Tooling Catalog

Revision 7
This catalog includes the complete line of tooling for Fatigue Technology (FTI)'s Cold Expansion and Structural-Life Enhancement Systems. Included is information to assist you in the proper selection of tools and parts that meet your specific requirements, as well as instructions for placing an order.

As we develop new products and improve tooling and processes, this catalog will be updated. The most current version is available for download on our website at http://www.fatiguetech.com/support-tooling-catalog-operation-manuals.asp

If you have any questions or need information regarding our On-Site Training, Field-Team Services, Materials Test Lab, or if your application requires custom capital equipment and tooling, our Sales Staff is available at (206) 246-2010 from 8:00am to 5:00pm PST, Monday through Friday.

You can also find more information by visiting our website at www.fatiguetech.com.

Split Sleeve Cold Expansion, SsCx, Cx, ForceLoc, Countersink Cold Expansion, CsCx, Cold Expansion to Size, Cx2s, FmCx, StopCrack, ScCx, BtCx, FtCx, GrCx, TtCx, Semi-Automatic Cold Expansion, and SaCx are trademarks of Fatigue Technology. ForceMate, ForceTec, BushLoc, GromEx, and TukLoc are registered trademarks of Fatigue Technology.

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1.0 GENERAL INFORMATION

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Fatigue Technology (FTI) has been providing innovative solutions to aircraft manufacturers since 1969. FTI's complete systems of tooling are used worldwide to significantly reduce manufacturing and maintenance flow-time and costs in both military and commercial aircraft programs.

FTI's professional staff provides a full range of support services which include:

- Special project application engineering
- Detailed project planning, implementation, and management
- On-site assistance which includes training, tool room setup, rental equipment, and a full-service field team
- Materials testing of metallic and composite materials

Our Sales Department is available to assist with your special fatigue life enhancement requirements and tooling selection. We would welcome an opportunity to assist you if you have any questions regarding any of our products or services.

Many of FTI's Cold Expansion Systems, processes, and products are protected by U.S. and foreign patents, and by pending patent applications. These systems and processes are dependent on specific tooling and must be performed in accordance with FTI's specifications or controlling documents. To ensure proper results, it is essential that FTI's complete integrated system of tooling be purchased and utilized. The use of tooling procured from other than a licensed supplier could jeopardize fatigue life enhancement and may not be licensed under FTI's patents and applications.

For additional details concerning legal matters, please contact FTI Headquarters.
Using This Catalog

This catalog is organized into separate tabbed sections for each of FTI's Cold Expansion Tooling Systems. As a general rule, determine the correct tools for each application by following these steps:

Step 1. Determine the material to be cold expanded.

Step 2. Choose the applicable process and turn to that section in this catalog:

- CB Tooling: Split Sleeve Cold Expansion™ in Aluminum and Mild Steel
- CW Tooling: Low Interference Cold Expansion in Aluminum
- CA Tooling: Split Sleeve Cold Expansion™ in Titanium and High Strength Steel
- CR Tooling: Rework Split Sleeve Cold Expansion in Aluminum and Mild Steel
- KB2 Tooling: Split Sleeve Cold Expansion to Size™ in Aluminum
- CB/KB Tooling: Countersink Cold Expansion™ in Aluminum
- FmCx™ Tooling: ForceMate® Bushing Installation
- FtCx™ Tooling: ForceTec® Rivetless Nut Plate
- GrCx™ Tooling: GromEx® Composite Hole Reinforcement
- ScCx™ Tooling: StopCrack™ Enhanced Stop Drill Repair Method

Step 3. Select the Standard Tool Diameter Number (STDN), where applicable.

Step 4. Use the STDN (where applicable) to select the system of Standard Tools and their model numbers.

Step 5. For additional information and complete description of each tool, please refer to the Detailed Tooling Section.

Step 6. For further assistance, please contact your FTI Representative. A complete listing of FTI Representatives can be found on at www.fatiguetech.com
1.3 System of Tooling

To ensure maximum fatigue life enhancement of a cold expanded hole, it is critical that FTI's integrated system of tooling be utilized. FTI's fatigue life enhancement processes incorporate a system of technology and tooling designed to provide optimum performance. If you are unable to find your special tooling needs using this catalog, please contact FTI's Sales Staff or Engineering Staff for assistance in meeting your unique tooling requirements.

A typical FTI system of tooling consists of everything required to properly cold expand a hole. This often includes (but is not limited to) cutting tools, powerpak, puller unit, mandrel, check fixtures, and split sleeves.
Placing an Order
To place an order, email or fax your request directly to our Customer Service Team. Please visit www.fatiguetech.com for our current contact information. Your order will be acknowledged in accordance with FTI's Standard Purchase Order Terms and Conditions. (http://www.fatiguetech.com/support-terms-and-conditions.asp)

Tooling from this catalog may be ordered individually or as a kit. Our kits are comprised of a complete system of tooling containing everything necessary for a particular hole size. Capital tooling, such as a powerpak and puller unit, may be purchased or rented. Rentals are subject to availability.

FTI provides a rush delivery service for AOG situations. Please note that rush orders are subject to availability and an expedite fee. For complete details please contact our Customer Service Team.

When you place an order, please be ready to provide the following information:

1. Model or Part Number(s) Needed.
2. Quantity Required.
3. Aircraft Platform or Industry.
4. Acceptable Alternative – if any (please provide us the application details: material, stackup, thickness, etc.)
5. Required Shipping Date.
   *If less than standard lead time, an expedite fee may be charged.*
6. Whether Partial Shipments will be accepted.
7. Preferred Carrier and Shipping Method.
8. Shipping Address.
10. Your Purchase Order Number.
11. Your Contact Information (name, email address, and telephone number).
1.5 Cold Expansion System Capabilities

Cold Expansion Systems

**Split Sleeve Cold Expansion** is performed by inserting a mandrel, pre-fitted with a disposable solid-film lubricated sleeve, into a hole and then pulling the mandrel back through the sleeve. The internally lubricated split sleeve protects the hole from damage and makes the system a one-sided process. The action of drawing the mandrel through the pre-lubricated split sleeve causes a radial plastic flow of the workpiece material. This produces an annular zone of residual compressive stresses that extends one radius to one diameter beyond the periphery of the hole. A zone of tension stress balances the zone of compressive stresses. The desired final hole diameter is obtained by reaming the cold expanded hole to the size required, or by using the Cold Expansion to Size process where no final ream is required.

*The ForceMate System* involves drawing an oversize mandrel through a pre-positioned clearance-fit bushing, that has been internally pre-lubricated by an FTI proprietary process. The tooling is sized so that a one-sided operation is standard. The resulting interference fit of the bushing, coupled with simultaneous cold working of the metal surrounding the hole, produces a 500 percent or better improvement in fatigue life. The bushing is then reamed to the required hole diameter.

*The ForceTec System* is a revolutionary rivetless nut plate system that uses split sleeve cold expansion. The rivetless nut plate installation consists of a retainer/cage assembly which is placed into a single hole from the back side. A mandrel, pre-fitted with a split sleeve, is inserted through the retainer from the front side. When the mandrel is drawn back through the sleeve, the retainer is expanded into the hole at an interference fit. The installed retainer holds a variety of standard floating locking nuts. This process results in increased fatigue life of the installation due to the high interference fit of the retainer, residual stresses imparted into the parent material by the cold expansion process, and elimination of fatigue prone satellite holes.

*The TukLoc System* combines cold expansion technology with the ease and versatility of blind nuts. FTI’s state-of-the-art cold expansion process locks the nut in the aircraft structure providing resistance to fatigue cracking by combining an interference fit nut with an installation in a clean, round hole. In addition to the benefits of cold expansion, preparation of the starting holes for TukLoc is easy as there are no special non-round countersinks, or stringent surface preparation requirements. TukLoc nuts meet or exceed all requirements of industry accepted procurement specifications, including NASM-25027. The TukLoc nuts are available in open and domed (sealed) configurations.

*The GromEx System* has been designed to install titanium or stainless steel grommets in composite materials to reinforce fastener holes. The system works by drawing a mandrel through an internally pre-lubricated grommet. The grommet is expanded into place, creating a fit that is more reliable than adhesively bonded grommets, and with better electrical grounding capability. Due to the complex nature and variety of composites, it is recommended that customers work closely with FTI’s Engineering and Technical Sales departments to determine the feasibility of any GromEx application.
Special Tool Design Capabilities

The professional staff at FTI are available to design and manufacture special tooling for all fatigue life enhancement repairs and rework. With over 45 years of proven applications, our experience has covered a wide range of metal and composite solutions. Our in-house Materials Testing Facility provides fatigue life testing in standard and exotic materials, in addition to supporting our Research and Development Team in developing new tooling.

Fatigue Technology’s Materials Testing Facility performs state-of-the-art testing of metals and composites. We currently offer the following services:

- Fatigue and crack growth cyclic testing under broadband spectrum and constant amplitude loading
- Automated static testing (tensile, compression, shear, flexure)
- Environmental effects testing (thermal shock, thermal gradient, humidity cycling, ultraviolet/moisture exposure)
- Crack growth rate (da/dN)
- Fracture toughness testing (K<sub>Ic</sub>)
- Stress corrosion testing

Related services include automated/manual eddy current inspections, strain gage installations and monitoring, and preparation of photo-electric coatings. Our CNC machining facility and staff is capable of manufacturing any complex fixtures and/or specimens required. FTI believes in being responsive to the unique requirements of each customer, while maintaining a realistic approach to testing as indicated below:

- Automated 24-hour per day test equipment and data collection to increase productivity and meet customer efficiency expectations.
- Flexibility and recognition that procedures and testing methods must often be modified to accommodate unpredictable test results.
- With a focus on test planning and in-process monitoring of data, FTI is able to minimize questions or doubts regarding test results
- Maintaining continuous communication, FTI provides timely, complete reports tailored to each customer’s individual needs.
# Detailed Tooling

## Section 2.1 Introduction

- Little Brute Puller Unit
- Medium Brute Puller Unit
- Big Brute Puller Unit
- Jumbo Brute Puller Unit
- Super Brute Puller Unit
- Hand Pullers
- Midget Pullers
- Little Brute Offset Adapters (LBOA)
- Hydraulic Offset Adapters (HOA)
- Medium Brute Offset Adapter (MBOA)
- Medium Brute Hydraulic_offsets (MBHO)
- Big Brute Hydraulic_offsets (BBHO)
- Little Brute Right Angle Adapter
- FT-200 PowerPak
- FT-220 Power Pak
- FT-20 PowerPak
- FTP-19 Hand Pump

## Section 2.2 Capital Tooling

- FTP-19 Hand Pump
- FT-20 PowerPak
- FT-220 Power Pak
- FT-20 PowerPak
- FTP-19 Hand Pump

## Section 2.3 Durable Tooling

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- Right Angle Starting Drills
- Core Drills
- Right Angle Core Drills
- Starting Reamers
- Right Angle Starting Reamers
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- Right Angle Gage Finish Reamers
- Combination Gages
- Mandrel Gages
- Final Hole Gages
- Stamp Gages
- Mandrels
- Little Brute Mandrels
- Medium Brute Mandrels
- Big Brute Mandrels
- Offset Mandrels
- Little Brute Offset Adapter Mandrels
- Medium Brute Offset Adapter Mandrels
- Midget Puller Mandrels
- Hydraulic Offset Adapter Mandrels
- Right Angle Puller Mandrel
- Modular Extension Nosecap Assembly
- Modular Extension Nosecap
- MEN for Little Brute Offset Adapter
- MEN for Medium Brute Offset Adapter
- MEN for Medium Brute Hydraulic Offset
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For detailed Capital Tooling Operation Manuals please visit our website at [www.fatiguetech.com/support-tooling-catalog-operation-manuals.asp](http://www.fatiguetech.com/support-tooling-catalog-operation-manuals.asp) or contact your nearest FTI Representative with any additional questions.

FTI Tooling is capable of a wide range of small and large applications.
Fatigue Technology’s split sleeve cold expansion systems are comprised of compatible pieces of tooling as seen in the above diagram. All tooling is divided into three categories: capital, durable, and expendable tooling.

2.1 INTRODUCTION

Capital Tooling
- Hydraulic PowerPaks
- Puller Units
- Offset Adapters

Durable Tooling
- Cutting Tools
- Gages
- Mandrels
- Nosecap Assemblies

Expendable Tooling
- Split Sleeves
- Backup Blocks

Figure 2.1-1
Cold Expansion System Components
2.2 CAPITAL TOOLING

Puller Units

Offset Adapters

PowerPaks

Detailed Tooling
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Table 2.2-1
Little Brute Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-1) (inch)</th>
<th>F (Ref. Fig. 2.2-1) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
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</thead>
<tbody>
<tr>
<td>LB-10</td>
<td>1.0</td>
<td>9.2</td>
<td>2.56</td>
<td>10.75</td>
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<td>LB-15</td>
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<td>3.06</td>
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<td>LB-35</td>
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<td>14.2</td>
<td>5.06</td>
<td>12.00</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Note: The LB-20 is standard since material stackups rarely exceed 2 inches in the applicable diameter range. Little Brute is designed for use with all FTI processes.

Air-actuated, hydraulic puller is capable of cold expanding holes up to 1/2-inch diameter in aluminum and mild steel and up to 3/8-inch diameter in titanium and high-strength steel.

- 8,000 lbs maximum pull force at 10,000 psi hydraulic pressure.
- Includes a 10-foot hose assembly, spanner wrench, and nosecap pin wrench.
- Hydraulic pressure provided by FT-200 or FT-20 PowerPak.
- The LB puller is compatible with FTI extension and flush nosecaps (see nosecap section).
- The LB puller is directly compatible with standard Type 1 (7/16-20) threaded mandrels.

Figure 2.2-1
Little Brute (LB) Puller Unit

Little Brute is designed for use with all FTI processes.
Medium Brute Puller Unit (MB)

- Air-actuated, hydraulic puller is capable of cold expanding holes up to 15/16-inch diameter in aluminum and mild steel and up to 3/4-inch diameter in titanium and high strength steel.
- 24,000 lbs maximum pull force 10,000 psi of hydraulic pressure.
- Includes a 10-foot hose assembly, 5/8-inch (-2) and 7/8-inch (-5) threaded adapters, spanner wrench, and nosecap pin wrench.
- Hydraulic pressure provided by FT-200 or FT-20 PowerPak.
- The MB puller is compatible with FTI Medium Brute extension and flush nosecaps (see nosecap section).
- The MB puller is directly compatible with standard Type 2 (5/8-18) threaded mandrels or may be used with Type 5 (7/8-14) threaded mandrels with the proper threaded adapter.

### Table 2.2-2
Medium Brute Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-2) (inch)</th>
<th>F (Ref. Fig. 2.2-2) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB-30</td>
<td>3.3</td>
<td>18.2</td>
<td>7.16</td>
<td>20</td>
<td>5.2</td>
</tr>
<tr>
<td>MB-70</td>
<td>7.0</td>
<td>25.5</td>
<td>10.16</td>
<td>24</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Note: The MB-30 is standard. Medium Brute is designed for use with all FTI processes.
• Air-actuated, hydraulic puller is capable of cold expanding holes up to 2.5 inches diameter in aluminum and mild steel and up to 1.25 inches diameter in titanium and high strength steel.

• For tool sizes larger than STDN 30-3-N or thick stackups of Ti or high strength steel; smaller tool sizes can be adapted. Contact FTI for more information.

• 38,000 lbs maximum pull force at 10,000 psi hydraulic pressure.

• Includes a 10-foot hose assembly, spanner wrench, and nosecap pin wrench.

• Hydraulic pressure provided by FT-200 or FT-20 PowerPak.

• The BB puller is compatible with both Big Brute flush and extension nosecaps (see nosecap section).

• The BB puller is directly compatible with -3, -4, -5, and -9 mandrels (see Table 2.3-15B Attachment Callout & Table 2.3-16B Attachment Callout). Proper mandrel adapter is required.

### Table 2.2-3

<table>
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<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-3) (inch)</th>
<th>F (Ref. Fig. 2.2-3) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
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<td>9.06</td>
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<td>BB-30A</td>
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</tr>
</tbody>
</table>

Note: The BB-30 is standard. Big Brute is designed for use with all FTI processes.
Table 2.2-4
Jumbo Brute Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-4) (inch)</th>
<th>M (Ref. Fig. 2.2-4) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
<th>F (Ref. Fig. 2.2-4) (inch)</th>
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<td>JB-30</td>
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</table>

*Loosen cylinder clamps to reposition handles
**JB-30 series does not use an extension tube.
Figure 2.2-5A
Super Brute (SB-2A) Puller Unit

- Utilizes pneumatic return system for rapid cycle times.
- 120,000 lbs maximum pull force at 10,000 psi pump pressure.
- Hydraulic pressure is provided by FTI FT-200 PowerPak.
- Remote air trigger required for activation (FTI part number 2049-007).
- Lifting handles provide additional mechanical support during operation.
- The Super Brute Puller Units are application-specific and use special mandrels and nosecaps. Please contact FTI for assistance in selecting tooling.

Table 2.2-5A
Super Brute Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-5A) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
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<tbody>
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<td>23.4</td>
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2.2.5
**SUPER BRUTE PULLER UNIT (SB-300B)**

**Table 2.2-5B**
Super Brute Specifications

<table>
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<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>L (Ref. Fig. 2.2-5B) (inch)</th>
<th>Weight (lb.)</th>
<th>Stroke (inch)</th>
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<td>26.25</td>
<td>360</td>
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*Only difference between SB-300A & SB-300B is the thread callout on the pull rod

**Figure 2.2-5B**
Super Brute (SB-300B) Puller Unit

- Utilizes pneumatic return system for rapid cycle times.
- 300,000 lbs maximum pull force at 10,000 psi pump pressure.
- Hydraulic pressure is provided by FTI FT-200 PowerPak.
- Remote air trigger required for activation (FTI part number 2049-007).
- Must use engine leveler to position during operation.
- The Super Brute Puller Units are application-specific and use special mandrels and nosecaps. Please contact FTI for assistance in selecting tooling.
- Compact mechanical hand puller ideal for restricted access locations.
- Suitable for cold expanding holes in aluminum up to 1/2-inch diameter and up to 3/8-inch diameter in steel and titanium.
- Pull force of approximately 8,000 lbs.
- Each rotation of the hex nut provides .167 inch of travel.
- A ratchet wrench is included to operate the hand puller.
- Uses Little Brute mandrels with either special flush HP-10 nosecaps or modular extension jaws with "B" threads (see nosecap section 2.3.23 for extension jaw information). Please call FTI Sales Department for additional flush nosecap information.
- Maximum material stackup 1.0 inch; overall length 3.50 inches with flush jaw.
2.2.6
HAND PULLERS (HP-20)

- Mechanically actuated puller designed for applications where a limited number of holes are cold expanded.
- Suitable for cold expanding holes in aluminum up to 3/8-inch diameter and up to 1/4-inch diameter in steel and titanium.
- Pull force of approximately 4,000 lbs.
- Each rotation of the hex nut provides .050 inch of travel.
- A ratchet wrench is included to operate the hand puller.
- Uses Little Brute nosecaps and mandrels.
- Maximum material stackup 2.0 inches; overall length 11.0 inches when using 2-inch extension nosecap.

Figure 2.2-6B
Hand Puller (HP-20)

Note: Hand Pullers are designed for use with all FTI processes.
• Hydraulic actuated pullers designed for use in severely restricted access areas.

• Weighs approximately 10 lbs with hoses. (10 ft hydraulic hose assembly is included)

• Use Little Brute flush or extension jaws. Modular extension jaws may be used with the proper adapter. Contact FTI for additional information.

• Midget Pullers are powered by the FTP-19 Hand Pump
2.2.7 MIDGET PULLERS

Table 2.2-7A
FTMP Specifications

<table>
<thead>
<tr>
<th>Midget Puller Type</th>
<th>Max. Pull Force (lb.)</th>
<th>Max. Hole Dia. in Aluminum (inch)</th>
<th>Max. Hole Dia. in Ti and Steel (inch)</th>
<th>Max. Mandrel Stackup (inch)</th>
<th>Stroke (inch)</th>
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<td>FTMP-7</td>
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<td>1/4</td>
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<tr>
<td>FTMP-8</td>
<td>8,000</td>
<td>1/2</td>
<td>3/8</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>FTMP-12</td>
<td>8,000</td>
<td>1/2</td>
<td>3/8</td>
<td>1.2</td>
<td>2.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Midget Puller Type</th>
<th>Working Front Side Clearance L (Ref. Fig. 2.2-7A-B) (inch)</th>
<th>Lateral Clearance C (Ref. Fig. 2.2-7A-B) (inch)</th>
<th>Width B (Ref. Fig. 2.2-7A-B) (inch)</th>
<th>Working Height Clearance F (Ref. Fig. 2.2-7A-B) (inch)</th>
<th>Compatible Hydraulic PowerPak*</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTMP-7</td>
<td>5.0</td>
<td>.75</td>
<td>2.2</td>
<td>7.0</td>
<td>FTP-19</td>
</tr>
<tr>
<td>FTMP-8</td>
<td>4.6</td>
<td>.80</td>
<td>2.5</td>
<td>11.5</td>
<td>FTP-19</td>
</tr>
<tr>
<td>FTMP-12</td>
<td>5.0</td>
<td>.80</td>
<td>2.5</td>
<td>11.5</td>
<td>FTP-19</td>
</tr>
</tbody>
</table>

* Hand pumps are purchased separately.

Table 2.2-7B
FTMP Jaw Callout

<table>
<thead>
<tr>
<th>Flush Jaw Callout</th>
<th>STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC-10-04F</td>
<td>4-0-N thru 4-3-N</td>
</tr>
<tr>
<td>CBC-10-06F</td>
<td>4-4-N thru 6-3-N</td>
</tr>
<tr>
<td>CBC-10-08F</td>
<td>6-3-N thru 8-3-N</td>
</tr>
<tr>
<td>CBC-10-10F</td>
<td>8-3-N thru 10-2-N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extension Jaw Callout</th>
<th>STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBCE-14A-0401F-JO</td>
<td>4-0-N thru 4-1-N</td>
</tr>
<tr>
<td>CBCE-14A-0423F-JO</td>
<td>4-2-N thru 4-3-N</td>
</tr>
<tr>
<td>CBCE-14A-0601F-JO</td>
<td>4-4-N thru 6-1-N</td>
</tr>
<tr>
<td>CBCE-14A-0623F-JO</td>
<td>8-0-N thru 8-1-N</td>
</tr>
<tr>
<td>CBCE-14A-0801F-JO</td>
<td>6-2-N thru 6-3-N</td>
</tr>
<tr>
<td>CBCE-14A-0823F-JO</td>
<td>8-2-N thru 8-3-N</td>
</tr>
</tbody>
</table>

Mandrel Selection: The FTMPs require special FTMP mandrels. See Mandrel section 2.3.20 (page 73).

FTMP-12 and FTMP-8 can use LB mandrels but one inch of length is lost to the puller.

Sleeve Selection: The FTMP-7 and FTMP-8 use 3/4-inch long sleeves, CBS-STDN-12F.

The FTMP-12 uses 16F sleeve lengths.

Ordering Example: CBM-10-0-N-1-20-V1 Mandrel
CBS-10-0-N-16F Sleeve
CBC-10-10F Jaw
Detailed Tooling

- UNCONTROLLED IF PRINTED -

2.2.8

LITTLE BRUTE OFFSET ADAPTERS (LBOA)

- UNCONTROLLED IF PRINTED -

Little Brute Offset Adapter (LBOA)

- Capable of cold expanding holes in restricted access areas up to 1/2 inch diameter in aluminum and mild steel, and 7/16 inch diameter in titanium and high strength steel.

- Attaches to the Little Brute (LB) series of puller units.

- Adapter weighs 6.5 lbs. With LB Puller Unit attached, complete unit weighs approximately 17.0 lbs.

- Requires only 1/4-inch lateral clearance.

- 7,000 lbs maximum pull force (generated by the Little Brute Puller Unit).

- Identification is provided by a machined model number and serial number.

Table 2.2-8

Little Brute Offset Adapter Specifications (In Inches)

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup</th>
<th>Combination Puller and Length OAL (Ref. Fig. 2.2-8)</th>
<th>Adapter Length L (Ref. Fig. 2.2-8)</th>
<th>Frontside Clearance F (Ref. Fig. 2.2-8)</th>
<th>Frontside Clearance F for Units with Barrel Nut Retaining Tab</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBOA-10</td>
<td>1.0</td>
<td>11.8</td>
<td>6.7</td>
<td>3.40</td>
<td>4.05</td>
</tr>
<tr>
<td>LBOA-10-RA1*</td>
<td>1.0</td>
<td>11.8</td>
<td>6.7</td>
<td>3.40</td>
<td>4.05</td>
</tr>
<tr>
<td>LBOA-10-RA4*</td>
<td>1.0</td>
<td>11.8</td>
<td>6.7</td>
<td>3.40</td>
<td>4.05</td>
</tr>
<tr>
<td>LBOA-15</td>
<td>1.5</td>
<td>13.3</td>
<td>7.7</td>
<td>3.90</td>
<td>4.55</td>
</tr>
<tr>
<td>LBOA-20</td>
<td>2.0</td>
<td>14.8</td>
<td>8.7</td>
<td>4.40</td>
<td>5.05</td>
</tr>
<tr>
<td>LBOA-25</td>
<td>2.5</td>
<td>16.3</td>
<td>9.7</td>
<td>4.90</td>
<td>5.55</td>
</tr>
<tr>
<td>LBOA-30</td>
<td>3.0</td>
<td>17.8</td>
<td>10.7</td>
<td>5.40</td>
<td>6.05</td>
</tr>
<tr>
<td>LBOA-35</td>
<td>3.5</td>
<td>19.3</td>
<td>11.7</td>
<td>5.90</td>
<td>6.55</td>
</tr>
</tbody>
</table>

*RA stands for Restricted Access, in which the puller may be used in corners or similar circumstances

Note: The LBOA-20 is standard.

Nosecap Selection: Refer to nosecap section for applicable LBOA nosecaps.

