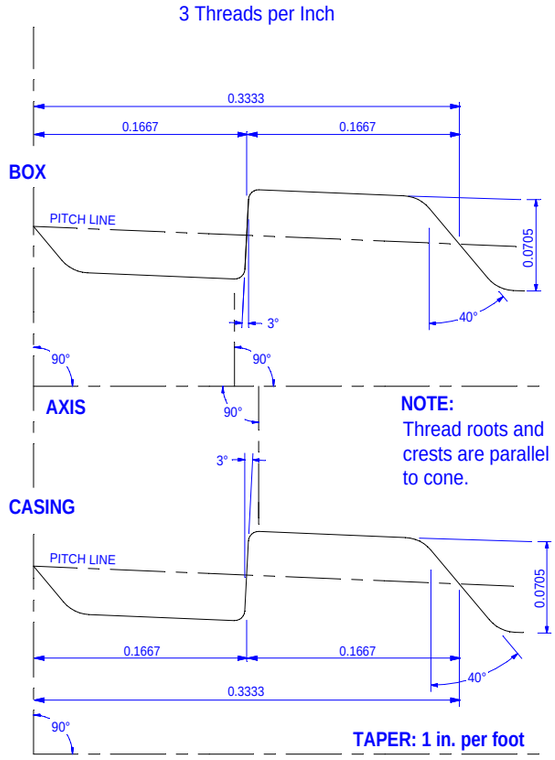


NOTE:
Thread roots and crests are parallel to cone.

TAPER: 3/4 in. per foot

GB 3P

3 Threads per Inch



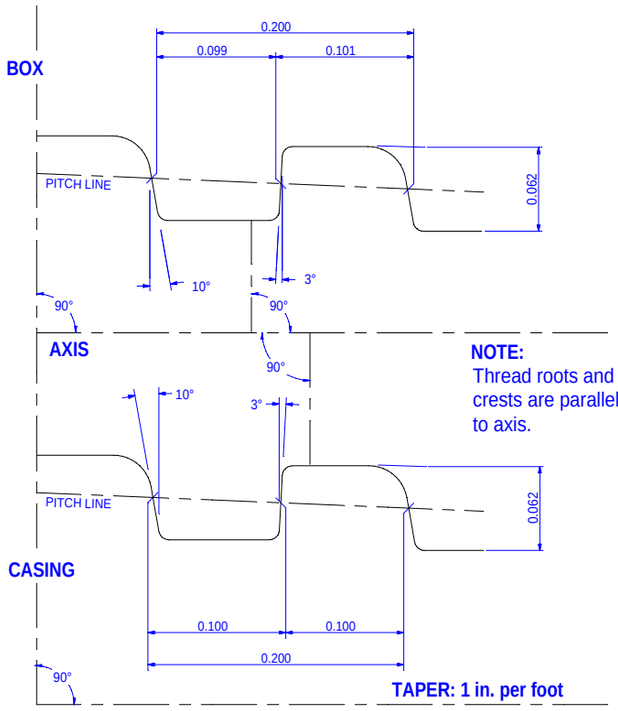
NOTE:
Thread roots and crests are parallel to cone.

TAPER: 1 in. per foot

GB BUTT

16" OD and Larger

5 Threads per Inch



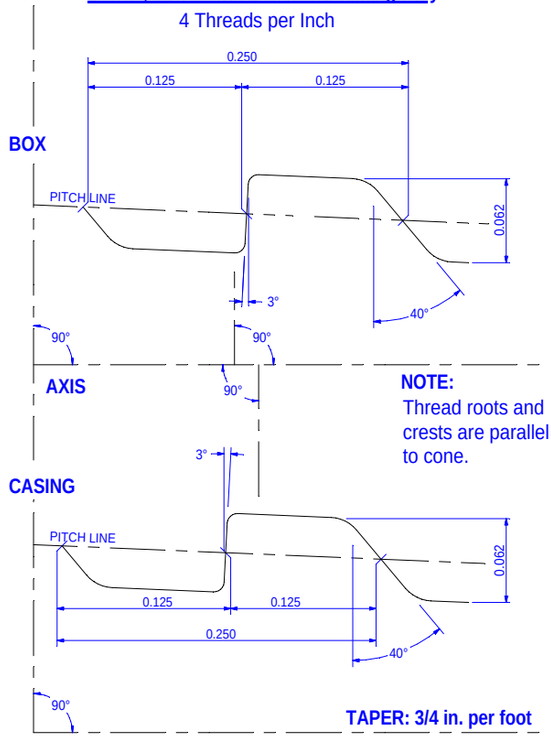
NOTE:
Thread roots and crests are parallel to axis.

TAPER: 1 in. per foot

GB 4P

10 3/4", 11 3/4" and 13 3/8" OD Casing Only

4 Threads per Inch



NOTE:
Thread roots and crests are parallel to cone.

TAPER: 3/4 in. per foot

GB THREADFORMS
GB Butt, GB 4P, & GB 3P for
GB Drilling with Casing Conns.

Date: 11/22/2005

Scale: 10X

Drawing No.: GB DWC601.0

Revision: 3.0 (06/22/2015)

Filename: GBDWC601 Rev 2.FC7

Units: Inches

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