Mandrel Selection: Refer to mandrel section for applicable mandrels.
2.2.9
HYDRAULIC OFFSET ADAPTERS (HOA)

• For use in severely restricted access areas.
• Use with the FTP-19 hand hydraulic pump (included with purchase of puller unit).
• Capable of cold expanding holes in aluminum or mild steel up to 3/8 inch diameter, and up to 5/16 inch diameter in high strength steel or titanium.
• Up to 2.5 inch material stackup capacity, maximum pull force of 5,000 lbs.
• Weighs 15 lbs with 10-foot hose (dry). Hose is included with all HOAs.
• Hose may be ported top or bottom. (Hose Reversal Kit Available - See Below)

HOA-6L: FTI Hose Reversal Kit Part Number 2816-001
HOA-7L: FTI Hose Reversal Kit Part Number 2816-002
HOA-8L: FTI Hose Reversal Kit Part Number 2816-003.

• Can be used to cold expand holes with lateral restrictions as low as 0.29 inch.
• Mandrel center line offset is 3 inches.

Table 2.2-9
Hydraulic Offset Adapter Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Nominal Maximum Stackup (inch)</th>
<th>Overall Length L (Ref. Fig. 2.2-9) (inch)</th>
<th>Frontside Clearance F (Ref. Fig. 2.2-9) (inch)</th>
<th>Stroke (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOA-6L</td>
<td>1.0</td>
<td>6.4</td>
<td>2.7</td>
<td>1.62</td>
</tr>
<tr>
<td>HOA-7L</td>
<td>1.5</td>
<td>7.4</td>
<td>3.1</td>
<td>2.06</td>
</tr>
<tr>
<td>HOA-8L</td>
<td>2.0</td>
<td>8.4</td>
<td>3.6</td>
<td>2.49</td>
</tr>
<tr>
<td>HOA-9L</td>
<td>2.5</td>
<td>9.5</td>
<td>4.3</td>
<td>2.92</td>
</tr>
</tbody>
</table>

Note: FTP-19 Hand Pump is included with the standard HOA-6L Nosecap Selection: The HOA puller is compatible with LBOA flush and extension nosecaps. See nosecap section.

Mandrel Selection: Refer to mandrel section for applicable mandrels.
2.2.10
Medium Brute Offset Adapter (MBOA)

- Designed for use with the Medium Brute (MB-30) Puller Unit.
- Capable of cold expanding holes in aluminum and mild steel up to 15/16 inch diameter, and up to 1/2 inch diameter in steel and titanium in restricted access areas.
- Used to cold expand holes with lateral clearances of 0.90 inch.
- A backup plate is included with each offset adapter.
- Weighs 30 lbs. With MB-30 puller attached, unit weighs 47 lbs.
- Identification is provided by an engraved model number and serial number.
- 22,000 lbs maximum pull force (from the Medium Brute Puller Unit).

Table 2.2-10
Medium Brute Offset Adapter Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>Combined Puller and Adapter Length OAL (Ref. Fig. 2.2-10) (inch)</th>
<th>Adapter Length L (Ref. Fig. 2.2-10) (inch)</th>
<th>Frontside Clearance F (Ref. Fig. 2.2-10) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBOA-30A</td>
<td>3.0</td>
<td>24.8</td>
<td>14.8</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Nosecap Selection: The MBOA uses special MBOA extension and flush nosecaps.
Mandrel Selection: Refer to mandrel section for applicable mandrels.
Nosecap Selection: The MBHO puller is compatible with MBHO series of nosecaps.

Mandrel Selection: The MBHO puller is directly compatible with the 5/8-inch (Type 20A) threaded Medium Brute Offset Adapter mandrels.

Table 2.2-11
Medium Brute Hydraulic Offset Adapter Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>Overall Length L (Ref. Fig. 2.2-11) (inch)</th>
<th>Frontside Clearance F (Ref. Fig. 2.2-11) (inch)</th>
<th>Clearance Height H (Ref. Fig. 2.2-11) (inch)</th>
<th>Stroke (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBHO-20</td>
<td>2.0</td>
<td>9.1</td>
<td>5.6</td>
<td>6.0</td>
<td>3.1</td>
</tr>
<tr>
<td>MBHO-20-1.42</td>
<td>2.0</td>
<td>9.3</td>
<td>6.1</td>
<td>6.0</td>
<td>3.1</td>
</tr>
<tr>
<td>MBHO-20-5.6</td>
<td>2.0</td>
<td>9.1</td>
<td>5.6</td>
<td>5.6</td>
<td>3.1</td>
</tr>
<tr>
<td>MBHO-35</td>
<td>3.5</td>
<td>12.1</td>
<td>7.1</td>
<td>6.0</td>
<td>4.6</td>
</tr>
<tr>
<td>MBHO-35-5.6</td>
<td>3.5</td>
<td>12.1</td>
<td>7.1</td>
<td>5.6</td>
<td>4.6</td>
</tr>
</tbody>
</table>
• Designed to cold expand holes up to 2.5 inches diameter in aluminum and mild steel
and up to 1 inch diameter in titanium and high strength steel. For other processes
such as ForceMate, diameters are greater. Contact FTI for assistance.

• 35,000 lbs maximum pull force at 10,000 psi of hydraulic pressure provided by the
FT-200 PowerPak.

• Up to 5.0 inches material stackup capacity.

• Weighs 160 lbs with 10-foot hose assembly.

• The BBHO is a specially designed tool for specific applications involving large
holes in restricted access areas. For nosecap and/or mandrel selection, contact
FTI’s Technical Help Desk for assistance.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Maximum Material Stackup (inch)</th>
<th>Overall Length L (Ref. Fig. 2.2-12) (inch)</th>
<th>Frontside Clearance F (Ref. Fig. 2.2-12) (inch)</th>
<th>Overall Width W (Ref. Fig. 2.2-12) (inch)</th>
<th>Lateral Clearance A (Ref. Fig. 2.2-12) (inch)</th>
<th>Housing Width Y (Ref. Fig. 2.2-12) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBHO-30</td>
<td>5.0</td>
<td>21.09</td>
<td>5.38</td>
<td>5.93</td>
<td>1.49</td>
<td>3.89</td>
</tr>
<tr>
<td>BBHO-30A</td>
<td>5.1</td>
<td>22.21</td>
<td>4.18</td>
<td>9.11</td>
<td>1.49</td>
<td>6.28</td>
</tr>
</tbody>
</table>

Note: The BBHO-30 is equipped with a tang mandrel attachment and the BBHO-30A is equipped with a threaded mandrel attachment.
2.2.13
**Little Brute Right Angle Adapter (LBRA)**

- Operated by attaching to the end of any Little Brute Puller Unit.
- Capable of cold expanding holes up to 0.40 inch diameter in aluminum.
- Pull force of approximately 3,400 lbs.
- Adapter weighs 1.4 lbs.
- Head can rotate 360 degrees on puller unit.
- Adapter may be disassembled to perform routine maintenance.

**Table 2.2-13**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>STDN Size</th>
<th>Maximum Sleeve Length</th>
<th>Maximum Material Stackup (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBRA-7</td>
<td>4-0-N thru 8-1-N</td>
<td>-14F (7/8&quot;)</td>
<td>0.840</td>
</tr>
<tr>
<td></td>
<td>8-2-N thru 12-3-N</td>
<td>-12F (3/4&quot;)</td>
<td>0.715</td>
</tr>
</tbody>
</table>

**Note:** See mandrel and nosecap sections for correct LBRA-7 tooling.
- FT-200 PowerPak is used to operate the FTI family of puller units including the Little Brute, Medium Brute, Big Brute, and Medium Brute Hydraulic Offset.
- Air-powered hydraulic unit that utilizes a hydraulic pump driven by an air motor to generate up to 10,000 psi of hydraulic pressure.
- The air motor is driven by compressed air at 90 to 120 psi and 50 cubic feet per minute (cfm) flow through a 3/8 inch or 1/2 inch inside diameter air hose supply.
- The FT-200 is equipped to accept a 1/2 inch hose (not included).
- Weighs 65 lbs when filled with 2 gallons (7.57 liters) of oil (85 lbs shipping weight).
- Wheels are included for portability.
- Typical cycle time is approximately 7 holes per minute in 1/4-inch thick aluminum and 5/16-inch diameter holes.
- Replaces the IW100MF PowerPak.
• Dual acting for hydraulic return puller unit.

• For use with Double Acting Unit.

• Air-powered hydraulic unit that utilizes a hydraulic pump to generate up to 10,000 psi of hydraulic pressure.

• The air motor is driven by compressed air at 90 to 120 psi and 50 cubic feet per minute (cfm) flow through a 1/2-inch inside diameter air hose supply.

• Weighs 65 lbs when filled with 2 gallons (7.57 liters) of oil (85 lbs shipping weight).

• Wheels are included for portability.
FT-20 PowerPak

- Used to operate the FTI standard series of puller units, including the Little Brute, Medium Brute, and Big Brute.
- Air-powered hydraulic unit.
- Lightweight and portable design to be used for applications where mobility is a key consideration.
- Weighs 18 lbs when filled with .45 gallons (1.72 liters) of oil (20 lbs shipping weight).
- Supplies up to 10,000 psi hydraulic pressure to the puller unit.
- The air motor is driven by compressed air at 90 to 120 psi and 20 cubic feet per minute (cfm) flow through a 3/8-inch inside diameter supply air hose.
- Equipped with a 3/8-inch diameter male quick disconnect air inlet fitting.
- Replaces the IW10MF PowerPak.
2.2.17
FTP-19
HAND PUMP

- Manually operated pump allows improved control of pullers during cold expansion.
- Weighs 6.6 lbs when filled with hydraulic fluid.
- Provides power for the FTMP-7 Midget Puller and the HOA offset puller.
- Provides up to 10,000 psi of hydraulic pressure.
- Identification is provided by decals on reservoir.

Figure 2.2-17
FTP-19 Hand Pump

Table 2.2-17
FTP-19 Specifications

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Pressure Rating (psi)</th>
<th>Reservoir Capacity (cubic inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTP-19</td>
<td>10,000</td>
<td>24.4</td>
</tr>
</tbody>
</table>
2.3 DURABLE TOOLING

Drills

Reamers

Gages

Mandrels
2.3.1
STARTING
DRILLS

- Used to create new holes in production or remove large amounts of material in rework.
- Designed to reduce the amount of force necessary to drill a hole; provides improved hole surface quality; split point feature improves accuracy of hole location.
- Identification is provided by an electroetched model number and a single-line ground or electroetched mark on the shank, indicating the first cutting tool operation.
- Available in high-strength steel, cobalt, or carbide. High-speed steel drills are most common, but cobalt and carbide drills are available for special applications.
- Special lengths and attachments are available upon request. For tooling outside standard tooling range, please contact our Sales Staff.

Figure 2.3-1
Starting Drill

Model Number Key:

C B S D - 1 0 - 0 - N - 1 - *

Process Callout

Starting Drill

Blank = High-Speed Steel
C = Cobalt
CBD = Carbide

1 = Straight Shank
2 = Tapered Shank

Standard Tool Diameter Number (STDN)
### Table 2.3-1A

<table>
<thead>
<tr>
<th>STDN</th>
<th>Model Number</th>
<th>L (Ref. Fig. 2.3-1) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N</td>
<td>CBSD-4-0-N-1</td>
<td>4.62</td>
</tr>
<tr>
<td>4-1-N</td>
<td>CBSD-4-1-N-1</td>
<td>5.12</td>
</tr>
<tr>
<td>4-2-N</td>
<td>CBSD-4-2-N-1</td>
<td>5.37</td>
</tr>
<tr>
<td>4-3-N</td>
<td>CBSD-4-3-N-1</td>
<td>5.37</td>
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<td>4-4-N</td>
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<tr>
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<tr>
<td>6-3-N</td>
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</tr>
<tr>
<td>8-0-N</td>
<td>CBSD-8-0-N-1</td>
<td>6.00</td>
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<td>8-1-N</td>
<td>CBSD-8-1-N-1</td>
<td>6.12</td>
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<td>CBSD-12-1-N-1</td>
<td>6.75</td>
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<tr>
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<td>CBSD-12-2-N-1</td>
<td>6.75</td>
</tr>
<tr>
<td>12-3-N</td>
<td>CBSD-12-3-N-1</td>
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<tr>
<td>14-0-N</td>
<td>CBSD-14-0-N-1</td>
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<tr>
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<td>CBSD-16-3-N-1</td>
<td>7.75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STDN</th>
<th>Model Number</th>
<th>L (Ref. Fig. 2.3-1) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-0-N</td>
<td>CBSD-18-0-N-1</td>
<td>8.00</td>
</tr>
<tr>
<td>18-1-N</td>
<td>CBSD-18-1-N-1</td>
<td>8.00</td>
</tr>
<tr>
<td>18-2-N</td>
<td>CBSD-18-2-N-1</td>
<td>8.25</td>
</tr>
<tr>
<td>18-3-N</td>
<td>CBSD-18-3-N-1</td>
<td>8.25</td>
</tr>
<tr>
<td>20-0-N</td>
<td>CBSD-20-0-N-1</td>
<td>8.25</td>
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### 2.3.1 Starting Drills

#### CA Starting Drills

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* Lengths may vary depending on tooling type.

#### KB2 Starting Drills

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* Lengths may vary depending on tooling type.

*** Refer to Cx2s Tooling for STDN information.
Figure 2.3-2
Right Angle Starting Drill

- Used as starting drills to create holes in applications that have restricted front side clearance.
- The split point configuration reduces the amount of force necessary to drill a hole, and provides improved hole surface quality.
- Identification is provided by an electroetched STDN and a single-line ground or electroetched mark on wrench flat.
- Shorter lengths are available upon request.
- Standard CB, KB, and CR drills are high-speed steel; standard CA drills are cobalt.

**Model Number Key:**

CB S D - 1 0 - 0 - N - R A

- Process Callout
- Starting Drill
- Right Angle
- Standard Tool Diameter Number (STDN)
## 2.3.2 Right Angle Starting Drills

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*Refer to Cx2s Tooling for STDN information.*

## Table 2.3-2D
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### 2.3.2
**RIGHT ANGLE STARTING DRILLS**
2.3.3
CORE DRILLS

- Used in rework applications to prepare existing holes for a starting reamer.
- Helical flutes give material removal capability comparable to a twist drill.
- A non-cutting pilot, sized to .001 to .002 inch under the existing hole, followed by cutting flutes gives the locational and dimensional accuracy characteristics of a reamer.
- Identification is provided by an electroetched model number and a single line ground or electroetched on the shank, indicating the first cutting tool operation.
- High-speed steel material is standard. Carbide material can be provided for special applications.
- Pilot diameter (customer supplied) is equal to the minimum existing hole diameter minus approximately .001 inch (in .001 inch increments).
- For other sizes please contact our Sales Staff.

**Model Number Key:**

- **CBD** = Carbide
- **C** = Blank = High-Speed Steel
- **B** = Process Callout
- **K** = Core Drill
- **D** = Std. Tool Diameter Number (STDN)
- **100N*** = Pilot Diameter

*Figure 2.3-3
Core Drill*
### Table 2.3-3A

**CB Core Drills**

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### 2.3.3 CORE DRILLS

#### Table 2.3-3B
**CA Core Drills**

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**KB2 Core Drills**

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**** Refer to Cx2s Tooling for complete STDN information.
• Used in rework applications to prepare existing holes for the starting reamer.

• Helical flutes give material removal capability comparable to a twist drill.

• A non-cutting pilot sized to .001 to .002 inch under the existing hole, followed by cutting flutes, gives the locational and dimensional accuracy characteristics of a reamer.

• Identification is provided by an electroetched model number.

• High-speed steel drills are standard. Carbide drills can be provided for special applications.

• Pilot diameter (customer supplied) is equal to the minimum existing hole diameter minus approximately .001 inch (in .001 inch increments).

• For other sizes please contact our Sales Staff.

**Figure 2.3-4**

*Right Angle Core Drill*

- Blank = High-Speed Steel
- CBD = Carbide
- Pilot Diameter
- Right Angle

**Model Number Key:**

- **CBKD** - **STDN** - **N** - **RA** - **** - *
### 2.3.4 Right Angle Core Drills

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**** Refer to Cx2s Tooling for complete STDN information.
• Designed principally for starting hole sizing where only a moderate amount of stock removal is required (typically .010 inch to .015 inch).

• Used to produce holes of superior dimensional accuracy and surface finish.

• Starting reamers feature a pilot which is sized to the drilled pilot hole.

• Identification is provided by an electroetched model number and two electroetched lines.

• High-Speed steel reamers are standard. Cobalt and carbide reamers are available for special applications.

• For other types or sizes, please contact our Sales Staff.

---

**Model Number Key:**

```
C B S R - 1 0 - 0 - N - 1 - *
```

- **Blank** = High-Speed Steel
- **C** = Cobalt
- **CBD** = Carbide
- **1** = Straight Shank
- **2** = Tapered Shank
- **STDN** = Standard Tool Diameter Number

---

**Figure 2.3-5**

*Starting Reamer*
### Table 2.3-5A

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**2.3.5 STARTING REAMERS**

Detailed Tooling

Page 46
### Table 2.3-5B
**CA Starting Reamers**

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**KB2 Starting Reamers**

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* Lengths may vary depending on tooling type.
**** Refer to Cx2s Tooling for STDN information.

### Table 2.3-5D
**CR Starting Reamers**

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2.3.5
STARTING REAMERS

Detailed Tooling
Page 47
2.3.6
RIGHT ANGLE STARTING REAMERS

• Designed principally for sizing starting holes where only a moderate amount of stock removal is required (typically .010 inch to .015 inch).

• Used only in restricted front-side clearance applications.

• High-Speed steel reamers feature a pilot which is sized to the drilled pilot hole.

• High-Speed steel reamers are standard. Cobalt and carbide reamers are available for special applications.

• Identification is provided by an electroetched STDN and two lines ground or electroetched mark on wrench flat, indicating the second cutting tool operation.

**Model Number Key:**

- **CBSR - 10 - 0 - N - RA - *:**
  - **Process Callout**
  - **Starting Reamer**
  - **Blank = High-Speed Steel**
  - **C = Cobalt**
  - **CBD = Carbide**
  - **Right Angle**
  - **Standard Tool Diameter Number (STDN)**

---

**Figure 2.3-6**
Right Angle Starting Reamer

---

Detailed Tooling
Page 48

- UNCONTROLLED IF PRINTED -
### Table 2.3-6A
**CB Starting Reamers**

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**CA Starting Reamers**

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### 2.3.6
**RIGHT ANGLE STARTINGREAMERS**

---

*Detailed Tooling*

*Page 49*
### KB2 Starting Reamers

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### CR Starting Reamers

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<td>CRSR-50-RA</td>
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<tr>
<td>R62</td>
<td>CRSR-62-RA</td>
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</table>

**** Refer to Cx2s Tooling for STDN information.
Designed principally for hole sizing after cold expansion where only a moderate amount of stock removal is required (typically .010 inch to .015 inch).

All gage finish reamers feature a non-cutting pilot that is sized to the cold expansion verification pin diameter, which verifies the hole has been cold expanded (see combination gage section). The pilot will not fit into a non-cold expanded hole.

Identification provided by an electroetched model number and three electroetched lines.

High-Speed steel reamers are standard. Cobalt and carbide reamers are available for special applications.

When possible, final hole diameter should be a multiple of .0005 inch.

Final reamers are sized to the minimum final hole diameter unless otherwise specified.

For other sizes, please contact our Sales Staff.

Figure 2.3-7
Gage Finish Reamer

Model Number Key:

Process Callout
Gage Finish Reamer
Standard Tool Diameter Number (STDN)

Blank = High-Speed Steel
C = Cobalt
CBD = Carbide

Desired Minimum Final Hole Diameter (customer specified)

1 = Straight Shank
2 = Tapered Shank

- UNCONTROLLED IF PRINTED -
## Table 2.3-7A
### CB Finish Reamers

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<th>STDN</th>
<th>Model Number</th>
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<th>STDN</th>
<th>Model Number</th>
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<td>CBR-18-1-N-1-.****</td>
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*Actual length may vary depending on final hole size.
**** Cutting diameter.
### Table 2.3-7B
**CA Finish Reamers**

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*Actual length may vary depending on the final hole size.

### Table 2.3-7C
**CR Finish Reamers**

<table>
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*Actual length may vary depending on the final hole size.
2.3.8

RIGHT ANGLE GAGE FINISH REAMERS

- Designed principally for hole sizing after cold expansion where only a moderate amount of stock removal is required (typically .010 inch to .015 inch).
- Used in restricted front-side clearance applications.
- All gage finish reamers feature a non-cutting pilot sized to the cold expansion verification pin diameter to verify the hole has been cold expanded (see verification gage section). The pilot will not fit into a non-cold expanded hole.
- High-Speed steel reamers are standard. Cobalt and carbide reamers are available for special applications.
- When possible, final hole diameter should be a multiple of .0005 inch.
- Identification is provided by an electroetched STDN and three lines ground or electroetched mark on wrench flat.

**Model Number Key:**

\[
\text{Process Callout} \quad \text{CBR - 10 - 0 - N - RA - **** - *}
\]

- **Blank** = High-Speed Steel
- **C** = Cobalt
- **CBD** = Carbide
- **Desired Minimum Final Hole Diameter** (customer specified)
- **Right Angle**

**Figure 2.3-8**

*Right Angle Gage Finish Reamer*

---

Detailed Tooling
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- UNCONTROLLED IF PRINTED -
### Table 2.3-8A
**CB Finish Reamers**

<table>
<thead>
<tr>
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<tbody>
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<td>CBR-4-2-N-RA-****</td>
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### Table 2.3-8C
**CR Finish Reamers**

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<td>CRR-60-RA-****</td>
</tr>
<tr>
<td>R62</td>
<td>CRR-62-RA-****</td>
</tr>
</tbody>
</table>

**** Cutting diameter.
## 2.3.9 Combination Gages

**Figure 2.3-9A**

*Combination Gage*

- A stepped go/no-go configuration pin allows one end to ensure starting hole is within the specification tolerance prior to cold expansion.
- The cold expansion verification end confirms the hole has been cold expanded prior to final reaming.
- Starting hole diameter gage pin is a blade configuration to detect hole ovality.
- Cold expansion verification pin has flats to allow clearance past sleeve ridge.
- Identification is provided by a stamped model number on the handle and electroetched diameters on the pins.
- Made of long wearing, hardened steel pins with an aluminum handle.
- For other sizes, please contact our Sales Staff.

**Model Number Key:**

```
C B G - 1 0 - 0 - N - 1 - R A*
```

- **CBG** - Process Callout
- **100N1** - Standard Tool Diameter Number (STDN)
- **RA** - Right Angle
- ***** - Revision Number

*Some legacy Right Angle Combination Gages have a -RA1 at the end of the model number.*

**Figure 2.3-9B**

*Right Angle Combination Gage*

*Detailed Tooling*  
*Page 56*
### Table 2.3-9A

**CB Combo Gages**

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**CA Combo Gages**

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#### KB2 Combo Gages

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### Table 2.3-9D
#### CR Combo Gages

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</table>

\**\* Refer to Cx2s Tooling for complete STDN information.

---

Detailed Tooling
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• No-go feature indicates that the mandrel is within the specification tolerance.

• Identification is provided by a machined model number on the front of the mandrel gage.

• Made from hardened steel.

• Sized to the minimum allowable major diameter of the mandrel.

**Model Number Key:**

- \( C B MG - 10 - 0 - N \)
- Process Callout
- Standard Tool Diameter Number (STDN)
- Mandrel Gage

![Figure 2.3-10 Mandrel Gage](image)
### Table 2.3-10A
**CB Mandrel Gages**

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**KB2 Mandrel Gages**

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*** Refer to Cx2s Tooling for complete STDN information.

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### 2.3.10
**MANDREL GAGES**

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**Detailed Tooling**

*Page 61*
2.3.11 Final Hole Gages

- Designed with a go/no-go feature to verify that the final hole has been properly reamed.
- Final hole gages are made from a hardened steel pin and an aluminum handle.
- Identification is provided by a stamped model number on the handle and electroetched final hole diameters on the pin.
- For other sizes and tool systems, contact our Sales Staff.

Model Number Key:

C B FG - 6-0-N - 1 - **** / ****

- Process Callout
- Final Hole Gage
- Final Hole Diameter (customer specified)
- Standard Tool Diameter Number (STDN)

Figure 2.3-11
Final Hole Gage
- UNCONTROLLED IF PRINTED -

**Figure 2.3-12**

*Stamp Gage*

- Used to identify discrepant starting hole diameters, and to verify and mark holes that have been cold expanded.

- A stepped go/no-go configuration allows one end to ensure starting hole is within the specification tolerance prior to cold expansion, and stamps the part with "SHD" and an arrow to identify the hole if oversized.

- The opposite end verifies the hole has been properly cold expanded prior to final reaming and stamps the part CXD with an arrow pointing toward the cold expanded hole.

- The pin configuration is flat to detect hole ovality.

- Identification is provided by a stamped model number on the handle and electroetched diameters on the pins.

- Stamp gages are made of long wearing, hardened steel pins with an aluminum handle.

- Supplied with felt stamp pad, ink not included.

- For other sizes or series of tooling, please contact our Technical Sales staff.

---

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**Detailed Tooling**

Page 64
- Used with a split sleeve to cold expand a hole.
- Identification is provided by an electroetched model number on the shank of the mandrel. (refer to B on Figure 2.3-13).
- Manufactured from high-strength, high-toughness alloy tool steel.
- Finished to a close diametrical tolerance of +/-0.0002 inch or tighter.
- Typically endures 1,000 to 5,000 applications before the major diameter becomes worn beyond limits (depends on material being cold worked).
- -V2 denotes increased material strength for use with titanium or high strength steel applications.

**Figure 2.3-13**
Parts of the Mandrel

- The major diameter (D) in conjunction with the thickness of the split sleeve provides the radial expansion required by the Cold Expansion System. This dimension is specified by the appropriate process.
- The minor diameter (B) is sized so that when the appropriate sleeve is placed on the mandrel, it will fit into the correct starting hole.
- The stackup length (1) is the maximum material stackup that can be cold expanded with the mandrel.
- The back taper (2) is controlled to provide the optimal pull force.
- The front taper (3) aids in loading the sleeve onto the mandrel and facilitates insertion of the mandrel into the hole. A single witness mark ground in the front taper denotes the V2 configuration.
- The attachment (4) is the means by which the mandrel is attached to the puller unit. A hex nut is provided for finger tightening of the mandrel attachment, while the O-ring provides an air seal and friction to lock the mandrel in the puller unit.
2.3.14  \textbf{LITTLE BRUTE MANDRELS}

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{figure_2.3-14.png}
\caption{Little Brute Mandrel}
\end{figure}

\textbf{Table 2.3-14A  Stackup Callout}

\begin{center}
\begin{tabular}{||c|c|c|c||}
\hline
With 2-Inch Extension Nosecap S & With Flush Nosecap S & With CsCx Nosecap S & Mandrel Stackup Callout \\
(Ref. Fig. 2.3-14) & (Ref. Fig. 2.3-14) & (Ref. Fig. 2.3-14) & \\
(inch) & (inch) & (inch) & \\
\hline
----- & 0.5 & ----- & 5  \\
----- & 1.0 & ----- & 10 \\
----- & 1.5 & ----- & 15  \\
----- & 2.0 & ----- & 20  \\
0.5 & 2.5 & ----- & 25  \\
1.0 & 3.0 & 1.3 & 30  \\
1.5 & 3.5 & 1.8 & 35  \\
2.0 & ----- & 2.3 & 40  \\
2.5 & ----- & 2.8 & 45  \\
3.0 & ----- & 3.3 & 50  \\
3.5 & ----- & ----- & 55  \\
\hline
\end{tabular}
\end{center}

Other lengths can be provided; please contact our Technical Sales Staff for more information.

\textbf{Model Number Key:}

\begin{center}
\begin{tikzpicture}
\node (process) at (0,0) {Process Callout};
\node (mandrel) at (2,0) {Mandrel};
\node (tool) at (0,-2) {Standard Tool};
\node (material) at (2,-2) {Material Callout};
\node (stackup) at (2,-3.5) {Stackup Callout (see Table 2.3-14A)};
\node (attachment) at (2,-5) {Attachment Callout 7/16 - 20 Thread};
\end{tikzpicture}
\end{center}

\textbf{Revision 7}  \\
\textbf{TEL: (206) 246-2010}  \\
\textbf{401 Andover Park East • Seattle, WA USA • 98188}  \\
\textbf{FAX: (206) 244-9886}  \\
\textbf{www.fatiguetech.com}

Detailed Tooling  \\
Page 66
### Table 2.3-14B
**CR Mandrels**

<table>
<thead>
<tr>
<th>STDN</th>
<th>Restricted Access Mandrel</th>
<th>Standard Mandrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>R30</td>
<td>CRM-R30-1-10-V1</td>
<td>KRM-R30-1-35-V1</td>
</tr>
<tr>
<td>R32</td>
<td>CRM-R32-1-10-V1</td>
<td>KRM-R32-1-35-V1</td>
</tr>
<tr>
<td>R40</td>
<td>CRM-R40-1-20-V1</td>
<td>KRM-R40-1-35-V1</td>
</tr>
<tr>
<td>R42</td>
<td>CRM-R42-1-20-V1</td>
<td>KRM-R42-1-35-V1</td>
</tr>
<tr>
<td>R50</td>
<td>CRM-R50-1-20-V1</td>
<td>KRM-R50-1-35-V1</td>
</tr>
<tr>
<td>R52</td>
<td>CRM-R52-1-20-V1</td>
<td>KRM-R52-1-35-V1</td>
</tr>
<tr>
<td>R60</td>
<td>CRM-R60-1-20-V1</td>
<td>KRM-R60-1-35-V1</td>
</tr>
<tr>
<td>R62</td>
<td>CRM-R62-1-20-V1</td>
<td>KRM-R62-1-35-V1</td>
</tr>
</tbody>
</table>

### Table 2.3-14C
**STDN Range**

<table>
<thead>
<tr>
<th>Mandrel Prefix</th>
<th>Allowable STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM</td>
<td>4-0-N to 16-3-N</td>
</tr>
<tr>
<td>CAM</td>
<td>20 to 53</td>
</tr>
<tr>
<td>KBM</td>
<td>4-4-N to 12-3-N</td>
</tr>
<tr>
<td>KB2M</td>
<td>40-<strong><strong>-0 to 123-</strong></strong>-0</td>
</tr>
<tr>
<td>BLM</td>
<td>3 to 805</td>
</tr>
<tr>
<td>FTM</td>
<td>3-0-1 to 8-1-3</td>
</tr>
</tbody>
</table>

**** Refer to Cx2s Tooling for complete STDN information.
2.3.15
MEDIUM BRUTE
MANDRELS

![Medium Brute Mandrel Diagram]

Figure 2.3-15
Medium Brute Mandrel

---

Table 2.3-15A
Stackup Callout

<table>
<thead>
<tr>
<th>With Flush Nosecap (Ref. Fig. 2.3-15) (inch)</th>
<th>With 3-inch Extension Nosecap (inch)</th>
<th>Mandrel Stackup Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>-----</td>
<td>5</td>
</tr>
<tr>
<td>1.0</td>
<td>-----</td>
<td>10</td>
</tr>
<tr>
<td>1.5</td>
<td>-----</td>
<td>15</td>
</tr>
<tr>
<td>2.0</td>
<td>-----</td>
<td>20</td>
</tr>
<tr>
<td>2.5</td>
<td>-----</td>
<td>25</td>
</tr>
<tr>
<td>3.0</td>
<td>-----</td>
<td>30</td>
</tr>
<tr>
<td>3.5</td>
<td>.05</td>
<td>35</td>
</tr>
<tr>
<td>4.0</td>
<td>1.0</td>
<td>40</td>
</tr>
<tr>
<td>4.5</td>
<td>1.5</td>
<td>45</td>
</tr>
<tr>
<td>5.0</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>5.5</td>
<td>2.5</td>
<td>55</td>
</tr>
<tr>
<td>6.0</td>
<td>3.0</td>
<td>60</td>
</tr>
<tr>
<td>6.5</td>
<td>3.5</td>
<td>65</td>
</tr>
<tr>
<td>7.0</td>
<td>4.0</td>
<td>70</td>
</tr>
</tbody>
</table>

Other lengths can be provided; please contact our Customer Service Department for more information.

Table 2.3-15B
Attachment Callout

<table>
<thead>
<tr>
<th>Mandrel Prefix</th>
<th>Allowable STDN Range</th>
<th>Thread Size</th>
<th>Attachment Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBM</td>
<td>10-3-N to 24-2-N</td>
<td>5/8 - 18</td>
<td>2</td>
</tr>
<tr>
<td>CBM</td>
<td>22-3-N to 30-3-N</td>
<td>7/8 - 14</td>
<td>5</td>
</tr>
<tr>
<td>CAM</td>
<td>60 to 93</td>
<td>5/8 - 18</td>
<td>2</td>
</tr>
<tr>
<td>CAM</td>
<td>60 to 111</td>
<td>7/8 - 14</td>
<td>5</td>
</tr>
<tr>
<td>KBM</td>
<td>14-0-N to 20-3-N</td>
<td>5/8 - 18</td>
<td>2</td>
</tr>
</tbody>
</table>

* The tooling adapters are provided with a MB-30.

Model Number Key:

- **CBM** - [18 - 0 - N - 2 - 60 - V1]
  - **Process Callout** (CB or CA)
  - **Mandrel**
  - **Standard Tool Diameter Number (STDN)**
  - **Material Callout**
    - V1 = Aluminum or Mild Steel
    - V2 = High Strength Steel or Titanium
  - **Stackup Callout** (see Table 2.3-15A)
  - **Attachment Callout** (See Table 2.3-15B)

Note: The **bold** callouts are for use with the standard MB-30 Puller Unit and standard MB nosecaps.
**Table 2.3-16A**
Stackup Callout

<table>
<thead>
<tr>
<th>Mandrel with Flush Nosecap S (Ref. Fig. 2.3-16) (inch)</th>
<th>With 3-inch Extension Nosecap S (inch)</th>
<th>Mandrel Stackup Callouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>-----</td>
<td>10</td>
</tr>
<tr>
<td>1.5</td>
<td>-----</td>
<td>15</td>
</tr>
<tr>
<td>2.0</td>
<td>-----</td>
<td>20</td>
</tr>
<tr>
<td>2.5</td>
<td>-----</td>
<td>25</td>
</tr>
<tr>
<td>3.0</td>
<td>-----</td>
<td>30</td>
</tr>
<tr>
<td>3.5</td>
<td>.05</td>
<td>35</td>
</tr>
<tr>
<td>4.0</td>
<td>1.0</td>
<td>40</td>
</tr>
<tr>
<td>4.5</td>
<td>1.5</td>
<td>45</td>
</tr>
<tr>
<td>5.0</td>
<td>2.0</td>
<td>50</td>
</tr>
<tr>
<td>5.5</td>
<td>2.5</td>
<td>55</td>
</tr>
<tr>
<td>6.0</td>
<td>3.0</td>
<td>60</td>
</tr>
<tr>
<td>6.5</td>
<td>3.5</td>
<td>65</td>
</tr>
<tr>
<td>7.0</td>
<td>4.0</td>
<td>70</td>
</tr>
</tbody>
</table>

May be threaded. See Table 2.3-16B.

*Figure 2.3-16*
Big Brute Mandrel

**Table 2.3-16B**
Attachment Callout

<table>
<thead>
<tr>
<th>Mandrel Prefix</th>
<th>Allowable STDN Range</th>
<th>Attachment Type</th>
<th>Attachment Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB</td>
<td>32-0-N to 56-3-N</td>
<td>.960 inch tang</td>
<td>3</td>
</tr>
<tr>
<td>CB</td>
<td>32-0-N to 56-3-N</td>
<td>7/8 - 14 Thd 2 piece</td>
<td>4</td>
</tr>
<tr>
<td>CB</td>
<td>26-3-N to 56-3-N</td>
<td>1 - 14 Thd 1 piece</td>
<td>9</td>
</tr>
<tr>
<td>FM</td>
<td>-14 to -20 OS</td>
<td>.960</td>
<td>3</td>
</tr>
</tbody>
</table>

* The 0.960 inch tang tooling adapter is provided with the BB-30.
* The 7/8” and 1” threaded tooling adapter is provided with the BB-30A.

**Model Number Key:**

- **C B M** - 3 6 - 0 - N - 3 - 30 - V1

- Process Callout
- Mandrel
- Standard Tool Diameter Number (STDN)
- Material Callout
  - V1 = Aluminum or Mild Steel
  - V2 = High-Strength Steel or Titanium
- Stackup Callout
  (see Table 2.3-16A)
- Attachment Callout
  (See Table 2.3-16B)

**Note:** The **bold** callouts are for use with the standard BB-30 Fuller Unit and flush BB nosecaps.
2.3.17 OFFSET MANDRELS

- Used with a split sleeve to cold expand a restricted access hole.
- Identification is provided by an electroetched model number on the shank of the mandrel.
- Manufactured from high-strength, high-toughness alloy tool steel.
- Finished to a close diametrical tolerance of +/-0.0002 inch or tighter.
- Typically endures 1,000 to 5,000 applications before the major diameter becomes worn out (depends on material being cold worked).
- Short front taper (SFT) mandrels can be provided when backside clearance is limited.
- -V2 denotes increased material strength for use with titanium or high-strength steel applications.
- A barrel nut is provided on the LBOA mandrels, for sizes 14-0-N to 16-3-N, to ensure the mandrel is properly lined up with the puller unit and workpiece.

Figure 2.3-17 Offset Mandrels
### Figure 2.3-18

**LBOA Mandrel**

![LBOA Mandrel Diagram](image)

**Note:** The bold callouts are most common for use with the LBOA-20 Offset Adapter, LB-20 Puller Unit, and LBOA flush nosecaps.

### Table 2.3-18A

**Stackup Callout**

<table>
<thead>
<tr>
<th>With 2-inch Extension Nosecap (inch)</th>
<th>Standard Flush Nosecap S (Ref. Fig. 2.3-18)</th>
<th>Stackup Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----</td>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>-----</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>-----</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>-----</td>
<td>2.0</td>
<td>20</td>
</tr>
<tr>
<td>0.5</td>
<td>2.5</td>
<td>25</td>
</tr>
<tr>
<td>1.0</td>
<td>3.0</td>
<td>30</td>
</tr>
<tr>
<td>1.5</td>
<td>3.5</td>
<td>35</td>
</tr>
<tr>
<td>2.0</td>
<td>-----</td>
<td>40</td>
</tr>
<tr>
<td>2.5</td>
<td>-----</td>
<td>45</td>
</tr>
<tr>
<td>3.0</td>
<td>-----</td>
<td>50</td>
</tr>
<tr>
<td>3.5</td>
<td>-----</td>
<td>55</td>
</tr>
</tbody>
</table>

### Table 2.3-18B

**STDN Range**

<table>
<thead>
<tr>
<th>Material Callout</th>
<th>Allowable STDN Range</th>
<th>Attachment Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Mild Steel (-V1)</td>
<td>4-0-N to 12-3-N</td>
<td>1</td>
</tr>
<tr>
<td>Aluminum Mild Steel (-V1)</td>
<td>14-0-N to 16-3-N</td>
<td>1OA</td>
</tr>
<tr>
<td>Titanium, High Strength Steel (-V2)</td>
<td>20 to 72</td>
<td>1</td>
</tr>
</tbody>
</table>

**Model Number Key:**

- **Process Callout**
  - **C B M**
- **Mandrel**
  - Standard Tool Diameter Number (STDN)
- **Material Callout**
  - V1= Aluminum or Mild Steel
  - V2= High-Strength Steel or Titanium
- **Stackup Callout**
  - (see Table 2.3-18A)
- **Attachment Callout**
  - (see Table 2.3-18B)
### 2.3.19 MEDIUM BRUTE OFFSET ADAPTER MANDRELS

**Figure 2.3-19**  
MBOA Mandrel

![MBOA Mandrel Image](image)

#### Table 2.3-19A Stackup Callout

<table>
<thead>
<tr>
<th>Mandrel Stackup Callout</th>
<th>With Flush Nosecap S (Ref. Fig. 2.3-19) (inch)</th>
<th>With 3-inch Extension Nosecap S (Ref. Fig. 2.3-19) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.0</td>
<td>-----</td>
</tr>
<tr>
<td>15</td>
<td>1.5</td>
<td>-----</td>
</tr>
<tr>
<td>20</td>
<td>2.0</td>
<td>-----</td>
</tr>
<tr>
<td>25</td>
<td>2.5</td>
<td>-----</td>
</tr>
<tr>
<td>30</td>
<td>3.0</td>
<td>0.5</td>
</tr>
<tr>
<td>35</td>
<td>3.5</td>
<td>1.0</td>
</tr>
<tr>
<td>40</td>
<td>4.0</td>
<td>1.5</td>
</tr>
<tr>
<td>50</td>
<td>4.5</td>
<td>2.0</td>
</tr>
<tr>
<td>55</td>
<td>5.0</td>
<td>2.5</td>
</tr>
<tr>
<td>60</td>
<td>5.5</td>
<td>3.0</td>
</tr>
<tr>
<td>65</td>
<td>6.0</td>
<td>3.5</td>
</tr>
<tr>
<td>70</td>
<td>6.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

#### Table 2.3-19B STDN Range

<table>
<thead>
<tr>
<th>Material Callout</th>
<th>Allowable STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum, Mild Steel (-V1)</td>
<td>12-0-N to 24-2-N</td>
</tr>
<tr>
<td>Titanium, High Strength Steel (-V2)</td>
<td>60 to 111</td>
</tr>
</tbody>
</table>

**Note:** The bold callouts are most common for use with the MBOA-30A Offset Adapter, MB-30 Puller Unit, and MBOA flush nosecaps.

**Model Number Key:**

- **C** = Process Callout  
- **B** = Mandrel  
- **M** = Standard Tool Diameter Number (STDN)  
- **OA** = Material Callout  
- **V1** = Aluminum or Mild Steel  
- **V2** = High Strength Steel or Titanium  
- **N** = Stackup Callout (see Table 2.3-19A)  
- **30** = Attachment Callout (5/8-18" Thread)
2.3.20
MIDGET PULLER MANDRELS

Table 2.3-20A
Stackup Callout for FTMP-7 and FTMP-12

<table>
<thead>
<tr>
<th>With 1-Inch Extension Nosecap S (inch)</th>
<th>With Flush Nosecap S (Ref. Fig. 2.3-20) (inch)</th>
<th>Mandrel Stackup Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----</td>
<td>0.75</td>
<td>7</td>
</tr>
<tr>
<td>0.75</td>
<td>-----</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 2.3-20B
STDN Range

<table>
<thead>
<tr>
<th>Material Callout</th>
<th>Allowable STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum, Mild Steel (-V1)</td>
<td>4-0-N to 12-0-N</td>
</tr>
<tr>
<td>Titanium, High Strength Steel (-V2)</td>
<td>20 to 33</td>
</tr>
</tbody>
</table>

Note: Use Midget Puller Units and Little Brute flush nosecap or extension nosecap jaws. The FTMP-8 requires special mandrel lengths. The FTMP-12 can use Little Brute mandrels, but one inch is lost to the puller.

Model Number Key:

- CBM - 6 - 1 - N - 1MP - 7 - V1
  - Process Callout
  - Mandrel
  - Standard Tool Diameter Number (STDN)
  - Material Callout
    - V1= Aluminum or Mild Steel
    - V2= High Strength Steel or Titanium
  - Stackup Callout
    (see Table 2.3-20A)
  - Attachment Callout
    (7/16-20 T Thread)
2.3.21 HYDRAULIC OFFSET ADAPTER MANDRELS

Figure 2.3-21
HOA Mandrel

Table 2.3-21A
Stackup Callout

<table>
<thead>
<tr>
<th>With 2-inch Extension Nosecap S (Ref. Fig. 2.3-21) (inch)</th>
<th>With Flush Nosecap S (Ref. Fig. 2.3-21) (inch)</th>
<th>Mandrel Stackup Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>-----</td>
<td>0.5</td>
<td>5</td>
</tr>
<tr>
<td>-----</td>
<td>1.0</td>
<td>10</td>
</tr>
<tr>
<td>-----</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>-----</td>
<td>2.0</td>
<td>20</td>
</tr>
<tr>
<td>0.5</td>
<td>2.5</td>
<td>25</td>
</tr>
<tr>
<td>1.0</td>
<td>-----</td>
<td>30</td>
</tr>
<tr>
<td>1.5</td>
<td>-----</td>
<td>35</td>
</tr>
<tr>
<td>2.0</td>
<td>-----</td>
<td>40</td>
</tr>
<tr>
<td>2.5</td>
<td>-----</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 2.3-21B
STDN Range

<table>
<thead>
<tr>
<th>Material Callout</th>
<th>Allowable STDN Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum, Mild Steel (-V1)</td>
<td>4-0-N to 14-3-N</td>
</tr>
<tr>
<td>Titanium, High Strength Steel (-V2)</td>
<td>CA-20 to CA-50</td>
</tr>
</tbody>
</table>

Model Number Key:

C B M - 6 - 1 - N - 1HOA - 20 - V1

- Material Callout
  - V1 = Aluminum or Mild Steel
  - V2 = High Strength Steel or Titanium

- Stackup Callout
  - (see Table 2.3-21A)

- Attachment Callout
  - (7-16-20" Thread)

Note: The bold callouts are most common for use with the Hydraulic Offset Adapter and LBOA/HOA flush nosecaps.

Detailed Tooling
Page 74
### Table 2.3-22
**Right-Angle Puller Mandrel Selection**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>STDN</th>
<th>Maximum Mandrel Length</th>
<th>Maximum Sleeve Length</th>
<th>Maximum Material Stackup S (Ref. Fig. 2.3-22) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBRA-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-0-N</td>
<td>CBM-4-0-N-7-8-V1</td>
<td>CBS-4-0-N-12F</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>4-1-N</td>
<td>CBM-4-1-N-7-8-V1</td>
<td>CBS-4-1-N-12F</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>4-2-N</td>
<td>CBM-4-2-N-7-7.5-V1</td>
<td>CBS-4-2-N-12F</td>
<td>0.750</td>
<td></td>
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<tr>
<td>4-3-N</td>
<td>CBM-4-3-N-7-7.5-V1</td>
<td>CBS-4-3-N-12F</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>4-4-N</td>
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<td>CBS-4-4-N-12F</td>
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<tr>
<td>6-0-N</td>
<td>CBM-6-0-N-7-7.5-V1</td>
<td>CBS-6-0-N-12F</td>
<td>0.750</td>
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<tr>
<td>6-1-N</td>
<td>CBM-6-1-N-7-7.5-V1</td>
<td>CBS-6-1-N-12F</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>6-2-N</td>
<td>CBM-6-2-N-7-7-V1</td>
<td>CBS-6-2-N-10F</td>
<td>0.625</td>
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</tr>
<tr>
<td>6-3-N</td>
<td>CBM-6-3-N-7-7-V1</td>
<td>CBS-6-3-N-10F</td>
<td>0.625</td>
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<tr>
<td>8-0-N</td>
<td>CBM-8-0-N-7-7-V1</td>
<td>CBS-8-0-N-10F</td>
<td>0.625</td>
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</tr>
<tr>
<td>8-1-N</td>
<td>CBM-8-1-N-7-7-V1</td>
<td>CBS-8-1-N-10F</td>
<td>0.625</td>
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<tr>
<td>8-2-N</td>
<td>CBM-8-2-N-7-6.5-V1</td>
<td>CBS-8-2-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>8-3-N</td>
<td>CBM-8-3-N-7-6.5-V1</td>
<td>CBS-8-3-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>10-0-N</td>
<td>CBM-10-0-N-7-6.5-V1</td>
<td>CBS-10-0-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>10-1-N</td>
<td>CBM-10-1-N-7-6.5-V1</td>
<td>CBS-10-1-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>10-2-N</td>
<td>CBM-10-2-N-7-6.5-V1</td>
<td>CBS-10-2-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>10-3-N</td>
<td>CBM-10-3-N-7-6.5-V1</td>
<td>CBS-10-3-N-10F</td>
<td>0.625</td>
<td></td>
</tr>
<tr>
<td>12-0-N</td>
<td>CBM-12-0-N-7-6-V1</td>
<td>CBS-12-0-N-8F</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>12-1-N</td>
<td>CBM-12-1-N-7-6-V1</td>
<td>CBS-12-1-N-8F</td>
<td>0.500</td>
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</tr>
<tr>
<td>12-2-N</td>
<td>CBM-12-2-N-7-6-V1</td>
<td>CBS-12-2-N-8F</td>
<td>0.500</td>
<td></td>
</tr>
<tr>
<td>12-3-N</td>
<td>CBM-12-3-N-7-6-V1</td>
<td>CBS-12-3-N-8F</td>
<td>0.500</td>
<td></td>
</tr>
</tbody>
</table>

### Model Number Key:
- **Process Callout**
- **Mandrel**
- **Standard Tool Diameter Number (STDN)**
- **Material Callout**
  - V1= Aluminum or Mild Steel
- **Stackup Callout**
- **Attachment Callout**
  - (1/4-28” Thread)
This product is designed as an improvement to standard CBCE nosecaps. It is the preferred extension nosecap assembly, with interchangeable jaws.

Single jaw and cap can be used together with tube and mandrel extension tooling to create a variety of lengths (see following pages).

Can be extended in length for use when cold expanding holes through a drill fixture/drill bushing, or when an obstruction is adjacent to the hole.

Identification is provided by an electroetched model number on each piece.

See table 2.3-24A for assembly model numbers.

**Jaw**

**Model Number Key:**

\[
\text{MI - A 4 - XXXXF}
\]

- Modular Jaw
- Thread:
  - A = 5/8 inch
  - B = 7/8 inch
  - C = 1-1/8 inches
  - D = 1-3/8 inches
- Jaw Size
- Length
  - 4 = 2 inches
  - 6 = 3 inches

**Cap**

**Model Number Key:**

\[
\text{MC - 1 A}
\]

- Modular Cap
- Puller Callout
  - 1 = LB
  - 2 = MB
  - 4 = LBOA/HOA
  - 5 = MBOA
  - 9 = MBHO
- Thread
  - A = 5/8 inch
  - B = 7/8 inch
  - C = 1-1/8 inches
  - D = 1-3/8 inches
# Table 2.3-24A

Little Brute and Medium Brute

## Modular Extension Nosecaps Assemblies

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>CA Tooling STDN Range</th>
<th>CR Tooling STDN Range</th>
<th>KB2 Tooling STDN Range</th>
<th>Little Brute Assembly Model No.</th>
<th>Medium Brute Assembly Model No.</th>
<th>Max. Jaw Dia. A Ref. Fig.2.3-23</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N to 4-1-N</td>
<td>20 to 21</td>
<td>-----</td>
<td>40-<strong><strong>.0 to 41-</strong></strong>.0</td>
<td>MEN-14A-0401F</td>
<td>-----</td>
<td>0.358</td>
</tr>
<tr>
<td>4-2-N to 4-3-N</td>
<td>22 to 23</td>
<td>R30</td>
<td>42-<strong><strong>.0 to 43-</strong></strong>.0</td>
<td>MEN-14A-0423F</td>
<td>-----</td>
<td>0.400</td>
</tr>
<tr>
<td>4-4-N to 6-1-N</td>
<td>30 to 31</td>
<td>R32</td>
<td>60-<strong><strong>.0 to 61-</strong></strong>.0</td>
<td>MEN-14A-0601F</td>
<td>-----</td>
<td>0.425</td>
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<tr>
<td>6-2-N to 6-3-N</td>
<td>32 to 33</td>
<td>R32</td>
<td>62-<strong><strong>.0 to 63-</strong></strong>.0</td>
<td>MEN-14A-0623F</td>
<td>-----</td>
<td>0.458</td>
</tr>
<tr>
<td>8-0-N to 8-1-N</td>
<td>40 to 41</td>
<td>R40</td>
<td>80-<strong><strong>.0 to 81-</strong></strong>.0</td>
<td>MEN-14A-0801F</td>
<td>-----</td>
<td>0.481</td>
</tr>
<tr>
<td>8-2-N to 8-3-N</td>
<td>42 to 43</td>
<td>R42</td>
<td>82-<strong><strong>.0 to 83-</strong></strong>.0</td>
<td>MEN-14A-0823F</td>
<td>-----</td>
<td>0.514</td>
</tr>
<tr>
<td>10-0-N to 10-1-N</td>
<td>50 to 51</td>
<td>R50</td>
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<td>MEN-14A-1001F</td>
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<tr>
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<td>52 to 53</td>
<td>R52</td>
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<td>0.593</td>
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<tr>
<td>12-0-N to 12-1-N</td>
<td>60 to 61</td>
<td>R60</td>
<td>120-<strong><strong>.0 to 121-</strong></strong>.0</td>
<td>MEN-14A-1201F</td>
<td>-----</td>
<td>0.625</td>
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<tr>
<td>12-2-N to 12-3-N</td>
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<td>R62</td>
<td>122-<strong><strong>.0 to 123-</strong></strong>.0</td>
<td>MEN-14A-1223F</td>
<td>-----</td>
<td>0.657</td>
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<tr>
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<td>70 to 71</td>
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<td>MEN-14B-1401F</td>
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<td>MEN-14B-1423F</td>
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<td>0.718</td>
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<tr>
<td>16-0-N to 16-1-N</td>
<td>80 to 81</td>
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<td>-----</td>
<td>MEN-14B-1601F</td>
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<tr>
<td>16-2-N to 16-3-N</td>
<td>82 to 83</td>
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<td>MEN-14B-1623F</td>
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<td>0.792</td>
</tr>
<tr>
<td>18-0-N to 18-1-N</td>
<td>90 to 91</td>
<td>-----</td>
<td>-----</td>
<td>MEN-18-1801F</td>
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<td>0.825</td>
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<tr>
<td>18-2-N to 18-3-N</td>
<td>92 to 93</td>
<td>-----</td>
<td>-----</td>
<td>MEN-18-1823F</td>
<td>-----</td>
<td>0.856</td>
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<tr>
<td>20-0-N to 20-1-N</td>
<td>100 to 101</td>
<td>-----</td>
<td>-----</td>
<td>MEN-18-2001F</td>
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<td>0.882</td>
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<tr>
<td>20-2-N to 20-3-N</td>
<td>102 to 103</td>
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<td>-----</td>
<td>MEN-18-2023F</td>
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<td>-----</td>
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<td>-----</td>
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<td>24-0-N to 24-1-N</td>
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<td>-----</td>
<td>MEN-18-2401F</td>
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<tr>
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<td>-----</td>
<td>-----</td>
<td>MEN-18-2423F</td>
<td>-----</td>
<td>1.053</td>
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<tr>
<td>26-0-N to 26-1-N</td>
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<td>MEN-18-2601F</td>
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<tr>
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<td>MEN-18-2623F</td>
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<tr>
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<td>-----</td>
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<td>MEN-18-2823F</td>
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<td>-----</td>
<td>-----</td>
<td>MEN-18-3001F</td>
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<td>1.210</td>
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<td>-----</td>
<td>MEN-18-3023F</td>
<td>-----</td>
<td>1.241</td>
</tr>
</tbody>
</table>

### Assembly Model Number Key:

- **MEN** - 1 4 A - XXXXF

#### Tool Code

- **MEN** - Assembly numbers are not marked with assembly model number. Each component is marked with its own model number.

#### Thread on Cap and Jaw

- **A** = 5/8 inch
- **B** = 7/8 inch
- **C** = 1-1/8 inches
- **D** = 1-1/4 inches

---

**Detailed Tooling**

Page 77
2.3.24
MODULAR
EXTENSION
NOSECAP
(OPTION 1)

- Mandrel lengths will vary according to overall length of nosecap. The main feature of this product is the Extension Tube (in diagram above), which is used to increase the overall length of nosecap. The original CBCE system requires purchase of an entire new nosecap when different nosecap lengths are necessary. For additional information please contact our Customer Service Department.

- See Table 2.3-24B

**Figure 2.3-24A**
Modular Extension Nosecap Option 1

**Tube**

<table>
<thead>
<tr>
<th>Model Number Key:</th>
</tr>
</thead>
<tbody>
<tr>
<td>MT - A - XX</td>
</tr>
</tbody>
</table>

- Modular Tube
- Thread
- A = 5/8 inch
- B = 7/8 inch
- C = 1-1/8 inches
- D = 1-3/8 inches

- Tube Length
- Length = 2 x inch
- 4 = 2 inches
- 20 = 10 inches
2.3.24
MODULAR EXTENSION NOSECAP (OPTION 2)

Figure 2.3-24B
Modular Extension Nosecap
Option 2

- This configuration utilizes a larger diameter extension tube, mandrel rod, and an adapter. This option allows the use of shorter length mandrels when using the MEN assembly. For example, the same mandrel can be used for both the 2-inch and 4-inch extension nosecaps when the correct mandrel rod is used.
- The adapter is required whenever a mandrel rod and extension tube are used.
- Uses interchangeable jaw, cap, and tube.
- See Table 2.3-24C

Adapters

Model Number Key:

**MA - A B**
- Modular Adapter
- Adapter Internal Thread,
  Jaw External Thread
  A = 5/8 inch
  B = 7/8 inch
  C = 1-1/8 inches

**MR - 1 1 - 20**
- Mandrel Rod
- Internal Thread,
  Mandrel
  1 = 7/16 inch
  2 = 5/8 inch
  5 = 7/8 inch

- Length
  2 x inch
  2 inch = 4
  10 inch = 20

- External Thread,
  Puller
  1 = 7/16 inch
  2 = 5/8 inch
  5 = 7/8 inch

- Rod Model Number Key:
### Table 2.3-24B

**Modular Nosecaps for Use with Extension Tube**  
Little Brute and Medium Brute Pullers (Option 1)

<table>
<thead>
<tr>
<th>CB STDN Range</th>
<th>CA STDN Range</th>
<th>CR STDN Range</th>
<th>KB2 STDN Range</th>
<th>Puller</th>
<th>Cap</th>
<th>Jaw Thread Callout</th>
<th>Extension Tube Fig. 2.3-24A</th>
<th>Applicable Mandrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N thru 12-3-N</td>
<td>20 thru 63</td>
<td>R30 thru R-62</td>
<td>40-<strong><strong>-0 to 123-</strong></strong>-0</td>
<td>LB</td>
<td>MC-1A</td>
<td>A</td>
<td>MT-A-XX (dia. = .73)</td>
<td>CBM-X-X-N-1-XX-VX</td>
</tr>
<tr>
<td>14-0-N thru 16-3-N</td>
<td>70 thru 83</td>
<td>-----</td>
<td>-----</td>
<td>LB</td>
<td>MC-1B</td>
<td>B</td>
<td>MT-B-XX (dia. = 1.10)</td>
<td>CBM-X-X-N-1-XX-VX</td>
</tr>
<tr>
<td>10-0-N thru 20-1-N</td>
<td>50 thru 101</td>
<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2B</td>
<td>B</td>
<td>MT-B-XX (dia. = 1.10)</td>
<td>CBM-X-X-N-2-XX-VX</td>
</tr>
<tr>
<td>20-2-N thru 24-2-N</td>
<td>102 thru 111</td>
<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2C</td>
<td>C</td>
<td>MT-C-XX (dia. = 1.29)</td>
<td>CBM-X-X-N-2-XX-VX</td>
</tr>
<tr>
<td>22-3-N thru 30-1-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2C</td>
<td>C</td>
<td>MT-C-XX (dia. = 1.29)</td>
<td>CBM-X-X-N-5-XX-VX</td>
</tr>
<tr>
<td>30-2-N thru 30-3-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2D</td>
<td>D</td>
<td>MT-D-XX (dia. = 1.57)</td>
<td>CBM-X-X-N-5-XX-VX</td>
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</tbody>
</table>

### Table 2.3-24C

**Modular Nosecaps for Use with Mandrel Rod for**  
Little Brute and Medium Brute Pullers (Option 2)

<table>
<thead>
<tr>
<th>CB STDN Range</th>
<th>CA STDN Range</th>
<th>CR STDN Range</th>
<th>KB2 STDN Range</th>
<th>Puller</th>
<th>Cap</th>
<th>Jaw Thread Callout</th>
<th>Modular Tube Adapter</th>
<th>Mandrel Rod Fig. 2.3-24B</th>
<th>Applicable Mandrels</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N thru 12-3-N</td>
<td>20 thru 63</td>
<td>R30 thru R-62</td>
<td>40-<strong><strong>-0 to 123-</strong></strong>-0</td>
<td>LB</td>
<td>MC-1B</td>
<td>A</td>
<td>MT-B-XX (dia. = 1.10)</td>
<td>MA-AB</td>
<td>MR-11-XX</td>
</tr>
<tr>
<td>10-0-N thru 16-3-N</td>
<td>50 thru 83</td>
<td>-----</td>
<td>-----</td>
<td>LB</td>
<td>MC-1B</td>
<td>B</td>
<td>MT-B-XX (dia. = 1.10)</td>
<td>N/A</td>
<td>MR-11-XX</td>
</tr>
<tr>
<td>20-2-N thru 24-2-N</td>
<td>102 thru 111</td>
<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2C</td>
<td>C</td>
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<td>-----</td>
<td>-----</td>
<td>MB</td>
<td>MC-2D</td>
<td>C</td>
<td>MT-D-XX (dia. = 1.57)</td>
<td>MA-CD</td>
<td>MR-55-XX</td>
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<td>-----</td>
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<td>MB</td>
<td>MC-2D</td>
<td>D</td>
<td>MT-D-XX (dia. = 1.57)</td>
<td>N/A</td>
<td>MR-55-XX</td>
</tr>
</tbody>
</table>
• Jaw is a standard modular extension configuration and can be used with other puller caps with same jaw thread.

• Designed to hold flared split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.

• Assembly consists of a threaded cap with a one-piece modular extension jaw that extends a minimum of two inches from the front of the cap.

• Modular extension jaws and threaded caps can be ordered separately.

• Identification is provided by an electroetched model number on each component.

• Other lengths available (E Ref. Figure 2.3-25). Please contact our Sales Staff.

**Cap**

**Model Number Key:**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Modular Cap</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC-4A</td>
<td></td>
<td>4 = 2 inches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 = 3 inches</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Thread:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 5/8 inch</td>
</tr>
<tr>
<td>B = 7/8 inch</td>
</tr>
<tr>
<td>C = 1-1/8 inches</td>
</tr>
<tr>
<td>D = 1-3/8-inches</td>
</tr>
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</table>

**Jaw**

**Model Number Key:**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Modular Jaw</th>
<th>Jaw Size</th>
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<tbody>
<tr>
<td>MJ - A 4 - XXXXF</td>
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<table>
<thead>
<tr>
<th>Thread:</th>
</tr>
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<tbody>
<tr>
<td>A = 5/8 inch</td>
</tr>
<tr>
<td>B = 7/8 inch</td>
</tr>
<tr>
<td>C = 1-1/8 inches</td>
</tr>
<tr>
<td>D = 1-3/8-inches</td>
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**Nosecap Assembly**

**Model Number Key:**

<table>
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<th>Model Number</th>
<th>Modular Extension Nosecap</th>
<th>Attachment</th>
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<td>MEN - 44A - XXXXF</td>
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<table>
<thead>
<tr>
<th>Thread:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 5/8 inch</td>
</tr>
<tr>
<td>B = 7/8 inch</td>
</tr>
<tr>
<td>C = 1-1/8 inches</td>
</tr>
<tr>
<td>D = 1-1/4-inches</td>
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</tbody>
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<table>
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<th>Length</th>
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</thead>
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<td>4 = 2 inch</td>
</tr>
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<td>6 = 3 inch</td>
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*Parts are not marked with assembly number. Each component is marked with its own model number.*
### Table 2.3-25A
STDN Range

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<th>CB Tooling</th>
<th>KB2 Tooling</th>
<th>CR Tool STDN</th>
<th>CA Tooling</th>
<th>A Max. (Ref. Fig. 2.3-25) (inch)</th>
<th>Jaw Model Number</th>
<th>Modular Cap/Jaw Attachment Plate</th>
<th>Modular Assembly</th>
</tr>
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<tbody>
<tr>
<td>4-0-N to 4-1-N</td>
<td>40.-<strong><strong>-0 to 41.-</strong></strong>-0</td>
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<td>20 to 21</td>
<td>0.358</td>
<td>MJ-A4-0401F</td>
<td>MC-4A</td>
<td>MEN-44A-0401F</td>
</tr>
<tr>
<td>4-2-N to 4-3-N</td>
<td>42.-<strong><strong>-0 to 43.-</strong></strong>-0</td>
<td>-----</td>
<td>22 to 23</td>
<td>0.400</td>
<td>MJ-A4-0423F</td>
<td>MC-4A</td>
<td>MEN-44A-0423F</td>
</tr>
<tr>
<td>4-4-N to 6-1-N</td>
<td>60.-<strong><strong>-0 to 61.-</strong></strong>-0</td>
<td>R30</td>
<td>30 to 31</td>
<td>0.425</td>
<td>MJ-A4-0601F</td>
<td>MC-4A</td>
<td>MEN-44A-0601F</td>
</tr>
<tr>
<td>6-2-N to 6-3-N</td>
<td>62.-<strong><strong>-0 to 63.-</strong></strong>-0</td>
<td>R32</td>
<td>32 to 33</td>
<td>0.458</td>
<td>MJ-A4-0623F</td>
<td>MC-4A</td>
<td>MEN-44A-0623F</td>
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<tr>
<td>8-0-N to 8-1-N</td>
<td>80.-<strong><strong>-0 to 81.-</strong></strong>-0</td>
<td>R40</td>
<td>40 to 41</td>
<td>0.481</td>
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<td>MC-4A</td>
<td>MEN-44A-0801F</td>
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<tr>
<td>8-2-N to 8-3-N</td>
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<td>R42</td>
<td>42 to 43</td>
<td>0.514</td>
<td>MJ-A4-0823F</td>
<td>MC-4A</td>
<td>MEN-44A-0823F</td>
</tr>
<tr>
<td>10-0-N to 10-1-N</td>
<td>100.-<strong><strong>-0 to 101.-</strong></strong>-0</td>
<td>R50</td>
<td>50 to 51</td>
<td>0.565</td>
<td>MJ-A4-1001F</td>
<td>MC-4A</td>
<td>MEN-44A-1001F</td>
</tr>
<tr>
<td>10-2-N to 10-3-N</td>
<td>102.-<strong><strong>-0 to 103.-</strong></strong>-0</td>
<td>R52</td>
<td>52 to 53</td>
<td>0.593</td>
<td>MJ-A4-1023F</td>
<td>MC-4A</td>
<td>MEN-44A-1023F</td>
</tr>
<tr>
<td>12-0-N to 12-1-N</td>
<td>120.-<strong><strong>-0 to 121.-</strong></strong>-0</td>
<td>R60</td>
<td>-----</td>
<td>0.625</td>
<td>MJ-A4-1201F</td>
<td>MC-4A</td>
<td>MEN-44A-1201F</td>
</tr>
<tr>
<td>12-2-N to 12-3-N</td>
<td>122.-<strong><strong>-0 to 123.-</strong></strong>-0</td>
<td>R62</td>
<td>-----</td>
<td>0.657</td>
<td>MJ-A4-1223F</td>
<td>MC-4A</td>
<td>MEN-44A-1223F</td>
</tr>
<tr>
<td>14-0-N to 14-1-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.689</td>
<td>MJ-B4-1401F</td>
<td>MC-4B</td>
<td>MEN-44B-1401F</td>
</tr>
<tr>
<td>14-2-N to 14-3-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.718</td>
<td>MJ-B4-1423F</td>
<td>MC-4B</td>
<td>MEN-44B-1423F</td>
</tr>
<tr>
<td>16-0-N to 16-1-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.760</td>
<td>MJ-B4-1601F</td>
<td>MC-4B</td>
<td>MEN-44B-1601F</td>
</tr>
<tr>
<td>16-2-N to 16-3-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.762</td>
<td>MJ-B4-1623F</td>
<td>MC-4B</td>
<td>MEN-44B-1623F</td>
</tr>
<tr>
<td>18-0-N to 18-1-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.825</td>
<td>MJ-B6-1801F*</td>
<td>MC-4B</td>
<td>MEN-46B-1801F</td>
</tr>
<tr>
<td>18-2-N to 18-3-N</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>0.856</td>
<td>MJ-B6-1823F*</td>
<td>MC-4B</td>
<td>MEN-46B-1823F</td>
</tr>
</tbody>
</table>

*18-0-N through 18-3-N jaws are 3-inch minimum extension lengths.

**** Refer to Cx2s Tooling for complete STDN information

### Table 2.3-25B
Extension Callouts

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-25) (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4*</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*Only available up to 16-3-N.
Jaw

Model Number Key:

\[ MJ - A 4 - XXXXF \]

Modular Jaw

Thread:
- A = 5/8 inch
- B = 7/8 inch
- C = 1-1/8 inches
- D = 1-3/8 inches

Jaw Size (Ref. E, Fig. 2.3-26)
- 4 = 2 inches
- 6 = 3 inches

*Parts are not marked with assembly number. Each component is marked with its own model number.

Figure 2.3-26

MBOA Modular Extension Nosecap

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.
- For cold expanding holes in aluminum up to 15/16-inch diameter and up to 1/2-inch diameter in steel and titanium in restricted access areas.
- Assembly consists of a one-piece jaw with a modular cap.
- Jaws and modular caps can be ordered separately (see Table 2.3-26B).
- Identification is provided by an electroetched model number.
- Other sizes are available. Please contact our Sales Staff for more information.

Table 2.3-26A

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-26) (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4*</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*Only available up to 16-3-N.

2.3.26

MEN FOR MEDIUM BRUTE OFFSET ADAPTER

Nosecap Assembly*

Model Number Key:

\[ MEN - 5 6 B - XXXXF \]

Modular Extension Nosecap

Thread:
- A = 5/8 inch
- B = 7/8 inch
- C = 1-1/8 inches
- D = 1-1/4 inches

Jaw Size

Length (Ref. E, Fig. 2.3-26)
- 4 = 2 inches
- 6 = 3 inches

*Parts are not marked with assembly number. Each component is marked with its own model number.
### Table 2.3-26B

**MBOA Modular Extension Nosecap Specifications**

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>A Diameter (Ref. Fig. 2.3-26) (inch)</th>
<th>Jaw Model Number</th>
<th>Jaw Attachment Plate (cap)</th>
<th>Modular Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-0-N</td>
<td>50</td>
<td>0.565</td>
<td>MJ-B6-1001F</td>
<td>MC-5B</td>
<td>MEN-56B-1001F</td>
</tr>
<tr>
<td>10-1-N</td>
<td>51</td>
<td>0.565</td>
<td>MJ-B6-1001F</td>
<td>MC-5B</td>
<td>MEN-56B-1001F</td>
</tr>
<tr>
<td>10-2-N</td>
<td>52</td>
<td>0.593</td>
<td>MJ-B6-1023F</td>
<td>MC-5B</td>
<td>MEN-56B-1023F</td>
</tr>
<tr>
<td>10-3-N</td>
<td>53</td>
<td>0.593</td>
<td>MJ-B6-1023F</td>
<td>MC-5B</td>
<td>MEN-56B-1023F</td>
</tr>
<tr>
<td>12-0-N</td>
<td>60</td>
<td>0.625</td>
<td>MJ-B6-1201F</td>
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<td>MEN-56B-1201F</td>
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<tr>
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<td>MEN-56B-1201F</td>
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<tr>
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<td>MC-5B</td>
<td>MEN-56B-1223F</td>
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<tr>
<td>12-3-N</td>
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<tr>
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<td>MEN-56B-1423F</td>
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<td>MEN-56B-1623F</td>
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<td>16-3-N</td>
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<td>MC-5B</td>
<td>MEN-56B-1623F</td>
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<tr>
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<td>MEN-56B-1823F</td>
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<tr>
<td>18-3-N</td>
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<td>0.856</td>
<td>MJ-B6-1823F</td>
<td>MC-5B</td>
<td>MEN-56B-1823F</td>
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<td>MC-5B</td>
<td>MEN-56B-2001F</td>
</tr>
<tr>
<td>20-1-N</td>
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<td>MJ-B6-2001F</td>
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<td>MC-5C</td>
<td>MEN-56C-2401F</td>
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<tr>
<td>24-1-N</td>
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<td>MJ-C6-2401F</td>
<td>MC-5C</td>
<td>MEN-56C-2401F</td>
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<tr>
<td>24-2-N</td>
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<td>MJ-C6-2423F</td>
<td>MC-5C</td>
<td>MEN-56C-2423F</td>
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<tr>
<td>24-3-N</td>
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<td>MJ-C6-2423F</td>
<td>MC-5C</td>
<td>MEN-56C-2423F</td>
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<td>MJ-C6-2601F</td>
<td>MC-5C</td>
<td>MEN-56C-2601F</td>
</tr>
<tr>
<td>26-1-N</td>
<td>119</td>
<td>1.087</td>
<td>MJ-C6-2601F</td>
<td>MC-5C</td>
<td>MEN-56C-2601F</td>
</tr>
<tr>
<td>26-2-N</td>
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<td>MJ-C6-2623F</td>
<td>MC-5C</td>
<td>MEN-56C-2623F</td>
</tr>
<tr>
<td>26-3-N</td>
<td>121</td>
<td>1.116</td>
<td>MJ-C6-2623F</td>
<td>MC-5C</td>
<td>MEN-56C-2623F</td>
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<td>28-0-N</td>
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<td>MJ-C6-2801F</td>
<td>MC-5C</td>
<td>MEN-56C-2801F</td>
</tr>
<tr>
<td>28-1-N</td>
<td>123</td>
<td>1.147</td>
<td>MJ-C6-2801F</td>
<td>MC-5C</td>
<td>MEN-56C-2801F</td>
</tr>
<tr>
<td>28-2-N</td>
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<td>MJ-C6-2823F</td>
<td>MC-5C</td>
<td>MEN-56C-2823F</td>
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<tr>
<td>28-3-N</td>
<td>125</td>
<td>1.186</td>
<td>MJ-C6-2823F</td>
<td>MC-5C</td>
<td>MEN-56C-2823F</td>
</tr>
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<td>30-0-N</td>
<td>126</td>
<td>1.210</td>
<td>MJ-C6-3001F</td>
<td>MC-5C</td>
<td>MEN-56C-3001F</td>
</tr>
<tr>
<td>30-1-N</td>
<td>127</td>
<td>1.210</td>
<td>MJ-C6-3001F</td>
<td>MC-5C</td>
<td>MEN-56C-3001F</td>
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<td>30-2-N</td>
<td>128</td>
<td>1.241</td>
<td>MJ-C6-3023F</td>
<td>MC-5D</td>
<td>MEN-56D-3023F</td>
</tr>
<tr>
<td>30-3-N</td>
<td>129</td>
<td>1.241</td>
<td>MJ-C6-3023F</td>
<td>MC-5D</td>
<td>MEN-56D-3023F</td>
</tr>
</tbody>
</table>
Figure 2.3-27
MBHO Modular Extension Nosecap

- Jaw is the same as standard MEN, thus they are interchangeable.
- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.
- For cold expanding holes in aluminum up to 15/16-inch diameter and up to 1/2-inch diameter in steel and titanium in restricted access areas.
- Assembly consists of a one-piece jaw with a modular cap.
- Jaws and modular cap can be ordered separately (see Table 2.3-27B).
- Identification is provided by an electroetched model number.
- Other sizes are available. Please contact our Sales Staff for more information.

<table>
<thead>
<tr>
<th>Table 2.3-27A Extension Callouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension Callouts</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>4*</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

*Only available up to 16-3-N.

*Parts are not marked with assembly number. Each component is marked with it's own model number.

Detailed Tooling
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### Table 2.3-27B

**MBHO Modular Extension Nosecap Specifications**

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>A Diameter (Ref. Fig. 2.3-27) (inch)</th>
<th>Jaw Model Number</th>
<th>Jaw Attachment Plate (cap)</th>
<th>Modular Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-0-N</td>
<td>50</td>
<td>0.565</td>
<td>MJ-B6-1001F</td>
<td>MC-9B</td>
<td>MEN-96B-1001F</td>
</tr>
<tr>
<td>10-1-N</td>
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<td>MC-9C</td>
<td>MEN-96C-2401F</td>
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<td>MC-9C</td>
<td>MEN-96C-2401F</td>
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<tr>
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<td>MJ-C6-2423F</td>
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<td>MEN-96C-2423F</td>
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<td>MJ-C6-2423F</td>
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<td>MJ-C6-2623F</td>
<td>MC-9C</td>
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<tr>
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<td>MJ-C6-2801F</td>
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<td>MEN-96C-2801F</td>
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<td>MEN-96C-2823F</td>
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<td>28-3-N</td>
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<td>1.186</td>
<td>MJ-C6-2823F</td>
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<td>MEN-96C-3001F</td>
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<tr>
<td>30-1-N</td>
<td>-----</td>
<td>1.210</td>
<td>MJ-C6-3001F</td>
<td>MC-9C</td>
<td>MEN-96C-3001F</td>
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<tr>
<td>30-2-N</td>
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<td>MJ-D6-3023F</td>
<td>MC-9D</td>
<td>MEN-96D-3023F</td>
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<tr>
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<td>-----</td>
<td>1.241</td>
<td>MJ-D6-3023F</td>
<td>MC-9D</td>
<td>MEN-96D-3023F</td>
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</table>
• Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.

• Can also be used when cold expanding holes through a drill fixture/drill bushing, or when an obstruction reduces access to the hole.

• Nosecap consists of a three-piece assembly including a cap, a one-piece extension jaw set that protrudes two inches from the front of the cap, and a retainer.

• Replacement extension jaws can be ordered separately.

• Identification is provided by an electroetched model number.

• Special extension jaw lengths of other than two inches are available, please refer to Table 2.3-28A.

### Table 2.3-28A

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-28) (inches)</th>
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<tbody>
<tr>
<td>4</td>
<td>2.0</td>
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<tr>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
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**Figure 2.3-28**

Little Brute Nosecap Assembly

**2.3.28**

**Little Brute Nosecap Assemblies**

Superseeded by Modular Extension Nosecap

See Table 2.3-28E-F
### Table 2.3-28B

#### CB and KB2 Tooling

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>KB2 Tooling STDN Range</th>
<th>A Diameter (Ref. Fig. 2.3-28) (inch)</th>
<th>Assembly Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N to 4-1-N</td>
<td>40-<strong><strong>-0 to 41-</strong></strong>-0</td>
<td>0.490</td>
<td>CBCE-14A-0401F</td>
</tr>
<tr>
<td>4-2-N to 4-3-N</td>
<td>42-<strong><strong>-0 to 43-</strong></strong>-0</td>
<td>0.490</td>
<td>CBCE-14A-0423F</td>
</tr>
<tr>
<td>6-2-N to 6-1-N</td>
<td>60-<strong><strong>-0 to 61-</strong></strong>-0</td>
<td>0.490</td>
<td>CBCE-14A-0601F</td>
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<tr>
<td>6-2-N to 6-3-N</td>
<td>62-<strong><strong>-0 to 63-</strong></strong>-0</td>
<td>0.490</td>
<td>CBCE-14A-0623F</td>
</tr>
<tr>
<td>8-0-N to 8-1-N</td>
<td>80-<strong><strong>-0 to 81-</strong></strong>-0</td>
<td>0.490</td>
<td>CBCE-14A-0801F</td>
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<td>8-2-N to 8-3-N</td>
<td>82-<strong><strong>-0 to 83-</strong></strong>-0</td>
<td>0.490</td>
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<tr>
<td>10-0-N to 10-1-N</td>
<td>100-<strong><strong>-0 to 101-</strong></strong>-0</td>
<td>0.615</td>
<td>CBCE-14B-1001F</td>
</tr>
<tr>
<td>10-2-N to 10-3-N</td>
<td>102-<strong><strong>-0 to 103-</strong></strong>-0</td>
<td>0.615</td>
<td>CBCE-14B-1023F</td>
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<tr>
<td>12-0-N to 12-1-N</td>
<td>120-<strong><strong>-0 to 121-</strong></strong>-0</td>
<td>0.615</td>
<td>CBCE-14B-1201F</td>
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<tr>
<td>12-2-N to 12-3-N</td>
<td>122-<strong><strong>-0 to 123-</strong></strong>-0</td>
<td>0.615</td>
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<td>14-0-N to 14-1-N</td>
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<td>0.741</td>
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<td>0.741</td>
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<td>0.741</td>
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**** Refer to Cx2s Tooling for complete STDN information.

### Table 2.3-28C

#### CA Tooling

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<th>STDN Range</th>
<th>A Diameter (Ref. Fig. 2.3-28) (inch)</th>
<th>Assembly Model Number</th>
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</thead>
<tbody>
<tr>
<td>20 to 21</td>
<td>0.490</td>
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<tr>
<td>22 to 23</td>
<td>0.490</td>
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<td>32 to 33</td>
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<td>CBCE-14A-0623F</td>
</tr>
<tr>
<td>40 to 41</td>
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</tr>
<tr>
<td>42 to 43</td>
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<tr>
<td>50 to 51</td>
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<td>CBCE-14B-1001F</td>
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<tr>
<td>52 to 53</td>
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### Table 2.3-28D

#### CR Tooling

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<th>A Diameter (Ref. Fig. 2.3-28) (inch)</th>
<th>Assembly Model Number</th>
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<td>R30</td>
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<td>CRCE-R32-1</td>
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<td>R50</td>
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Note: When ordering replacement jaws, add -JO to the assembly model number.

Note: CR nosecaps have a 2-inch extension callout.

**Model Number Key:**
- **C B C E - 1 4 A - 0 4 0 1 F**
  - Process Callout
  - Extension Nosecap
  - Puller Application
  - I = Little Brute
  - For use with flared sleeves
  - Jaw STDN Callout
  - Jaw Diameter Callout
  - Extension Callout (Table 2.3-28A)
### Table 2.3-28E
**Little Brute CB Tooling & CA Nosecaps**

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<td>CBCE-14B-1223F</td>
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**Little Brute CA Nosecaps**

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<td>CACE-14B-523F</td>
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2.3.29

**MEDIUM BRUTE EXTENSION NOSECAPS**

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.
- Can also be used when cold expanding holes through a drill fixture/drill bushing or when an obstruction is adjacent to the hole.
- Consists of a three-piece assembly including a cap, a one-piece extension jaw set that protrudes from the front of the cap, and a retainer.
- Identification is provided by an electroetched model number.
- Replacement jaws can be ordered separately.
- For other sizes and extension lengths, please contact our Sales Staff.

**Model Number Key:**

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<tr>
<th>C</th>
<th>B</th>
<th>C</th>
<th>E</th>
<th>2</th>
<th>6</th>
<th>D</th>
<th>16</th>
<th>0</th>
<th>N</th>
<th>F</th>
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</table>

*Figure 2.3-29*

Medium Brute Extension Nosecap
## Table 2.3-29A
**Medium Brute Extension Nosecap**

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>A Diameter (Ref. Fig. 2.3-29) inches</th>
<th>Assembly Model Number</th>
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<td>1.105</td>
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<tr>
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<td>1.235</td>
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<td>CBCE-26F-28-2-NF</td>
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<td>1.235</td>
<td>CBCE-26F-28-3-NF</td>
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## Table 2.3-29B
**Extension Callouts**

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-29) inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>4*</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* STDNs 20-2-N through 30-3-N are not available with an extension callout of "4."

Note: When ordering replacement jaws, add -JO to the assembly model number.

---

**2.3.29**

**MEDIUM BRUTE EXTENSION NOSECAPS**

SUPERSEDED BY

**MODULAR EXTENSION NOSECAP**

See Table 2.3-29C

---

**Detailed Tooling**

Page 91
# Table 2.3-29C
## Medium Brute CB Tooling Nosecaps

<table>
<thead>
<tr>
<th>Extension Nosecap</th>
<th>Modular Extension Nosecap</th>
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<tr>
<td>CBCE-26D-10-3-NF</td>
<td>MEN-26B-1023F</td>
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<tr>
<td>CBCE-26D-12-0-NF</td>
<td>MEN-26B-1201F</td>
</tr>
<tr>
<td>CBCE-26D-12-1-NF</td>
<td>MEN-26B-1201F</td>
</tr>
<tr>
<td>CBCE-26D-12-2-NF</td>
<td>MEN-26B-1223F</td>
</tr>
<tr>
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<td>MEN-26B-1223F</td>
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<td>MEN-26B-1401F</td>
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<td>MEN-26C-2201F</td>
</tr>
<tr>
<td>CBCE-26E-22-2-NF</td>
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<td>MEN-26C-2801F</td>
</tr>
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<tr>
<td>CBCE-26F-28-3-NF</td>
<td>MEN-26C-2823F</td>
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<td>MEN-26C-3001F</td>
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<td>MEN-26D-3023F</td>
</tr>
<tr>
<td>CBCE-26F-30-3-NF</td>
<td>MEN-26D-3023F</td>
</tr>
</tbody>
</table>
• Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.

• Can also be used when cold expanding holes through a drill fixture/drill bushing or when an obstruction is adjacent to the hole.

• Unique one-piece design.

• Identification is provided by an electroetched model number.

• For use with flared sleeves only.

• Three-inch extension (E (ref.) is standard).

• For other sizes and extension lengths, please contact our Sales Staff.

**Model Number Key:**

- **C B C E - 3 801 F - 3 - 6**

- Extension Nosecap
- Jaw STDN Callout
- Designates Flared Sleeve
- Designates Big Brute Puller Unit

**Extension Callout:**

- (Ref. E, Fig. 2.3-30)
- 6 = 3 inches

---

**Figure 2.3-30**

*Big Brute Extension Nosecap*
### Table 2.3-30
**Big Brute Extension Nosecap**

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>A Diameter (Ref. Fig. 2.3-30) (inch)</th>
<th>Assembly Model Number</th>
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</thead>
<tbody>
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<td>28-0-N to 28-1-N</td>
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<td>28-2-N to 28-3-N</td>
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<td>CBCE-2823F-3-6</td>
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<td>CBCE-3001F-3-6</td>
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<td>30-2-N to 30-3-N</td>
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<td>CBCE-3023F-3-6</td>
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<td>CBCE-3201F-3-6</td>
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<td>32-2-N to 32-3-N</td>
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<td>CBCE-3223F-3-6</td>
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<td>2.108</td>
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</table>
• Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.

• Consists of a three-part assembly including a cap, sleeve retention jaw set, and a retainer.

• Used where access restricts length of puller/nosecap assembly.

• Configurations are available for use with either flared or straight sleeves.

• Each nosecap or jaw size covers the nominal hole diameter and its associated oversizes.

• Replacement jaw sets can be ordered separately.

• Identification is provided by an electroetched model number.

### Table 2.3-31
**Little Brute Flush Nosecap Assemblies CB, KB2, and CA Tooling**

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>KB2 Tooling STDN Range</th>
<th>CA Tooling STDN Range</th>
<th>Assembly Model Number</th>
<th>Replacement Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N to 4-4-N</td>
<td>40-<strong><strong>-0 to 43-</strong></strong>-0</td>
<td>20 to 30</td>
<td>CBC-11-04F</td>
<td>CBC-10-04F</td>
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<td>30 to 40</td>
<td>CBC-11-06F</td>
<td>CBC-10-06F</td>
</tr>
<tr>
<td>6-3-N to 8-3-N</td>
<td>63-<strong><strong>-0 to 83-</strong></strong>-0</td>
<td>40 to 50</td>
<td>CBC-11-08F</td>
<td>CBC-10-08F</td>
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<tr>
<td>8-3-N to 10-3-N</td>
<td>83-<strong><strong>-0 to 103-</strong></strong>-0</td>
<td>50 to 53</td>
<td>CBC-11-10F</td>
<td>CBC-10-10F</td>
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<td>CBC-12-12F</td>
<td>CBC-10-12F</td>
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<td>-----</td>
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<td>CBC-10-14F</td>
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<td>-----</td>
<td>-----</td>
<td>CBC-13-16F</td>
<td>CBC-10-16F</td>
</tr>
</tbody>
</table>

**Model Number Key:**

- **C** = Little Brute
- **B** = Medium Brute
- **C** = Big Brute
- **F** = Flared Sleeves
- **S** = Straight Sleeves

**Figure 2.3-31**
*Flush Nosecap Assembly*
### Table 2.3-32A

**Medium Brute Flush Nosecap Assemblies**

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>CA Tooling STDN Range</th>
<th>Assembly Model Number</th>
<th>Replacement Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-3-N to 12-3-N</td>
<td>60 to 70</td>
<td>*CBC-22-12F</td>
<td>CBC-20-12F</td>
</tr>
<tr>
<td>14-0-N to 14-3-N</td>
<td>70 to 80</td>
<td>*CBC-22-14F</td>
<td>CBC-20-14F</td>
</tr>
<tr>
<td>16-0-N to 16-3-N</td>
<td>80 to 90</td>
<td>*CBC-23-16F</td>
<td>CBC-20-16F</td>
</tr>
<tr>
<td>18-0-N to 18-3-N</td>
<td>90 to 100</td>
<td>*CBC-23-18F</td>
<td>CBC-20-18F</td>
</tr>
<tr>
<td>20-0-N to 20-3-N</td>
<td>100 to 103</td>
<td>*CBC-23-20F</td>
<td>CBC-20-20F</td>
</tr>
<tr>
<td>22-0-N to 22-3-N</td>
<td>103 to 111</td>
<td>*CBC-24-22F</td>
<td>CBC-20-22F</td>
</tr>
<tr>
<td>24-0-N to 24-3-N</td>
<td>-----</td>
<td>*CBC-24-24F</td>
<td>CBC-20-24F</td>
</tr>
<tr>
<td>26-0-N to 26-3-N</td>
<td>-----</td>
<td>*CBC-24-26F</td>
<td>CBC-20-26F</td>
</tr>
<tr>
<td>28-0-N to 28-3-N</td>
<td>-----</td>
<td>*CBC-25-28F</td>
<td>CBC-20-28F</td>
</tr>
<tr>
<td>30-0-N to 30-3-N</td>
<td>-----</td>
<td>*CBC-25-30F</td>
<td>CBC-20-30F</td>
</tr>
</tbody>
</table>

* These nosecaps can cover one oversize smaller, e.g., STDN 20-3-N can be used with CBC-24-22F.

### Table 2.3-32B

**Big Brute Flush Nosecap Assemblies CB Tooling**

<table>
<thead>
<tr>
<th>CB Tooling STDN Range</th>
<th>Assembly Model Number</th>
<th>Replacement Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-0-N to 30-3-N</td>
<td>CBC-31-30F</td>
<td>CBC-30-30F</td>
</tr>
<tr>
<td>32-0-N to 32-3-N</td>
<td>CBC-31-32F</td>
<td>CBC-30-32F</td>
</tr>
<tr>
<td>34-0-N to 34-3-N</td>
<td>CBC-31-34F</td>
<td>CBC-30-34F</td>
</tr>
<tr>
<td>36-0-N to 36-3-N</td>
<td>CBC-31-36F</td>
<td>CBC-30-36F</td>
</tr>
<tr>
<td>38-0-N to 38-3-N</td>
<td>*CBC-31-38F</td>
<td>CBC-30-38F</td>
</tr>
<tr>
<td>40-0-N to 40-3-N</td>
<td>*CBC-31-40F</td>
<td>CBC-30-40F</td>
</tr>
<tr>
<td>42-0-N to 42-3-N</td>
<td>*CBC-32-42F</td>
<td>CBC-30-42F</td>
</tr>
<tr>
<td>44-0-N to 44-3-N</td>
<td>*CBC-32-44F</td>
<td>CBC-30-44F</td>
</tr>
<tr>
<td>46-0-N to 46-3-N</td>
<td>*CBC-32-46F</td>
<td>CBC-30-46F</td>
</tr>
<tr>
<td>48-0-N to 48-3-N</td>
<td>*CBC-32-48F</td>
<td>CBC-30-48F</td>
</tr>
<tr>
<td>50-0-N to 50-3-N</td>
<td>*CBC-33-50F</td>
<td>CBC-30-50F</td>
</tr>
<tr>
<td>52-0-N to 52-3-N</td>
<td>*CBC-33-52F</td>
<td>CBC-30-52F</td>
</tr>
<tr>
<td>54-0-N to 54-3-N</td>
<td>*CBC-33-54F</td>
<td>CBC-30-54F</td>
</tr>
<tr>
<td>56-0-N to 56-3-N</td>
<td>*CBC-33-56F</td>
<td>CBC-30-56F</td>
</tr>
<tr>
<td>58-0-N to 58-3-N</td>
<td>*CBC-34-58F</td>
<td>CBC-30-58F</td>
</tr>
<tr>
<td>60-0-N to 60-3-N</td>
<td>*CBC-34-60F</td>
<td>CBC-30-60F</td>
</tr>
<tr>
<td>62-0-N to 62-3-N</td>
<td>*CBC-34-62F</td>
<td>CBC-30-62F</td>
</tr>
<tr>
<td>64-0-N to 64-3-N</td>
<td>*CBC-35-64F</td>
<td>CBC-30-64F</td>
</tr>
<tr>
<td>66-0-N to 66-3-N</td>
<td>*CBC-35-66F</td>
<td>CBC-30-66F</td>
</tr>
<tr>
<td>68-0-N to 68-3-N</td>
<td>*CBC-35-68F</td>
<td>CBC-30-68F</td>
</tr>
<tr>
<td>70-0-N to 70-3-N</td>
<td>*CBC-35-70F</td>
<td>CBC-30-70F</td>
</tr>
</tbody>
</table>

* These nosecaps can cover one oversize smaller, e.g., STDN 36-3-N can be used with CBC-31-38F.
• The FTI patented countersink nosecap assemblies permit the simultaneous cold expansion of the straight and countersunk portions of pre-countersunk holes.

• Designed to hold the split sleeve in the hole during puller operation and to concurrently transfer the reactive forces from the puller into the countersink portion of the workpiece.

• Used for cold expansion of 3/16 through 27/64 inch 100-degree countersunk holes in aluminum alloys, using Little Brute Puller (Tables 2.3-35A and 2.3-35B).

• Multi-material stackups may be cold expanded using the CsCx nosecap assembly provided the countersink portion of the hole is in the aluminum part of the stackup.

• Consists of a four-part assembly including cap, retainer, sleeve retaining (inner) jaw, and expanding (outer) jaw which extends approximately 1-5/8 inches from the face of the cap for the Little Brute Puller (Figure 2.3-33).

• Replacement inner and outer jaws are available. Please contact our Sales department for more information.

**Table 2.3-33**

Little Brute Countersink (CsCx) Nosecap Assembly

<table>
<thead>
<tr>
<th>Puller Unit</th>
<th>Jaw A Diameter</th>
<th>Cap Length</th>
<th>Jaw Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Brute</td>
<td>0.78</td>
<td>1.50</td>
<td>1.69</td>
</tr>
</tbody>
</table>

**Model Number Key:**

K B C - 063 - 1A

1A = Little Brute 100° Countersink Callout

CsCx Nosecap Assembly

Size Code
2.3.34
MEDIUM BRUTE
COUNTERSINK
NOSECAP
ASSEMBLIES

- UNCONTROLLED IF PRINTED -

The FTI patented countersink nosecap assemblies permit the simultaneous cold expansion of the straight and countersunk portions of pre-countersunk holes.

Designed to hold the split sleeve in the hole during puller operation and to concurrently transfer the reactive forces from the puller into the countersink portion of the workpiece.

Used for cold expansion of 3/16 through 27/64-inch 100-degree countersunk holes in aluminum alloys, using Medium Brute Puller (Table 2.3-35C).

Multi-material stackups may be cold expanded using the CsCx nosecap assembly provided the countersink portion of the hole is in the aluminum part of the stackup.

Consists of a four-part assembly including cap, retainer, sleeve retaining (inner) jaw, and expanding (outer) jaw that extends 1-5/8 inches from the face of the cap for the Medium Brute Puller (Figure 2.3-34).

Replacement inner and outer jaws are available. Please contact our Customer Service Department for more information.

Table 2.3-34
Medium Brute CsCx Nosecap Assembly

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Brute</td>
<td>1.23</td>
<td>2.37</td>
<td>1.89</td>
</tr>
</tbody>
</table>

Model Number Key:

K B C - T I A - 2A

CsCx Nosecap Assembly

Size Code

2A = Medium Brute 100° Countersink Callout

Refer to Cx2s Tooling for complete STDN information.
## Table 2.3-35A
Countersink Nosecap Assembly KB and KB2 Tooling For Use with Little Brute

<table>
<thead>
<tr>
<th>KB Tooling</th>
<th>KB2 Tooling</th>
<th>Assembly Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N</td>
<td>-----</td>
<td>KBC-040-1A</td>
</tr>
<tr>
<td>4-1-N</td>
<td>-----</td>
<td>KBC-041-1A</td>
</tr>
<tr>
<td>4-2-N</td>
<td>-----</td>
<td>KBC-042-1A</td>
</tr>
<tr>
<td>4-3-N</td>
<td>-----</td>
<td>KBC-043-1A</td>
</tr>
<tr>
<td>4-4-N</td>
<td>-----</td>
<td>KBC-044-1A</td>
</tr>
<tr>
<td>6-0-N</td>
<td>60.****-0</td>
<td>KBC-060-1A</td>
</tr>
<tr>
<td>6-1-N</td>
<td>61.****-0</td>
<td>KBC-061-1A</td>
</tr>
<tr>
<td>6-2-N</td>
<td>62.****-0</td>
<td>KBC-062-1A</td>
</tr>
<tr>
<td>6-3-N</td>
<td>63.****-0</td>
<td>KBC-063-1A</td>
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<td>8-0-N</td>
<td>80.****-0</td>
<td>KBC-080-1A</td>
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<td>8-1-N</td>
<td>81.****-0</td>
<td>KBC-081-1A</td>
</tr>
<tr>
<td>8-2-N</td>
<td>82.****-0</td>
<td>KBC-082-1A</td>
</tr>
<tr>
<td>8-3-N</td>
<td>83.****-0</td>
<td>KBC-083-1A</td>
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<td>10-0-N</td>
<td>100.****-0</td>
<td>KBC-100-1A</td>
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<tr>
<td>10-1-N</td>
<td>101.****-0</td>
<td>KBC-101-1A</td>
</tr>
<tr>
<td>10-2-N</td>
<td>102.****-0</td>
<td>KBC-102-1A</td>
</tr>
<tr>
<td>10-3-N</td>
<td>103.****-0</td>
<td>KBC-103-1A</td>
</tr>
<tr>
<td>12-0-N</td>
<td>120.****-0</td>
<td>KBC-120-1A</td>
</tr>
<tr>
<td>12-1-N</td>
<td>121.****-0</td>
<td>KBC-121-1A</td>
</tr>
<tr>
<td>12-2-N</td>
<td>122.****-0</td>
<td>KBC-122-1A</td>
</tr>
<tr>
<td>12-3-N</td>
<td>123.****-0</td>
<td>KBC-123-1A</td>
</tr>
</tbody>
</table>

**** Refer to Cx2s tooling for complete STDN information.

## Table 2.3-35B
LB CsCx Nosecap Assemblies for CR Tooling

<table>
<thead>
<tr>
<th>CR Tooling</th>
<th>Assembly Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>R30</td>
<td>KRC-R30-1A</td>
</tr>
<tr>
<td>R32</td>
<td>KRC-R32-1A</td>
</tr>
<tr>
<td>R40</td>
<td>KRC-R40-1A</td>
</tr>
<tr>
<td>R42</td>
<td>KRC-R42-1A</td>
</tr>
<tr>
<td>R50</td>
<td>KRC-R50-1A</td>
</tr>
<tr>
<td>R52</td>
<td>KRC-R52-1A</td>
</tr>
<tr>
<td>R60</td>
<td>KRC-R60-1A</td>
</tr>
<tr>
<td>R62</td>
<td>KRC-R62-1A</td>
</tr>
</tbody>
</table>

## Table 2.3-35C
MB CsCx Nosecap Assemblies for CB Tooling

<table>
<thead>
<tr>
<th>CR Tooling</th>
<th>Assembly Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-0-N</td>
<td>KBC-140-2A</td>
</tr>
<tr>
<td>14-1-N</td>
<td>KBC-141-2A</td>
</tr>
<tr>
<td>14-2-N</td>
<td>KBC-142-2A</td>
</tr>
<tr>
<td>14-3-N</td>
<td>KBC-143-2A</td>
</tr>
<tr>
<td>16-0-N</td>
<td>KBC-160-2A</td>
</tr>
<tr>
<td>16-1-N</td>
<td>KBC-161-2A</td>
</tr>
<tr>
<td>16-2-N</td>
<td>KBC-162-2A</td>
</tr>
<tr>
<td>16-3-N</td>
<td>KBC-163-2A</td>
</tr>
<tr>
<td>18-0-N</td>
<td>KBC-180-2A</td>
</tr>
<tr>
<td>18-1-N</td>
<td>KBC-181-2A</td>
</tr>
<tr>
<td>18-2-N</td>
<td>KBC-182-2A</td>
</tr>
<tr>
<td>18-3-N</td>
<td>KBC-183-2A</td>
</tr>
<tr>
<td>20-0-N</td>
<td>KBC-200-2A</td>
</tr>
<tr>
<td>20-1-N</td>
<td>KBC-201-2A</td>
</tr>
<tr>
<td>20-2-N</td>
<td>KBC-202-2A</td>
</tr>
<tr>
<td>20-3-N</td>
<td>KBC-203-2A</td>
</tr>
</tbody>
</table>

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**2.3.35 COUNTERSINK NOSECAP ASSEMBLIES**
Detailed Tooling
Page 100

- UNCONTROLLED IF PRINTED -

2.3.36
OFFSET
ADAPTER
FLUSH
NOSECAPS

Figure 2.3-36A
LBOA and HOA
Flush Nosecaps

Figure 2.3-36B
MBOA Flush Nosecaps

Figure 2.3-36C
MBHO Flush Nosecaps

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece in restricted access areas.

- The LBOA and the HOA nosecaps consist of a two-part set which is spring loaded against the minor diameter of the mandrel.

- The LBOA and HOA jaws use flared sleeves.

- The MBOA and MBHO nosecaps use both flared and straight sleeves. See Table 2.3-36C.

- Identification is provided by an electroetched model number.

- For other sizes, please contact our Sales Staff.
### Table 2.3-36A
#### LBOA and HOA Flush Nosecaps

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>KB2 Tooling</th>
<th>CA Tooling</th>
<th>Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N to 4-1-N</td>
<td>41-<strong><strong>-0 to 42-</strong></strong>-0</td>
<td>20 to 21</td>
<td>CBC-40-0401F</td>
</tr>
<tr>
<td>4-2-N to 4-3-N</td>
<td>43-<strong><strong>-0 to 61-</strong></strong>-0</td>
<td>22 to 23</td>
<td>CBC-40-0423F</td>
</tr>
<tr>
<td>4-4-N to 6-1-N</td>
<td>62-<strong><strong>-0 to 63-</strong></strong>-0</td>
<td>30 to 32</td>
<td>CBC-40-0601F</td>
</tr>
<tr>
<td>6-2-N to 6-3-N</td>
<td>80-<strong><strong>-0 to 81-</strong></strong>-0</td>
<td>33 to 40</td>
<td>CBC-40-0623F</td>
</tr>
<tr>
<td>8-0-N to 8-1-N</td>
<td>82-<strong><strong>-0 to 83-</strong></strong>-0</td>
<td>41 to 42</td>
<td>CBC-40-0801F</td>
</tr>
<tr>
<td>8-2-N to 8-3-N</td>
<td>100-<strong><strong>-0 to 101-</strong></strong>-0</td>
<td>43 to 50</td>
<td>CBC-40-0823F</td>
</tr>
<tr>
<td>10-0-N to 10-1-N</td>
<td>102-<strong><strong>-0 to 103-</strong></strong>-0</td>
<td>51 to 52</td>
<td>CBC-40-1001F</td>
</tr>
<tr>
<td>10-2-N to 10-3-N</td>
<td>120-<strong><strong>-0 to 121-</strong></strong>-0</td>
<td>53 to 60</td>
<td>CBC-40-1023F</td>
</tr>
<tr>
<td>12-0-N to 12-1-N</td>
<td>122-<strong><strong>-0 to 123-</strong></strong>-0</td>
<td>61 to 62</td>
<td>CBC-40-1201F</td>
</tr>
<tr>
<td>12-2-N to 12-3-N</td>
<td>-----</td>
<td>63 to 70</td>
<td>CBC-40-1223F</td>
</tr>
<tr>
<td>14-0-N to 14-1-N</td>
<td>-----</td>
<td>71 to 72</td>
<td>CBC-40-1401F</td>
</tr>
<tr>
<td>14-2-N to 14-3-N</td>
<td>-----</td>
<td>73 to 80</td>
<td>CBC-40-1423F</td>
</tr>
<tr>
<td>16-0-N to 16-1-N</td>
<td>-----</td>
<td>81 to 82</td>
<td>CBC-40-1601F</td>
</tr>
<tr>
<td>16-2-N to 16-3-N</td>
<td>-----</td>
<td>83 to 90</td>
<td>CBC-40-1623F</td>
</tr>
</tbody>
</table>

**** Refer to Cx2s Tooling for complete STDN information.

Note: Bold STDN notes highest allowable HOA Standard Tool Diameter Number.

### Table 2.3-36B
#### CR Tooling-LBOA Flush Nosecaps

<table>
<thead>
<tr>
<th>STDN</th>
<th>Nosecap Model Number</th>
<th>Stdn</th>
<th>Nosecap Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>R30</td>
<td>CRC-R30-1</td>
<td>R50</td>
<td>CRC-R50-1</td>
</tr>
<tr>
<td>R32</td>
<td>CRC-R32-1</td>
<td>R52</td>
<td>CRC-R52-1</td>
</tr>
<tr>
<td>R40</td>
<td>CRC-R40-1</td>
<td>R60</td>
<td>CRC-R60-1</td>
</tr>
<tr>
<td>R42</td>
<td>CRC-R42-1</td>
<td>R62</td>
<td>CRC-R62-1</td>
</tr>
</tbody>
</table>

### Table 2.3-36C
#### MBOA and MBHO Flush Nosecaps

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>*MBOA Flush Nosecap Model Number</th>
<th>*MBHO Flush Nosecap Model Number</th>
<th>*Replacement Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>12-0-N to 12-3-N</td>
<td>60 to 70</td>
<td>CBC-52-12F</td>
<td>CBC-92-12F</td>
<td>CBC-20-12F</td>
</tr>
<tr>
<td>14-0-N to 14-3-N</td>
<td>70 to 80</td>
<td>CBC-52-14F</td>
<td>CBC-92-14F</td>
<td>CBC-20-14F</td>
</tr>
<tr>
<td>16-0-N to 16-3-N</td>
<td>80 to 90</td>
<td>CBC-53-16F</td>
<td>CBC-93-16F</td>
<td>CBC-20-16F</td>
</tr>
<tr>
<td>18-0-N to 18-3-N</td>
<td>90 to 100</td>
<td>CBC-53-18F</td>
<td>CBC-93-18F</td>
<td>CBC-20-18F</td>
</tr>
<tr>
<td>20-0-N to 20-3-N</td>
<td>100 to 103</td>
<td>CBC-53-20F</td>
<td>CBC-93-20F</td>
<td>CBC-20-20F</td>
</tr>
<tr>
<td>22-0-N to 22-3-N</td>
<td>103 to 111</td>
<td>CBC-54-22F</td>
<td>CBC-94-22F</td>
<td>CBC-20-22F</td>
</tr>
<tr>
<td>24-0-N to 24-3-N</td>
<td>-----</td>
<td>CBC-54-24F</td>
<td>CBC-94-24F</td>
<td>CBC-20-24F</td>
</tr>
<tr>
<td>26-0-N to 26-3-N</td>
<td>-----</td>
<td>CBC-54-26F</td>
<td>CBC-94-26F</td>
<td>CBC-20-26F</td>
</tr>
<tr>
<td>28-0-N to 28-3-N</td>
<td>-----</td>
<td>CBC-55-28F</td>
<td>CBC-95-28F</td>
<td>CBC-20-28F</td>
</tr>
<tr>
<td>30-0-N to 30-3-N</td>
<td>-----</td>
<td>CBC-55-30F</td>
<td>CBC-95-30F</td>
<td>CBC-20-30F</td>
</tr>
<tr>
<td>32-0-N to 32-3-N</td>
<td>-----</td>
<td>CBC-55-32F</td>
<td>CBC-95-32F</td>
<td>CBC-20-32F</td>
</tr>
<tr>
<td>34-0-N to 34-3-N</td>
<td>-----</td>
<td>CBC-55-34F</td>
<td>CBC-95-34F</td>
<td>CBC-20-34F</td>
</tr>
<tr>
<td>36-0-N to 36-3-N</td>
<td>-----</td>
<td>CBC-55-36F</td>
<td>CBC-95-36F</td>
<td>CBC-20-36F</td>
</tr>
</tbody>
</table>

* Will work with either flared or straight sleeves.
2.3.37
LITTLE BRUTE
OFFSET
ADAPTER
EXTENSION
NOSECAPS

Figure 2.3-37
Little Brute Offset Adapter (LBOA) Extension Nosecap

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.
- Consists of a two-piece assembly including a cap and a one-piece jaw set that extends two inches from the jaw flange.
- Replacement modular jaws can be ordered separately. See page 76.
- Other characteristics are similar to standard extension nosecaps.
- Flared sleeves are required.
- Identification is provided by an electroetched model number.
- Other lengths are available (E ref. Figure 2.3-37). Please contact our Customer Service Department.

Model Number Key:

Extension Nosecap
Puller Application
4 = LBOA or HOA

For use with flared sleeves
Jaw Size Code
Diameter Callout
Extension Callout (Table 2.3-37B)
### Table 2.3-37A

**STDN Range**

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>KB2 Tooling</th>
<th>CA Tooling</th>
<th>A (Ref. Fig. 2.3-37)</th>
<th>Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N to 4-1-N</td>
<td>40.<strong><strong>-0 to 41.</strong></strong>-0</td>
<td>20 to 21</td>
<td>0.49</td>
<td>CBCE-44A-0401F</td>
</tr>
<tr>
<td>4-2-N to 4-3-N</td>
<td>42.<strong><strong>-0 to 43.</strong></strong>-0</td>
<td>22 to 23</td>
<td>0.49</td>
<td>CBCE-44A-0423F</td>
</tr>
<tr>
<td>4-4-N to 6-1-N</td>
<td>60.<strong><strong>-0 to 61.</strong></strong>-0</td>
<td>30 to 32</td>
<td>0.49</td>
<td>CBCE-44A-0601F</td>
</tr>
<tr>
<td>6-2-N to 6-3-N</td>
<td>62.<strong><strong>-0 to 63.</strong></strong>-0</td>
<td>32 to 33</td>
<td>0.49</td>
<td>CBCE-44A-0623F</td>
</tr>
<tr>
<td>8-0-N to 8-1-N</td>
<td>80.<strong><strong>-0 to 81.</strong></strong>-0</td>
<td>40 to 41</td>
<td>0.49</td>
<td>CBCE-44A-0801F</td>
</tr>
<tr>
<td>8-2-N to 8-3-N</td>
<td>82.<strong><strong>-0 to 83.</strong></strong>-0</td>
<td>42 to 43</td>
<td>0.49</td>
<td>CBCE-44A-0823F</td>
</tr>
<tr>
<td>10-0-N to 10-1-N</td>
<td>100.<strong><strong>-0 to 101.</strong></strong>-0</td>
<td>50 to 51</td>
<td>0.61</td>
<td>CBCE-44B-1001F</td>
</tr>
<tr>
<td>10-2-N to 10-3-N</td>
<td>102.<strong><strong>-0 to 103.</strong></strong>-0</td>
<td>52 to 53</td>
<td>0.61</td>
<td>CBCE-44B-1023F</td>
</tr>
<tr>
<td>12-0-N to 12-1-N</td>
<td>120.<strong><strong>-0 to 121.</strong></strong>-0</td>
<td>-----</td>
<td>0.61</td>
<td>CBCE-44B-1201F</td>
</tr>
<tr>
<td>12-2-N to 12-3-N</td>
<td>122.<strong><strong>-0 to 123.</strong></strong>-0</td>
<td>-----</td>
<td>0.61</td>
<td>CBCE-44B-1223F</td>
</tr>
<tr>
<td>14-0-N to 14-1-N</td>
<td>-----</td>
<td>-----</td>
<td>0.74</td>
<td>CBCE-44C-1401F</td>
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<tr>
<td>14-2-N to 14-3-N</td>
<td>-----</td>
<td>-----</td>
<td>0.74</td>
<td>CBCE-44C-1423F</td>
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<tr>
<td>16-0-N to 16-1-N</td>
<td>-----</td>
<td>-----</td>
<td>0.74</td>
<td>CBCE-44C-1601F</td>
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<tr>
<td>16-2-N to 16-3-N</td>
<td>-----</td>
<td>-----</td>
<td>0.74</td>
<td>CBCE-44C-1623F</td>
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### Table 2.3-37B

**Extension Callouts**

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-40) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
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</table>
### Table 2.3-37C
LBOA Nosecaps

<table>
<thead>
<tr>
<th>Extension Nosecap</th>
<th>Modular Extension Nosecap</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBCE-44A-0401F</td>
<td>MEN-44A-0401F</td>
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<tr>
<td>CBCE-44A-0423F</td>
<td>MEN-44A-0423F</td>
</tr>
<tr>
<td>CBCE-44A-0601F</td>
<td>MEN-44A-0601F</td>
</tr>
<tr>
<td>CBCE-44A-0623F</td>
<td>MEN-44A-0623F</td>
</tr>
<tr>
<td>CBCE-44A-0801F</td>
<td>MEN-44A-0801F</td>
</tr>
<tr>
<td>CBCE-44A-0823F</td>
<td>MEN-44A-0823F</td>
</tr>
<tr>
<td>CBCE-44B-1001F</td>
<td>MEN-44A-1001F</td>
</tr>
<tr>
<td>CBCE-44B-1023F</td>
<td>MEN-44A-1023F</td>
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<tr>
<td>CBCE-44B-1201F</td>
<td>MEN-44A-1201F</td>
</tr>
<tr>
<td>CBCE-44B-1223F</td>
<td>MEN-44A-1223F</td>
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<tr>
<td>CBCE-44C-1401F</td>
<td>MEN-44B-1401F</td>
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<tr>
<td>CBCE-44C-1601F</td>
<td>MEN-44B-1601F</td>
</tr>
<tr>
<td>CBCE-44C-1623F</td>
<td>MEN-44B-1623F</td>
</tr>
</tbody>
</table>
**Figure 2.3-38**

Medium Brute Offset Adapter (MBOA) Extension Nosecap

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.

- For cold expanding holes in aluminum up to 15/16-inch diameter and up to 1/2-inch diameter in steel and titanium in restricted access areas.

- Consist of a three-piece assembly including a cap, a one-piece jaw set that extends from the front of the cap, and a retaining washer to hold the jaw in place.

- Replacement jaws can be ordered separately (see Table 2.3-38B).

- Identification is provided by an electroetched model number.

- Other sizes are available. Please contact our Sales Staff for information.

**Table 2.3-38A**

<table>
<thead>
<tr>
<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-38) (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>6</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>4.5</td>
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</tbody>
</table>

*STDNs 20-2-N through 30-3-N are not available with a callout of "4."
### Table 2.3-38B
**MBOA Extension Nosecap Specifications**

<table>
<thead>
<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>A Diameter (Ref. Fig. 2.3-38) (inch)</th>
<th>Assembly Model Number</th>
<th>Replacement Jaw Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-3-N</td>
<td>60</td>
<td>0.86</td>
<td>CBCE-56D-10-3-NF</td>
<td>CBCE-26D-10-3-NF-JO</td>
</tr>
<tr>
<td>12-0-N</td>
<td>61</td>
<td>0.86</td>
<td>CBCE-56D-12-0-NF</td>
<td>CBCE-26D-12-0-NF-JO</td>
</tr>
<tr>
<td>12-1-N</td>
<td>62</td>
<td>0.86</td>
<td>CBCE-56D-12-1-NF</td>
<td>CBCE-26D-12-1-NF-JO</td>
</tr>
<tr>
<td>12-2-N</td>
<td>63</td>
<td>0.86</td>
<td>CBCE-56D-12-2-NF</td>
<td>CBCE-26D-12-2-NF-JO</td>
</tr>
<tr>
<td>12-3-N</td>
<td>70</td>
<td>0.86</td>
<td>CBCE-56D-12-3-NF</td>
<td>CBCE-26D-12-3-NF-JO</td>
</tr>
<tr>
<td>14-0-N</td>
<td>71</td>
<td>0.86</td>
<td>CBCE-56D-14-0-NF</td>
<td>CBCE-26D-14-0-NF-JO</td>
</tr>
<tr>
<td>14-1-N</td>
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<td>0.86</td>
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<td>CBCE-26D-14-1-NF-JO</td>
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<tr>
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<td>73</td>
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<td>CBCE-26D-14-2-NF-JO</td>
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<td>14-3-N</td>
<td>80</td>
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<td>CBCE-56D-14-3-NF</td>
<td>CBCE-26D-14-3-NF-JO</td>
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<tr>
<td>16-0-N</td>
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</tr>
<tr>
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<td>CBCE-26D-16-1-NF-JO</td>
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<td>16-3-N</td>
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<td>18-0-N</td>
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<td>CBCE-26D-20-1-NF-JO</td>
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<tr>
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<td>CBCE-26E-20-2-NF-JO</td>
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<td>CBCE-26E-20-3-NF-JO</td>
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<tr>
<td>22-0-N</td>
<td>111</td>
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<td>CBCE-26E-22-0-NF-JO</td>
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<tr>
<td>22-1-N</td>
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<td>CBCE-56E-22-2-NF</td>
<td>CBCE-26E-22-2-NF-JO</td>
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<tr>
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<td>CBCE-26E-22-3-NF-JO</td>
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<tr>
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<tr>
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### Table 2.3-38C

**MBOA Extension Nosecaps**

<table>
<thead>
<tr>
<th>Extension Nosecap</th>
<th>Modular Extension Nosecap</th>
</tr>
</thead>
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<td>MEN-56B-1201F</td>
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<tr>
<td>CBCE-56F-30-3-NF</td>
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</tbody>
</table>
Figure 2.3-39

MBHO Extension Nosecap

- Designed to hold the split sleeve in the hole during puller operation and to transfer the reactive forces from the puller to the workpiece.
- Capable of cold expanding holes in aluminum and mild steel up to 15/16-inch diameter and up to 1/2-inch diameter in steel and titanium in restricted access areas.
- Consists of a three-piece assembly including a cap, a one-piece jaw that extends from the front of the cap, and a back plate that holds the jaw to the puller unit.
- Replacement extension jaws can be ordered separately (see Table 2.3-39B).
- Identification is provided by an electroetched model number.
- Other sizes are available. Please contact our Sales Staff for information.

Table 2.3-39A

Extension Callout

<table>
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<th>Extension Callouts</th>
<th>E (Ref. Fig. 2.3-39) (inch)</th>
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<td>9</td>
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* STDNs 20-2-N through 30-3-N are not available with a callout of "4."

Model Number Key:

- C B C E - 9 6 D - 14 - 0 - N F
- For use w/flared sleeves
- Standard Tool Diameter Number (STDN)
- Diameter Callout (Ref. A, Fig. 2.3-39)
  - D = 0.820 inch
  - E = 1.100 inches
  - F = 1.230 inches

Extension Nosecap

Puller Application
9 = MBHO

Extension Callout
(Table 2.3-39A)
### Table 2.3-39B

**STDN Range**

<table>
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<tr>
<th>CB Tooling</th>
<th>CA Tooling</th>
<th>A Diameter (Ref. Fig. 2.3-39) (inch)</th>
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2.3.39

**MEDIUM BRUTE HYDRAULIC OFFSET EXTENSION NOSECAPS**

See Table 2.3-39C

Superseded by Modular Extension Nosecap

---

**Detailed Tooling**

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www.fatiguetech.com
TEL: (206) 246-2010

FATIGUE TECHNOLOGY
401 Andover Park East • Seattle, WA USA • 98188

FAX: (206) 244-9886
### Table 2.3-39C
**MBHO Modular Nosecaps**

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</table>
Flush Nosecap
Puller Callout LBRA-7
Extension Callout

Figure 2.3-40
Right-Angle Puller Nosecap

- For cold expansion of holes with access restrictions such as drain holes, holes in pockets, and other areas with limited front-side access.
- Capable of cold expanding up to 3/8-inch diameter holes in aluminum and 1/4-inch diameter holes in steel or titanium. Stackup capability of up to 0.8 inch, depending on material.
- Can be used for all FTI processes.

Table 2.3-40
Right Angle Puller Nosecap Selection

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Model Number Key:

- Flush Nosecap
- Puller Callout LBRA-7
- Extension Callout
- For use with flared sleeves only
- Jaw Callout

2.3.40
RIGHT ANGLE PULLER NOSECAP

Detailed Tooling
Page 111
2.4 EXPENDABLE TOOLING

- Flared Sleeves
- Straight Sleeves
- Backup Blocks
• Sleeves are used in conjunction with a mandrel to allow a one-sided operation, provide lubrication, ensure that the hole is expanded in a radial direction, and protect the hole from damage.

• A flared sleeve configuration is generally recommended (except when stacking or when using the countersink nosecap).

• Each sleeve may only be used once.

• Manufactured from stainless steel.

• Each sleeve is internally pre-lubricated with a proprietary dry-film lubricant.

• Maximum length is identified in Table 2.4-1B, but shorter sleeves may be stacked to provide increased length.

• A flared or straight configuration can be provided.

• Sleeve must be at least 1/32 inch longer than the material stackup with a standard nosecap, 5/32 inch longer with a countersink nosecap.

• Identification is provided by an electroetched model number on each sleeve (model number may only be STDN).

• Special order sleeve lengths are available.

• For larger sizes, please contact our Sales Staff.

---

**Model Number Key:**

```
CB S - 10 - 0 - N - 16 F
```

- **Process Callout** (CB, CA, CR, or KB2)
- **Flared or Straight**
- **Sleeve Length in 16ths of an inch**
- **Standard Tool Diameter Number (STDN)**

---

**Figure 2.4-1A**  
*Flared Sleeve*

**Figure 2.4-1B**  
*Straight Sleeve*
### Table 2.4-1A
Available Sleeve Lengths

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### Flared Sleeves

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* For flared sleeves, the effective length is from the bottom of the flare to the end of the sleeve (refer to Figure 2.4-1A).

### Table 2.4-1B
Maximum Sleeve Lengths

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<th>Maximum Length in 1/16-inch</th>
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<td>6-0-N through 8-3-N</td>
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<td>10-0-N through 10-2-N</td>
<td>-40F/-41S</td>
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<td>10-3-N through 16-1-N</td>
<td>-48F/-49S</td>
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<td>16-2-N through 18-2-N</td>
<td>-56F/-57S</td>
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<td>18-3-N through 22-3-N</td>
<td>-64F/-65S</td>
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<td>-72F/-73S</td>
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### Table 2.4-1C
**CB Sleeves**

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*** Refer to Cx2s Tooling for complete STDN information.

---

**Table 2.4-1F**

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`Detailed Tooling Page 116`
FIGURE 2.4-2
Backup Block

- Used in the cold expansion process to provide either a higher pull force for countersink cold expansion or in-plane stability to thin structure.

- The inside diameter is manufactured to the same starting hole dimensional requirements as the fastener hole that is being cold expanded.

- The backup block combined with the thickness of the straight portion of the hole must be greater than or equal to the finish hole diameter.

- The outside diameter of the backup block should be at least five times greater than the diameter of the hole.

- Backup blocks can only be used once.

MODEL NUMBER KEY:

```
KB B B - 10 - 0 - N - 1
```

- **Process Callout** (CB, KB, KR, or KB2)
- **Standard Tool Diameter Number (STDN)**
### Table 2.4-2A
**KB Blocks**

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Sizes available up to STDN 20-3-N. See Model Number Key.

### Table 2.4-2B
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**KB2 Blocks**

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*** Refers to Cx2s Tooling for complete STDN information.
Visit [www.fatiguetech.com](http://www.fatiguetech.com) for the most up-to-date content, answers to your most frequently asked sales and technical questions, contact information, and more.
CB TOOLING FOR Cx IN ALUMINUM AND MILD STEELS

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<th>Page</th>
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</thead>
<tbody>
<tr>
<td>3.1 Process Description</td>
<td>122</td>
</tr>
<tr>
<td>3.2 Process Overview</td>
<td>123</td>
</tr>
<tr>
<td>3.3 STDN Selection Table for New Holes</td>
<td>124</td>
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<td>3.4 STDN Selection Table for Rework of Existing Holes</td>
<td>126</td>
</tr>
<tr>
<td>3.5 Standard Tooling</td>
<td>128</td>
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<tr>
<td>3.6 Countersink Tooling</td>
<td>132</td>
</tr>
</tbody>
</table>

For complete CB Tooling specifications please visit our online technical library at [www.fatiguetech.com/technical-library.asp](http://www.fatiguetech.com/technical-library.asp) and download FTI Spec 8101, or contact your nearest FTI Representative. Product specifications include a system overview, structure requirements, installation procedure, and a tooling selection guide.
The FTI basic system of Split Sleeve Cold Expansion (SsCx) tooling, CB series, was designed primarily for production applications in aluminum and mild steel. The process includes development of the starting hole, cold expanding the hole, and post-sizing of the hole to accommodate the required interference fastener or fastening device. The CB series system of tooling is also used for rework applications and has commonly been called out for aircraft service bulletins. For pre-existing countersunk holes, the countersink and straight portion of the hole can be simultaneously cold expanded using a special Countersink Cold Expansion (CsCx) nosecap assembly.

CB tooling is available in nominal and 1/64-inch oversizes from 1/8 inch to 1 inch and larger. For tooling applicable to high strength steel and titanium, please see Section 5.0 for our CA Series. For tooling specifically designed for rework, see Section 6.0 for our CR Series. For technical assistance outside the scope of this catalog, please contact our Customer Service Department at 206-246-2010.

Figure 3.1
CB System Components
1. Drill starting hole.

2. Ream starting hole.

3. Check starting hole diameter.

4. Inspect mandrel.

5. Slide split sleeve over mandrel.

6. Insert mandrel and split sleeve into starting hole.

7. Place nosecap firmly against workpiece.

8. Cold expand hole by pulling the mandrel through the pre-lubricated split sleeve.

9. Remove distorted sleeve.

10. Verify cold expansion.

11. Finish ream hole.

12. Install fastener.
The "CB" STDN selection tables provide a choice of two final ream allowances after cold expansion. Since the process provides a large zone of residual compressive stress, either ream amount can be used without impacting the fatigue life. The smaller ream allowance (OPTION #1) removes less material. The larger ream allowance (OPTION #2) removes more of the surface upset around the hole, which may be more desirable for multi-material stackups. The average ream allowances shown in Table 3.3A are based on installation of a typical Hi-Lok fastener.

**Note:** In column 1A, for a 3/16-inch final fastener you may use either the 4-4-N or 6-0-N tooling depending on your final ream preference.

### Table 3.3A

**CB Tooling STDN Selection for New Holes**

<table>
<thead>
<tr>
<th>Reference Fastener</th>
<th>Ave. Ream Allowance</th>
<th>Reference Fastener</th>
<th>Ave. Ream Allowance</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Max Finished Hole Diameter Not to Exceed</th>
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<td>.007</td>
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<td>.006</td>
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<td>.006</td>
<td>11/64</td>
<td>.006</td>
<td>4-2-N</td>
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<td>.012</td>
<td>3/16</td>
<td>.012</td>
<td>4-3-N</td>
<td>.1920</td>
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<td>.003</td>
<td>3/16</td>
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<td>.019</td>
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<td>.006</td>
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<td>.012</td>
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<td>.027</td>
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<td></td>
<td></td>
<td></td>
<td>16-3-N</td>
<td>.5860</td>
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</tbody>
</table>
To properly select the STDN:

- For a smaller ream allowance, use column 1A to determine the final fastener size.
- For a larger ream allowance use column 1B to select the final fastener.
- Move across to Column 2 to select the proper STDN.
- Using this STDN, select the proper set of tooling from Table 3.5A.
- Column 3 states the maximum diameter the hole can be reamed to before requiring further cold expansion.

### Table 3.3A (Continued)

**CB Tooling STDN Selection for New Holes**

<table>
<thead>
<tr>
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<td><strong>Max Finished Hole Diameter Not to Exceed</strong></td>
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<td>.012</td>
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</tbody>
</table>

Greater than 1 inch contact Fatigue Technology for technical assistance.
Table 3.4A has been designed to assist with STDN selection for existing fastener holes in rework conditions. Every aircraft manufacturer has guidelines for fastener removal, pre-existing crack removal, and hole preparation that should be followed. Use this table to select an STDN using either your existing fastener or required final fastener as a guide. Note that the STDNs listed in Column 3 have been chosen for minimal ream allowances.

### Table 3.4A

<table>
<thead>
<tr>
<th>Nominal Existing Fastener Diameter</th>
<th>Maximum Allowable Existing Diameter Before Cx</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Cold Expansion Starting Hole Diameter</th>
<th>Final Fastener Diameter</th>
<th>Maximum Finished Hole Diameter (not to exceed)</th>
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</thead>
<tbody>
<tr>
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<td>.144</td>
<td>.146</td>
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<tr>
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<td>.150</td>
<td>4-3-N</td>
<td>.160</td>
<td>.162</td>
<td>11/64 .192</td>
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<tr>
<td>5/32</td>
<td>.159</td>
<td>4-4-N</td>
<td>.169</td>
<td>.171</td>
<td>3/16 .202</td>
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<tr>
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<td>.167</td>
<td>6-0-N</td>
<td>.177</td>
<td>.180</td>
<td>3/16 .213</td>
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<tr>
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<td>.199</td>
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<td>.209</td>
<td>.212</td>
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<td>6-3-N</td>
<td>.225</td>
<td>.228</td>
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<td>.300</td>
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<td>.303</td>
<td>10-1-N</td>
<td>.313</td>
<td>.316</td>
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<tr>
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<td>.318</td>
<td>10-2-N</td>
<td>.328</td>
<td>.331</td>
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<tr>
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<td>.334</td>
<td>10-3-N</td>
<td>.344</td>
<td>.347</td>
<td>23/64 .399</td>
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<tr>
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<td>.375</td>
<td>.378</td>
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<td>.406</td>
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<td>.424</td>
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<td>29/64 .502</td>
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<td>.453</td>
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<td>.455</td>
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<td>.505</td>
<td>.508</td>
<td>17/32 .570</td>
</tr>
</tbody>
</table>

Continued on next page...
To select the STDN using Table 3.4A, use the following steps:

1. Remove the existing fastener and measure the hole diameter.

2. If a minimal amount of material is to be removed, select the STDN from Column 3 that corresponds with the existing hole diameter in Column 2. If a larger final fastener is desired, find the final fastener size in Column 5 and select the corresponding STDN in Column 3.

3. Using the STDN, select the tooling from Table 3.5A on the following pages.

### Table 3.4A (Continued)

**CB Tooling STDN Selection for Rework of Existing Holes**

<table>
<thead>
<tr>
<th>Nominal Existing Fastener Diameter</th>
<th>Maximum Allowable Existing Diameter Before Cx</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Cold Expansion Starting Hole Diameter</th>
<th>Final Fastener Diameter</th>
<th>Maximum Finished Hole Diameter (not to exceed)</th>
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<td>.527</td>
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<td>.537</td>
<td>.540</td>
<td>9/16</td>
</tr>
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<td>.662</td>
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<td>.693</td>
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<td>.949</td>
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**CB Tooling**

Page 127
1. To select a Standard Tool Diameter Number refer to Table 3.3A or 3.4A.
2. With the STDN, select the system of Standard Tooling from Table 3.5A.

### Table 3.5A

**Standard CB Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
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<tbody>
<tr>
<td>4-0-N</td>
<td>CBSD-4-0-N-1</td>
<td>CBR-4-0-N-1</td>
<td>CBG-4-0-N-1</td>
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<td>CBSD-4-1-N-1</td>
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<td>CBSD-4-2-N-1</td>
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Continued on next page...
3. Refer to Section 2.0, Detailed Tooling for complete description of part.

4. Replace **** in gage finish reamer model number with the minimum final hole diameter.

Table 3.5A (Continued)
Standard CB Tooling

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<th>Standard Tool Diameter Number (STDN)</th>
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<th>Mandrel</th>
<th>Nosecap Assembly</th>
<th>Gage Finish Reamer</th>
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**** Denotes final hole diameter to be determined by customer.

Continued on next page...
1. To select a Standard Tool Diameter Number, refer to Table 3.3A or 3.4A.

2. With the STDN, select the system of Standard Tooling from Table 3.5A.

### Table 3.5A (Continued)

**Standard CB Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
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<td>CBG-30-3-N-1</td>
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</table>
3. Refer to Section 2.0, Detailed Tooling for complete description of part.

4. Replace **** in gage finish reamer model number with the minimum final hole diameter.

**Note:** This tooling may not be maintained in stock.

### Table 3.5A (Continued)
**Standard CB Tooling**

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<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Flared Sleeve</th>
<th>Mandrel</th>
<th>Nosecap Assembly</th>
<th>Gage Finish Reamer</th>
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<td>CBR-30-3-N-1-****</td>
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**** Denotes final hole diameter to be determined by customer.
To cold expand existing countersunk holes, the countersink nosecap, mandrel, and straight sleeve must be used. A backup block may be necessary for countersunk holes in thin material. To assemble tooling for a countersunk hole, substitute the nosecap, mandrel, and sleeve for the STDN found in Table 3.6A.

For more information on cold expanding countersink holes, refer to Section 8, Countersink Cold Expansion (CsCx).

### Table 3.6A
Alternate Tooling for Countersunk Holes

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Countersink Nosecap</th>
<th>Countersink Mandrel</th>
<th>Straight Sleeve</th>
<th>Backup Block</th>
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<tbody>
<tr>
<td>4-0-N</td>
<td>KBC-040-1A</td>
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</table>

CB Tooling
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To cold expand existing countersunk holes, the countersink nosecap, mandrel, and straight sleeve must be used. A backup block may be necessary for countersunk holes in thin material. To assemble tooling for a countersunk hole, substitute the nosecap, mandrel, and sleeve for the STDN found in Table 3.6A.

For more information on cold expanding countersink holes, refer to Section 8.0, Countersink Cold Expansion (CsCx).

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Countersink Nosecap</th>
<th>Countersink Mandrel</th>
<th>Straight Sleeve</th>
<th>Backup Block</th>
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Table 3.6A (Continued)  
Alternate Tooling for Countersunk Holes
4.0 CW TOOLING

CW TOOLING FOR LOW INTERFERENCE CX IN ALUMINUM

PART NUMBER CROSS REFERENCES

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
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<td>137</td>
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<td>141</td>
</tr>
<tr>
<td>4.6 Standard Nosecap Part Number Cross Reference</td>
<td>142</td>
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</tbody>
</table>

For complete CW Tooling specifications please reference Boeing’s CW Specification BAC5973, Class II. For more information, please visit www.fatiguetech.com/technical-library.asp or contact your nearest FTI representative.
The Boeing Low Interference (Class II) Sleeve Cold Working process is very similar to the high interference process. FTI manufactures and markets low interference split sleeve cold working tooling to support the Boeing 5973 Class II cold working specification. FTI's low interference tooling system is called **CW Tooling**.

The principal features of the **CW Tooling System** are:

- A medium level of expansion.
- Starting hole and tool diameters are sized to give a finished hole diameter compatible with clearance fits of standard fasteners.
- Standard Tool Diameter Numbers contain the estimated finished cold worked hole diameter.
- Final reaming is not required.

**The Basic Part Number:**
The basic part number is identical to the Cx Tooling system except for the following differences:

1. A CW prefix is used instead of a CB prefix.
2. The Standard Tool Diameter Number has a different format.

### Model Number Key:

```
CW * - **** -
```

- **Tool Callout**
  - CWSD - Starting Drill
  - CWSR - Starting Reamer
  - CWS - Split Sleeve
  - CWM - Mandrel
  - CWG - Combination Gage

- **Standard Tool Diameter Number**
  - Table 4.3A - Bolts and Open Holes
  - Table 4.3B - Hex Drive Bolts and Lock Bolts
  - Table 4.3C - Rivets

**Note:** Refer to page 140 for ordering examples.
Recommended Tooling for the Low Interference Split Sleeve Cold Expansion Process (Boeing Class II):

- Puller Unit .........................LB-20/HP-20/ST1350A
- PowerPak ........................................FT-20 or FT-200
- Starting Drill.................................CWSD_*****-1
- Starting Reamer ..............................CWSR_*****-1
- Mandrel........................................CWM_*****-1-20-V1
- Split Sleeves .................................CWS_*****-16F
- Nosecaps ....................................CBC- (see Table 4.2)
- Combination Gage ............................CWG_*****

***** = Standard Tool Diameter Number from Tables 4.3A, 4.3B, or 4.3C.

FTI Extension Nosecaps are available for CW Series tooling. Contact FTI for assistance in selecting the applicable extension nosecap for your tooling STDN.

Table 4.2
Recommended Nosecaps

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number ****</th>
<th>Minimum (inch)</th>
<th>Maximum (inch)</th>
<th>Nosecap Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1267</td>
<td>0.2206</td>
<td>CBC-11-06F</td>
<td></td>
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<tr>
<td>0.2364</td>
<td>0.2990</td>
<td>CBC-11-08F</td>
<td></td>
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<td>0.3090</td>
<td>0.3458</td>
<td>CBC-11-10F</td>
<td></td>
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<tr>
<td>0.3615</td>
<td>0.4083</td>
<td>CBC-12-12F</td>
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<td>0.4241</td>
<td>0.4708</td>
<td>CBC-12-14F</td>
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<td>0.4865</td>
<td>0.5489</td>
<td>CBC-13-16F</td>
<td></td>
</tr>
</tbody>
</table>

Note: ST1350 puller units may be modified to allow use of FTI nosecaps and mandrels (see Table 13.1C). FTI standard puller unit is the LB-20. Refer to Section 2.0 Detailed Tooling for other FTI puller units.
## Table 4.3A
**BAC 5973 Class II Cold Working Requirements for Bolts and Open Holes**

<table>
<thead>
<tr>
<th>Standard Hole Size</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Finished Hole Diameter (inch)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
<tr>
<td>1/8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9/64</td>
<td>B1267</td>
<td>0.1250</td>
<td>0.1267</td>
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<td>5/32</td>
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<tr>
<td>3/16</td>
<td>B1894</td>
<td>0.1875</td>
<td>0.1894</td>
<td>0.1922</td>
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<tr>
<td>13/64</td>
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<tr>
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<tr>
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<tr>
<td>1/4</td>
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<td>0.2500</td>
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<td>0.5020</td>
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</table>

Continued on next page...
### Table 4.3A (Continued)
BAC 5973 Class II Cold Working Requirements for 
Bolts and Open Holes

<table>
<thead>
<tr>
<th>Nominal Hole Size</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Finished Hole Diameter (inch)</th>
</tr>
</thead>
<tbody>
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<td>Standard</td>
<td>Oversize</td>
<td>Nominal</td>
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<td>0.6250</td>
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<td>43/64</td>
<td>B6742</td>
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<td>0.8750</td>
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<td>0.9375</td>
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<td>1-1/64</td>
<td>B10187</td>
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<td>1-1/32</td>
<td>B10343</td>
<td>1.0312</td>
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</tbody>
</table>
**Table 4.3B**

**BAC 5973 Class II Cold Working Requirements for Hex-Drive Bolts and Lock Bolts**

<table>
<thead>
<tr>
<th>Nominal Hole Size</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Finished Hole Diameter (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Oversize</td>
<td>Minimum</td>
</tr>
<tr>
<td>3/16</td>
<td>H1870</td>
<td>H2000, H2160</td>
<td>0.1855, 0.1985</td>
</tr>
<tr>
<td>1/4</td>
<td>H2470</td>
<td>H2630, H2780</td>
<td>0.2455, 0.2615</td>
</tr>
<tr>
<td>5/16</td>
<td>H3090</td>
<td>H3250, H3410</td>
<td>0.3080, 0.3230</td>
</tr>
<tr>
<td>3/8</td>
<td>H3710</td>
<td>H3880, H4030</td>
<td>0.3695, 0.3865</td>
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<tr>
<td>7/16</td>
<td>H4340</td>
<td>H4500, H4660</td>
<td>0.4310, 0.4625</td>
</tr>
</tbody>
</table>

**Table 4.3C**

**BAC 5973 Class II Cold Working Requirements for Rivet Holes**

<table>
<thead>
<tr>
<th>Nominal Hole Size</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Finished Hole Diameter (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Oversize</td>
<td>Minimum</td>
</tr>
<tr>
<td>1/8</td>
<td>R1280</td>
<td>R1590</td>
<td>0.1270, 0.1580</td>
</tr>
<tr>
<td>3/16</td>
<td>R1900</td>
<td>R2200</td>
<td>0.1890, 0.2185</td>
</tr>
<tr>
<td>1/4</td>
<td>R2530</td>
<td>R2830</td>
<td>0.2520, 0.2810</td>
</tr>
<tr>
<td>5/16</td>
<td>R3170</td>
<td>R3450</td>
<td>0.3140, 0.3435</td>
</tr>
<tr>
<td>3/8</td>
<td>R3780</td>
<td>R4080</td>
<td>0.3750, 0.4060</td>
</tr>
<tr>
<td>7/16</td>
<td>R4410</td>
<td></td>
<td>0.4365, 0.461</td>
</tr>
</tbody>
</table>

CW Tooling

Page 139
4.4 ORDERING EXAMPLES

EXAMPLE #1

Requirement:
Low interference coldwork 1/4-inch nominal open hole in 1/2-inch thick aluminum; unrestricted access.

1. Select STDN from Table 4.3A: B2520.
2. Order standard tooling as per instructions on page 141 of this section.

Puller......................... LB-20
PowerPak....................... FT-20 or FT-200
Starting Drill .................... CWSD-B2520-1
Starting Reamer ............... CWSR-B2520-1
Mandrel ....................... CWM-B2520-1-20-V1
Split Sleeves............... CWS-B2520-16F
Nosecap .................... CBC-11-08F
Combination Gage ....... CWG-B2520

EXAMPLE #2

Requirement:
Low interference coldwork 3/8-inch (1/32-oversize) hole intended for a rivet.

1. Select STDN from Table 4.3C: R4080.
2. Order standard tooling as per instructions on page 141 of this section.

Puller......................... LB-20
PowerPak....................... FT-20 or FT-200
Starting Drill .................... CWSD-R4080-1
Starting Reamer ............... CWSR-R4080-1
Mandrel ....................... CWM-R4080-1-20-V1
Split Sleeves............... CWS-R4080-16F
Nosecap .................... CBC-12-12F
Combination Gage ....... CWG-R4080
There have been three changes to the standard mandrel part numbering system:

1. The (IWMF, IWLB, IWMB, IWBB) prefixes have been deleted.
2. The V1 material callout for aluminum cold expansion has been added.
3. The attachment callout has changed (see below).

**Old Part Number:**

<table>
<thead>
<tr>
<th>Model Number Key:</th>
<th>IWMF - CBM - ** - * - N - * - **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Std. Tool Diameter Number</td>
<td></td>
</tr>
<tr>
<td>Attachment (changed, see Table 4.5A)</td>
<td></td>
</tr>
</tbody>
</table>

**Material code (added)**

**Stackup Callout**

(changed on Ext. Mandrel see Table 4.5B)

---

**Table 4.5A**

Attachements Callouts

<table>
<thead>
<tr>
<th>New Attachment Callout</th>
<th>Attachment Description</th>
<th>Old Attachment Callout</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7/16 - 20</td>
<td>1AB</td>
</tr>
<tr>
<td>2</td>
<td>5/8 - 18</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>0.960&quot;</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>7/8 - 14</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>7/8 - 14</td>
<td>3</td>
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</tbody>
</table>

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**Table 4.5B**

Attachements Callouts for Stackups

<table>
<thead>
<tr>
<th>Old Stackup Callout</th>
<th>New Stackup Callout</th>
</tr>
</thead>
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<td>10E4</td>
<td>30</td>
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<tr>
<td>10E5</td>
<td>35</td>
</tr>
<tr>
<td>10E6</td>
<td>40</td>
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<tr>
<td>15E4</td>
<td>35</td>
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<td>15E5</td>
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<td>20E5</td>
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<tr>
<td>20E6</td>
<td>50</td>
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</tbody>
</table>
### OLD PART NUMBER:

**Model Number Key:**

IWLB
IWMB - CBC - * - **** F/S
IWBB

**Deleted**

Cap Callout
(changed, see Table 4.6)

**Jaw Callout**
(changed, see Table 4.6)

### NEW PART NUMBER:

**CBC - * * - ** F/S**

Puller Model
1 = LB Little Brute
2 = MB Medium Brute
3 = BB Big Brute

Cap Callout
(changed, see Table 4.6)

Table 4.6

**Nosecap Part Number Cross Reference**

<table>
<thead>
<tr>
<th>Nominal Size</th>
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<th>New Part Number</th>
<th>Old Part Number</th>
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<td>LB</td>
<td>CBC-11-06F/S</td>
<td>IWLB-CBC-1-0507F/S</td>
</tr>
<tr>
<td>1/4</td>
<td>LB</td>
<td>CBC-11-08F/S</td>
<td>IWLB-CBC-1-0809F/S</td>
</tr>
<tr>
<td>5/16</td>
<td>LB</td>
<td>CBC-11-10F/S</td>
<td>IWLB-CBC-1-1011F/S</td>
</tr>
<tr>
<td>3/8</td>
<td>LB</td>
<td>CBC-12-12F/S</td>
<td>IWLB-CBC-2-1213F/S</td>
</tr>
<tr>
<td>7/16</td>
<td>LB</td>
<td>CBC-12-14F/S</td>
<td>IWLB-CBC-2-1416F/S</td>
</tr>
<tr>
<td>1/2</td>
<td>LB</td>
<td>CBC-13-16F/S</td>
<td>IWLB-CBC-2-1416F/S*</td>
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**MB Nosecaps**

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<th>Puller</th>
<th>New Part Number</th>
<th>Old Part Number</th>
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<td>MB</td>
<td>CBC-22-12F/S</td>
<td>IWMB-CBC-2-1213F/S</td>
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<td>MB</td>
<td>CBC-22-14F/S</td>
<td>IWMB-CBC-2-1416F/S</td>
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<td>IWMB-CBC-2-1416F/S</td>
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<td>MB</td>
<td>CBC-23-18F/S</td>
<td>IWMB-CBC-3-1821F/S</td>
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<td>CBC-23-20F/S</td>
<td>IWMB-CBC-3-1821F/S</td>
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<td>MB</td>
<td>CBC-24-22F/S</td>
<td>IWMB-CBC-3-2225F/S</td>
</tr>
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<td>MB</td>
<td>CBC-24-24F/S</td>
<td>IWMB-CBC-3-2225F/S</td>
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<td>CBC-24-26F/S</td>
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**BB Nosecaps**

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<td>IWBB-CBC-3-5253F/S</td>
</tr>
<tr>
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<td>IWBB-CBC-3-5455F/S</td>
</tr>
<tr>
<td>1-3/4</td>
<td>BB</td>
<td>CBC-33-56F/S</td>
<td>IWBB-CBC-3-5657F/S</td>
</tr>
</tbody>
</table>

* Incompatible with 16-1, 16-2, and 16-3 mandrels.
### 5.0 CA Tooling for CX in Titanium and High Strength Steel

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<th>Page</th>
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</thead>
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<td>5.2</td>
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<tr>
<td>5.5</td>
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</tr>
</tbody>
</table>

For complete CA Tooling specifications please visit our online technical library at [www.fatiguetech.com/technical-library.asp](http://www.fatiguetech.com/technical-library.asp) and download FTI Spec 8101, or contact your nearest FTI Representative. Product specifications include a system overview, structure requirements, installation procedure, and a tooling selection guide.
The CA series of Split Sleeve Cold Expansion (SsCx) tooling is designed to cold expand holes in titanium and high strength steels (up to 160 ksi). A slightly higher applied expansion, as compared to the CB series of tooling for aluminum, is specified for these materials; requiring special high strength mandrels. This system of tooling is used for both production and rework applications and has been called out for several aircraft service bulletins.

CA tooling is available in nominal and 1/64-inch oversize hole diameters between 1/8 and 45/64 inch. Final hole diameters greater than 45/64 inch require special 2-sided cold expansion tooling and may require applied expansions specifically tailored to the particular application. For special applications or sizes not covered in this Tool Catalog, please contact our Customer Service Department for assistance.
1. Drill starting hole.

2. Ream starting hole.

3. Check starting hole diameter.

4. Inspect mandrel.

5. Slide split sleeve over mandrel.

6. Insert mandrel and split sleeve into starting hole.

7. Place nosecap firmly against workpiece.

8. Cold expand hole by pulling the mandrel through the pre-lubricated split sleeve.

9. Remove distorted sleeve.

10. Verify cold expansion.

11. Finish ream hole.

12. Install fastener.
**5.3 STDN SELECTION TABLE FOR NEW HOLES**

**How to select the Standard Tool Diameter Number:**

1. Determine the final fastener diameter in Column 1.
2. Move across to Column 2 to select the proper STDN.
3. Using this STDN, select the proper set of tooling from Tables 5.5A and 5.5B.

**Note:** For metric conversions refer to Table A.2 in the Appendix.

**Table 5.3A**

<table>
<thead>
<tr>
<th>Reference Final Fastener Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Maximum Allowable Finished Hole Diameter (inch)</th>
</tr>
</thead>
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<td>Minimum</td>
<td>Maximum</td>
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<tr>
<td>1/8</td>
<td>.110</td>
<td>.127</td>
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<tr>
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<td>3/16</td>
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<td>13/64</td>
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<td>7/32</td>
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<tr>
<td>27/64</td>
<td>.394</td>
<td>.397</td>
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</table>

Continued on next page...
**How to Select Your Standard Tool Diameter Number:**

1. Determine the final fastener diameter in Column 1.
2. Move across to Column 2 to select the proper STDN.
3. Using this STDN, select the proper set of tooling from Tables 5.5A and 5.5B.

**Note:** For metric conversions refer to Table A.2 in the Appendix.

**Table 5.3A (Continued)**

**CA Tooling STDN Selection for New Holes**

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<th>Reference Final Fastener</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter (inch)</th>
<th>Maximum Allowable Finished Hole Diameter (inch)</th>
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<td></td>
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**Note:** For sizes greater than 45/64, contact FTI for technical assistance.
Table 5.4A has been designed to assist with STDN selection for existing fastener holes in rework conditions. Every aircraft manufacturer has guidelines for fastener removal, crack removal, and hole preparation that should be followed. Use this table to select an STDN using either your existing fastener or required final fastener as a guide. Note that the STDNs chosen in Column 3 have been chosen for minimal ream allowances.

<table>
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<th>Nominal Existing Fastener Diameter (in.)</th>
<th>Allowable Existing Diameter Before Cx (in.)</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter Minimum</th>
<th>Starting Hole Diameter Maximum</th>
<th>Final Fastener Diameter (in.)</th>
<th>Maximum Finished Hole Diameter (not to exceed) (in.)</th>
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</table>

Continued on next page...
To select the STDN using Table 5.4A, use the following steps:

1. Remove the existing fastener and measure the resulting hole diameter.
2. If a minimal amount of material is to be removed, select the STDN from Column 3 that corresponds to the existing hole diameter in Column 2.
3. If you wish to install a larger required final fastener, find the final fastener size in Column 5 and select the corresponding STDN from Column 3.
4. Using the STDN, select the tooling from Tables 5.5A and 5.5B on the following pages.

### Table 5.4A(Continued)
**CA Tooling STDN Selection for Rework of Existing Holes**

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<th>Nominal Existing Fastener Diameter (inch)</th>
<th>Allowable Existing Diameter Before Cx (inch)</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Hole Diameter</th>
<th>Final Fastener Diameter (inch)</th>
<th>Maximum Finished Hole Diameter (not to exceed) (inch)</th>
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<td>.638</td>
<td>.641</td>
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<td>110</td>
<td>.653</td>
<td>.656</td>
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<td>.672</td>
<td>45/64 .7340</td>
</tr>
</tbody>
</table>

- UNCONTROLLED IF PRINTED -
1. To select a Standard Tool Diameter Number refer to Table 5.3A or 5.4A.

2. With the STDN, select the system of Standard Tooling from Table 5.5A.

3. Refer to Section 2.0, Detailed Tooling for complete description of part.

4. Replace **** in gage finish reamer model number with the minimum final hole diameter.

### Table 5.5A

<table>
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<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
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</table>

* All CA cutting tools are cobalt, unless otherwise specified.

Continued on next page...
## Table 5.5A(Continued)  
**Standard CA Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Flared Sleeve</th>
<th>Mandrel</th>
<th>Nosecap Assembly</th>
<th>Gage Finish Reamer</th>
</tr>
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<tbody>
<tr>
<td>20 CAS-20-16F</td>
<td>CAM-20-1-30-V2</td>
<td>MEN-14A-0401F</td>
<td>CAR-20-1-.*****</td>
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</tr>
<tr>
<td>21 CAS-21-16F</td>
<td>CAM-21-1-30-V2</td>
<td>MEN-14A-0401F</td>
<td>CAR-21-1-.*****</td>
<td></td>
</tr>
<tr>
<td>22 CAS-22-16F</td>
<td>CAM-22-1-30-V2</td>
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<td>CAR-22-1-.*****</td>
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</tr>
<tr>
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<td>CAM-23-1-30-V2</td>
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<td>CAR-23-1-.*****</td>
<td></td>
</tr>
<tr>
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<td>CAM-30-1-30-V2</td>
<td>MEN-14A-0601F</td>
<td>CAR-30-1-.*****</td>
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<td>CAR-31-1-.*****</td>
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<tr>
<td>43 CAS-43-16F</td>
<td>CAM-43-1-40-V2</td>
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<tr>
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<td>CAM-50-1-40-V2</td>
<td>MEN-14A-1001F</td>
<td>CAR-50-1-.*****</td>
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<td>CAM-51-1-40-V2</td>
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<tr>
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<td>CAR-52-1-.*****</td>
<td></td>
</tr>
</tbody>
</table>

* All CA cutting tools are cobalt.
**** Denotes final hole diameter to be determined by customer.
1. To select a Standard Tool Diameter Number refer to Table 5.3A and 5.4A.
2. With the STDN, select the system of Standard Tooling from Table 5.5B.
3. Refer to Section 2.0, Detailed Tooling for complete description of part.
4. Replace **** in gage finish reamer model number with the minimum final hole diameter.

**Note:** This tooling may not be maintained in stock.

**Note:** STDN 60 and above use CBCE nosecap assemblies as indicated.

### Table 5.5B
**Standard CA Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
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<tbody>
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<td>CAMG-111</td>
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</table>

* All CA cutting tools are cobalt, unless otherwise specified.

Continued on next page...
### Table 5.5B (Continued)

#### Standard CA Tooling

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Flared Sleeve</th>
<th>Mandrel</th>
<th>Nosecap Assembly</th>
<th>Gage Finish Reamer</th>
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<tr>
<td>60 CAS-60-16F</td>
<td>CAM-60-2-60-V2</td>
<td>MEN-26B-1201F</td>
<td>CAR-60-1-.****</td>
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</tr>
<tr>
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<td>CAM-61-2-60-V2</td>
<td>MEN-26B-1201F</td>
<td>CAR-61-1-.****</td>
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</tr>
<tr>
<td>63 CAS-63-16F</td>
<td>CAM-63-2-60-V2</td>
<td>MEN-26B-1223F</td>
<td>CAR-63-1-.****</td>
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<tr>
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<td>CAM-70-2-60-V2</td>
<td>MEN-26B-1401F</td>
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</tr>
<tr>
<td>71 CAS-71-16F</td>
<td>CAM-71-2-60-V2</td>
<td>MEN-26B-1401F</td>
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</tr>
<tr>
<td>72 CAS-72-16F</td>
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<td>MEN-26B-1423F</td>
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<td>CAR-91-1-.****</td>
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<td>CAR-93-1-.****</td>
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</tr>
<tr>
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<td>MEN-26B-2001F</td>
<td>CAR-100-1-.****</td>
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</tr>
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<td>CAR-102-1-.****</td>
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<td>MEN-26C-2023F</td>
<td>CAR-103-1-.****</td>
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<td>MEN-26C-2201F</td>
<td>CAR-110-1-.****</td>
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<tr>
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<td>MEN-26C-2201F</td>
<td>CAR-111-1-.****</td>
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</tr>
</tbody>
</table>

* All CA cutting tools are cobalt.

**** Denotes final hole diameter to be determined by customer.
6.0 CR TOOLING

CR TOOLING FOR REWORK Cx
IN ALUMINUM AND MILD STEEL

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Process Description</td>
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<tr>
<td>6.2 Process Overview</td>
<td>157</td>
</tr>
<tr>
<td>6.3 STDN Selection Table</td>
<td>158</td>
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<tr>
<td>6.4 Standard Tooling</td>
<td>159</td>
</tr>
<tr>
<td>6.5 Countersink Tooling</td>
<td>160</td>
</tr>
</tbody>
</table>

For additional information on CR Tooling specifications please contact your nearest FTI Representative.
**6.1 PROCESS DESCRIPTION**

The Rework Cold Expansion (RwCx) tooling system, CR series, was specifically designed for rework applications. However, CR series tooling is also acceptable for new holes in the 3/16 to 3/8-inch diameter range. A system of standard tooling for nominal starting hole diameters has been developed for this split sleeve hole expansion process to simplify the procedure and minimize tooling inventory. (Use of RwCx tooling for new holes is the same as that described for the standard SsCx process using CB tooling.)

In rework, the procedure involves the removal of fasteners, clean up of the hole (and Non Destructive Inspection if applicable), pre-sizing the hole, split sleeve cold expansion, and post-sizing of the hole to accept a nominal 1/32-inch oversize fastener. Previously countersunk holes must be cold expanded using the special CsCx nosecap and straight sleeves.

A special tooling kit of durable and expendable CR tooling required to cold expand the most common hole sizes in aluminum structures may be purchased in a special Cold Expansion Overhaul and Repair Kit (CXORK-2A).
1. Drill starting hole.

2. Ream starting hole.

3. Check starting hole diameter.

4. Inspect mandrel.

5. Slide split sleeve over mandrel.

6. Insert mandrel and split sleeve into starting hole.

7. Place nosecap firmly against workpiece.

8. Cold expand hole by pulling the mandrel through the pre-lubricated split sleeve.

9. Remove distorted sleeve.

10. Verify cold expansion.

11. Finish ream hole.

12. Install fastener.
How to select the Standard Tool Diameter Number:

1. Determine the final fastener diameter (1), or the existing fastener diameter (4).
2. Select the applicable size from Table 6.3A.
4. With STDN go to Table 6.4A to determine the proper set of tooling.

### Table 6.3A

**CR Tooling STDN Selection**

<table>
<thead>
<tr>
<th>Reference Final Fastener (inch)</th>
<th>Final Hole Diameter Range (inch)</th>
<th>Standard Tool Diameter Number (inch)</th>
<th>Existing Fastener Diameter (inch)</th>
<th>Maximum Existing Hole Diameter (inch)</th>
<th>Minimum Starting Hole Diameter</th>
<th>Maximum Starting Hole Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16</td>
<td>.182 to .192</td>
<td>R30</td>
<td>5/32</td>
<td>.164</td>
<td>.169</td>
<td>.171</td>
</tr>
<tr>
<td>7/32</td>
<td>.214 to .224</td>
<td>R32</td>
<td>3/16</td>
<td>.194</td>
<td>.199</td>
<td>.202</td>
</tr>
<tr>
<td>1/4</td>
<td>.245 to .255</td>
<td>R40</td>
<td>13/64, 7/32</td>
<td>.224</td>
<td>.229</td>
<td>.232</td>
</tr>
<tr>
<td>9/32</td>
<td>.276 to .286</td>
<td>R42</td>
<td>1/4</td>
<td>.255</td>
<td>.260</td>
<td>.263</td>
</tr>
<tr>
<td>5/16</td>
<td>.307 to .317</td>
<td>R50</td>
<td>17/64, 9/32</td>
<td>.285</td>
<td>.290</td>
<td>.293</td>
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<tr>
<td>11/32</td>
<td>.339 to .349</td>
<td>R52</td>
<td>5/16</td>
<td>.317</td>
<td>.322</td>
<td>.325</td>
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<td>3/8</td>
<td>.370 to .380</td>
<td>R60</td>
<td>21/64, 11/32</td>
<td>.347</td>
<td>.352</td>
<td>.355</td>
</tr>
</tbody>
</table>
1. To select a Standard Tool Diameter Number refer to Table 6.3A.

2. With the STDN, select the system of Standard Tooling from Table 6.4A.

3. Refer to Section 2.0, Detailed Tooling for complete description of parts.

### Table 6.4A
**Standard CR Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
<th>Flared Sleeve</th>
</tr>
</thead>
<tbody>
<tr>
<td>R30</td>
<td>CRSD-R30-1</td>
<td>CRSR-R30-1</td>
<td>CRG-R30</td>
<td>CRMG-R30</td>
<td>CRS-R30-16F</td>
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<tr>
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<td>CRSD-R32-1</td>
<td>CRSR-R32-1</td>
<td>CRG-R32</td>
<td>CRMG-R32</td>
<td>CRS-R32-16F</td>
</tr>
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<td>CRSD-R40-1</td>
<td>CRSR-R40-1</td>
<td>CRG-R40</td>
<td>CRMG-R40</td>
<td>CRS-R40-16F</td>
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<td>CRSD-R42-1</td>
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<td>CRMG-R42</td>
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<td>CRMG-R50</td>
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### Table 6.4A
**Standard CR Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Mandrel</th>
<th>Nosecap Assembly</th>
<th>Gage Finish Reamer*</th>
<th>Final Hole Gage**</th>
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</thead>
<tbody>
<tr>
<td>R30</td>
<td>CRM-R30-1-30-V1</td>
<td>MEN-14A-0423F</td>
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<tr>
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<td>CFRG-R32-1-.<strong><strong>/</strong></strong></td>
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<td>CRM-R40-1-40-V1</td>
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<td>CRR-R40-1-.****</td>
<td>CFRG-R40-1-.<strong><strong>/</strong></strong></td>
</tr>
<tr>
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<td>MEN-14A-0823F</td>
<td>CRR-R42-1-.****</td>
<td>CFRG-R42-1-.<strong><strong>/</strong></strong></td>
</tr>
<tr>
<td>R50</td>
<td>CRM-R50-1-40-V1</td>
<td>MEN-14A-1001F</td>
<td>CRR-R50-1-.****</td>
<td>CFRG-R50-1-.<strong><strong>/</strong></strong></td>
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<td>R60</td>
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<td>MEN-14A-1201F</td>
<td>CRR-R60-1-.****</td>
<td>CFRG-R60-1-.<strong><strong>/</strong></strong></td>
</tr>
</tbody>
</table>

* The diameter of the gage finish reamer, (represented by the last four digits in the model number, .****) is to be specified by customer.

** The go/no-go measurements of the final hole gage (represented by the last eight digits in the model number, .****/****) are designed to accommodate the final hole diameter.
To cold expand pre-countersunk holes, substitute the CRM mandrel, MEN nosecap, and flared sleeve with the KRM mandrel, KRC nosecap, and straight sleeve found in Table 6.5A.

### Table 6.5A

**Alternative Tooling for Countersunk Holes**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Countersink Mandrel</th>
<th>Countersink Nosecap Assembly</th>
<th>Straight Sleeve</th>
<th>Backup Block*</th>
</tr>
</thead>
<tbody>
<tr>
<td>R30</td>
<td>KRM-R30-1-35-V1</td>
<td>KRC-R30-1A</td>
<td>CRS-R30-24S</td>
<td>KRBB-R30-1</td>
</tr>
<tr>
<td>R32</td>
<td>KRM-R32-1-35-V1</td>
<td>KRC-R32-1A</td>
<td>CRS-R32-24S</td>
<td>KRBB-R32-1</td>
</tr>
<tr>
<td>R40</td>
<td>KRM-R40-1-35-V1</td>
<td>KRC-R40-1A</td>
<td>CRS-R40-24S</td>
<td>KRBB-R40-1</td>
</tr>
<tr>
<td>R42</td>
<td>KRM-R42-1-35-V1</td>
<td>KRC-R42-1A</td>
<td>CRS-R42-24S</td>
<td>KRBB-R42-1</td>
</tr>
<tr>
<td>R50</td>
<td>KRM-R50-1-35-V1</td>
<td>KRC-R50-1A</td>
<td>CRS-R50-24S</td>
<td>KRBB-R50-1</td>
</tr>
<tr>
<td>R52</td>
<td>KRM-R52-1-35-V1</td>
<td>KRC-R52-1A</td>
<td>CRS-R52-24S</td>
<td>KRBB-R52-1</td>
</tr>
<tr>
<td>R60</td>
<td>KRM-R60-1-35-V1</td>
<td>KRC-R60-1A</td>
<td>CRS-R60-24S</td>
<td>KRBB-R60-1</td>
</tr>
</tbody>
</table>

* The backup block is necessary when cold expanding countersunk holes in thin materials. Contact our Customer Service Department for more information.
### Cx2s Tooling

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Process Description</td>
<td>162</td>
</tr>
<tr>
<td>7.2 Process Overview</td>
<td>163</td>
</tr>
</tbody>
</table>

For additional information on Cx2s Tooling specifications please contact your nearest FTI Representative.
The Split Sleeve Cold Expansion to Size System (Cx2s) simultaneously cold expands and final sizes holes and, if required, cold expands a countersink using the CsCx nose-cap. Standard Cx2s tooling provides holes that result in specific amounts of fastener interference, or clearance, when used with standard fastener diameters (e.g., Hi-Lok™ or equivalent). Use of the Cx2s system reduces cold expansion processing to only one step, as compared to the basic Split Sleeve Cold Expansion system (SsCx). Although the Cx2s system is designed primarily for new production applications it has also been shown to be effective in rework applications. It is ideal for incorporating cold expansion into automated drilling/fastener insertion systems.

Tooling is selected based on:

1. The material(s) being cold expanded to size
2. The required fastener fit
3. The type of fastener system being used

Use of the appropriate Cx2s tooling results in a cold expanded hole with a .0015-inch total tolerance, better than that typically associated with conventional drilling/reaming operations.

FTI's Cx2s tooling that is designed to provide fastener fits in most of the common aerospace aluminum alloys. These fasteners range from high interference to clearance fit, Hi-Loks™, Huck blind bolts, and equivalent diameter fasteners for each fastener type. Fatigue Technology can design Cx2s Tooling for special applications. Contact your nearest FTI Representative for more information.
1. Drill starting hole.

2. Ream starting hole.

3. Check starting hole diameter.

4. Inspect mandrel.

5. Slide split sleeve over mandrel.

6. Insert mandrel and split sleeve into starting hole.

7. Place nosecap firmly against workpiece.

8. Cold expand hole by pulling the mandrel through the pre-lubricated split sleeve.

9. Remove distorted sleeve.

10. Verify cold expansion.

11. Install fastener.
8.0 CsCx Tooling

CsCx IN ALUMINUM

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For complete CsCx Tooling specifications please visit our online technical library at www.fatiguetech.com/technical-library.asp and download FTI Spec 8101, or contact your nearest FTI Representative. Product specifications include a system overview, structure requirements, installation procedure, and a tooling selection guide.
Figure 8.1
CsCx System Components

The Countersink Cold Expansion (CsCx) system of tooling is designed to simultaneously cold expand the countersink and the straight portion of a hole in new production or rework applications. The system is designed to be used in aluminum alloys and will coldwork countersunk holes from 3/16 to 27/64 inch diameters. A special nosecap and mandrel is used to cold expand 100-degree countersinks. Use of the CsCx nosecap assembly eliminates the requirement to machine countersinks subsequent to cold expansion as required by the Split Sleeve Cold Expansion process. The desired final hole diameter is obtained by reaming of the cold expanded hole, or by use of the Split Sleeve Cold Expansion to Size (Cx2s) system.

For special applications or sizes not covered in this tooling catalog, please contact our Customer Service Department.
1. Drill starting hole.

2. Ream starting hole.

3. Cut countersink.

4. Check starting hole diameter.

5. Inspect mandrel.

6. Cold expand hole - slide split sleeve over mandrel.

7. Insert mandrel and sleeve into starting hole with backup block (if necessary).

8. Place nosecap firmly against the workpiece.

9. Cold expand hole by pulling the mandrel through the pre-lubricated split sleeve.

10. Remove distorted sleeve.

11. Verify cold expansion.

12. Final ream hole (if necessary).

13. Install fastener.
If you are using CsCx tooling with the SsCx system, use Table 8.3A to select the STDN and Table 8.4A to select the tooling.

If you are using CsCx tooling with the Cx2s system, use Tables 8.3B to 8.3E to select the STDN and Table 8.4B to select the tooling.

1. Determine the final fastener diameter (1), or the existing fastener diameter (4).
2. Select the applicable size from Table 8.3A.
4. With the STDN go to Table 8.4A to determine system of tooling.

Note: For metric conversion refer to Table A.2A and A.2B in Appendix A.

**Table 8.3A**

CsCx Tooling STDN Selection

<table>
<thead>
<tr>
<th>Reference Final Fastener (inch)</th>
<th>Final Hole Diameter Range (inch)</th>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Existing Fastener Diameter (inch)</th>
<th>Maximum Existing Hole Diameter (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16</td>
<td>.183 to .193</td>
<td>4-4-N</td>
<td>5-32</td>
<td>.159</td>
</tr>
<tr>
<td>13/64</td>
<td>.198 to .208</td>
<td>6-0-N</td>
<td>5/32</td>
<td>.167</td>
</tr>
<tr>
<td>7/32</td>
<td>.214 to .224</td>
<td>6-1-N</td>
<td>11/64</td>
<td>.182</td>
</tr>
<tr>
<td>15/64</td>
<td>.229 to .239</td>
<td>6-2-N</td>
<td>3/16</td>
<td>.199</td>
</tr>
<tr>
<td>1/4</td>
<td>.245 to .255</td>
<td>6-3-N</td>
<td>13/64</td>
<td>.215</td>
</tr>
<tr>
<td>17/64</td>
<td>.261 to .271</td>
<td>8-0-N</td>
<td>7/32</td>
<td>.225</td>
</tr>
<tr>
<td>9/32</td>
<td>.276 to .286</td>
<td>8-1-N</td>
<td>15/64</td>
<td>.241</td>
</tr>
<tr>
<td>19/64</td>
<td>.292 to .302</td>
<td>8-2-N</td>
<td>1/4</td>
<td>.256</td>
</tr>
<tr>
<td>5/16</td>
<td>.308 to .318</td>
<td>8-3-N</td>
<td>17/64</td>
<td>.273</td>
</tr>
<tr>
<td>21/64</td>
<td>.323 to .333</td>
<td>10-0-N</td>
<td>9/32</td>
<td>.287</td>
</tr>
<tr>
<td>11/32</td>
<td>.339 to .349</td>
<td>10-1-N</td>
<td>19/64</td>
<td>.303</td>
</tr>
<tr>
<td>23/64</td>
<td>.354 to .364</td>
<td>10-2-N</td>
<td>5/16</td>
<td>.318</td>
</tr>
<tr>
<td>3/8</td>
<td>.370 to .380</td>
<td>10-3-N</td>
<td>21/64</td>
<td>.334</td>
</tr>
<tr>
<td>25/64</td>
<td>.386 to .396</td>
<td>12-0-N</td>
<td>11/32</td>
<td>.349</td>
</tr>
<tr>
<td>13/32</td>
<td>.401 to .411</td>
<td>12-1-N</td>
<td>23/64</td>
<td>.365</td>
</tr>
<tr>
<td>27/64</td>
<td>.417 to .427</td>
<td>12-2-N</td>
<td>3/8</td>
<td>.381</td>
</tr>
<tr>
<td>7/16</td>
<td>.433 to .443</td>
<td>12-3-N</td>
<td>25/64</td>
<td>.396</td>
</tr>
</tbody>
</table>
If you are using CsCx tooling with the SsCx system, use Table 8.3A to select the STDN and Table 8.4A to select the tooling.

If you are using CsCx tooling with the Cx2s system, use Tables 8.3B to 8.3E to select the STDN and Table 8.4B to select the tooling.

**HOW TO DETERMINE THE STANDARD TOOL DIAMETER NUMBER:**

1. Determine the Material Code based upon the material to be cold expanded to size.

**Table 8.3B**

*CsCx (2s) Material Code*

<table>
<thead>
<tr>
<th>Material Code</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Material</td>
<td>NA</td>
<td>7178-T6</td>
<td>7075-T6</td>
<td>7050-T73</td>
<td>7075-T73</td>
<td>2024-T3</td>
<td>NA</td>
</tr>
</tbody>
</table>

2. Determine the Fastener Code based upon the fastener system to be used.

**Table 8.3C**

*CsCx (2s) Fastener Code*

<table>
<thead>
<tr>
<th>Fastener Code</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Material</td>
<td>Hi-Lok or equivalent diameter</td>
<td>NA</td>
<td>Huck blind bolts or equivalent diameter</td>
</tr>
</tbody>
</table>

3. Determine the Fastener Interference Level Code based upon the desired fastener fit.

**Table 8.3D**

*CsCx (2s) Fastener Interference Level Code*

<table>
<thead>
<tr>
<th>Fastener Interference Level Code</th>
<th>1 Light</th>
<th>2 High</th>
<th>3 Transition</th>
<th>4 Clearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum possible fastener interference range, inches (expected range)</td>
<td>.0010 to .0035</td>
<td>.0025 to .0050</td>
<td>.0005 to .0020</td>
<td>.0040 to .0000</td>
</tr>
</tbody>
</table>

(0015 to .0020) | (0030 to .0035) | (.0000 to .0005) | (.0015 to .0020) |
4. Determine the **Fastener Diameter Code** based upon the fastener size to be used.

![Table 8.3E](image)

**Table 8.3E**

**Fastener Diameter Code**

<table>
<thead>
<tr>
<th>Reference Final Fastener</th>
<th>Hi-Lok or Equivalent Diameter</th>
<th>Huck Blind Bolt or Equivalent Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/8</td>
<td>40</td>
<td>NA</td>
</tr>
<tr>
<td>9/64</td>
<td>41</td>
<td>NA</td>
</tr>
<tr>
<td>5/32</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>11/64</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>3/16</td>
<td>60</td>
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<td>63</td>
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<td>82</td>
<td>NA</td>
</tr>
<tr>
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<td>83</td>
<td>NA</td>
</tr>
<tr>
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<td>100</td>
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<td>11/32</td>
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<td>NA</td>
</tr>
<tr>
<td>23/64</td>
<td>103</td>
<td>NA</td>
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<tr>
<td>3/8</td>
<td>120</td>
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<td>121</td>
</tr>
<tr>
<td>13/32</td>
<td>122</td>
<td>NA</td>
</tr>
<tr>
<td>27/64</td>
<td>123</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA = Not Applicable.

5. Construct the CsCx2s STDN.

6. With the STDN, go to Table 8.4A to determine the system of tooling.
1. To select a Standard Tool Diameter Number, refer to Table 8.3A.
2. With the STDN, select the system of Standard Tooling from the table below.
3. Refer to Section 2.0 Detailed Tooling for complete description of part.
4. To replace ****, refer to the subsection on Gage Finish Reamers in Section 2.0, Detailed Tooling.

### Table 8.4A

**Standard CsCx Tooling**

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-0-N</td>
<td>CBSD-4-0-N-1</td>
<td>CBSR-4-0-N-1</td>
<td>CBG-4-0-N-1</td>
<td>CBMG-4-0-N</td>
</tr>
<tr>
<td>4-1-N</td>
<td>CBSD-4-1-N-1</td>
<td>CBSR-4-1-N-1</td>
<td>CBG-4-1-N-1</td>
<td>CBMG-4-1-N</td>
</tr>
<tr>
<td>4-2-N</td>
<td>CBSD-4-2-N-1</td>
<td>CBSR-4-2-N-1</td>
<td>CBG-4-2-N-1</td>
<td>CBMG-4-2-N</td>
</tr>
<tr>
<td>4-3-N</td>
<td>CBSD-4-3-N-1</td>
<td>CBSR-4-3-N-1</td>
<td>CBG-4-3-N-1</td>
<td>CBMG-4-3-N</td>
</tr>
<tr>
<td>4-4-N</td>
<td>CBSD-4-4-N-1</td>
<td>CBSR-4-4-N-1</td>
<td>CBG-4-4-N-1</td>
<td>CBMG-4-4-N</td>
</tr>
<tr>
<td>6-0-N</td>
<td>CBSD-6-0-N-1</td>
<td>CBSR-6-0-N-1</td>
<td>CBG-6-0-N-1</td>
<td>CBMG-6-0-N</td>
</tr>
<tr>
<td>6-1-N</td>
<td>CBSD-6-1-N-1</td>
<td>CBSR-6-1-N-1</td>
<td>CBG-6-1-N-1</td>
<td>CBMG-6-1-N</td>
</tr>
<tr>
<td>6-2-N</td>
<td>CBSD-6-2-N-1</td>
<td>CBSR-6-2-N-1</td>
<td>CBG-6-2-N-1</td>
<td>CBMG-6-2-N</td>
</tr>
<tr>
<td>6-3-N</td>
<td>CBSD-6-3-N-1</td>
<td>CBSR-6-3-N-1</td>
<td>CBG-6-3-N-1</td>
<td>CBMG-6-3-N</td>
</tr>
<tr>
<td>8-0-N</td>
<td>CBSD-8-0-N-1</td>
<td>CBSR-8-0-N-1</td>
<td>CBG-8-0-N-1</td>
<td>CBMG-8-0-N</td>
</tr>
<tr>
<td>8-1-N</td>
<td>CBSD-8-1-N-1</td>
<td>CBSR-8-1-N-1</td>
<td>CBG-8-1-N-1</td>
<td>CBMG-8-1-N</td>
</tr>
<tr>
<td>8-2-N</td>
<td>CBSD-8-2-N-1</td>
<td>CBSR-8-2-N-1</td>
<td>CBG-8-2-N-1</td>
<td>CBMG-8-2-N</td>
</tr>
<tr>
<td>8-3-N</td>
<td>CBSD-8-3-N-1</td>
<td>CBSR-8-3-N-1</td>
<td>CBG-8-3-N-1</td>
<td>CBMG-8-3-N</td>
</tr>
<tr>
<td>10-0-N</td>
<td>CBSD-10-0-N-1</td>
<td>CBSR-10-0-N-1</td>
<td>CBG-10-0-N-1</td>
<td>CBMG-10-0-N</td>
</tr>
<tr>
<td>10-1-N</td>
<td>CBSD-10-1-N-1</td>
<td>CBSR-10-1-N-1</td>
<td>CBG-10-1-N-1</td>
<td>CBMG-10-1-N</td>
</tr>
<tr>
<td>10-2-N</td>
<td>CBSD-10-2-N-1</td>
<td>CBSR-10-2-N-1</td>
<td>CBG-10-2-N-1</td>
<td>CBMG-10-2-N</td>
</tr>
<tr>
<td>10-3-N</td>
<td>CBSD-10-3-N-1</td>
<td>CBSR-10-3-N-1</td>
<td>CBG-10-3-N-1</td>
<td>CBMG-10-3-N</td>
</tr>
<tr>
<td>12-0-N</td>
<td>CBSD-12-0-N-1</td>
<td>CBSR-12-0-N-1</td>
<td>CBG-12-0-N-1</td>
<td>CBMG-12-0-N</td>
</tr>
<tr>
<td>12-1-N</td>
<td>CBSD-12-1-N-1</td>
<td>CBSR-12-1-N-1</td>
<td>CBG-12-1-N-1</td>
<td>CBMG-12-1-N</td>
</tr>
<tr>
<td>12-2-N</td>
<td>CBSD-12-2-N-1</td>
<td>CBSR-12-2-N-1</td>
<td>CBG-12-2-N-1</td>
<td>CBMG-12-2-N</td>
</tr>
<tr>
<td>12-3-N</td>
<td>CBSD-12-3-N-1</td>
<td>CBSR-12-3-N-1</td>
<td>CBG-12-3-N-1</td>
<td>CBMG-12-3-N</td>
</tr>
</tbody>
</table>

Continued on next page...
### Standard CsCx Tooling

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Straight Sleeve</th>
<th>Countersink Mandrel</th>
<th>Countersink Nosecap</th>
<th>Gage Finish Reamer</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-0-N</td>
<td>CBS-6-0-N-24S</td>
<td>KBM-6-0-N-1-35-V1</td>
<td>KBC-060-1A</td>
<td>CBR-6-0-N-1-****</td>
</tr>
<tr>
<td>6-1-N</td>
<td>CBS-6-1-N-24S</td>
<td>KBM-6-1-N-1-35-V1</td>
<td>KBC-061-1A</td>
<td>CBR-6-1-N-1-****</td>
</tr>
<tr>
<td>6-2-N</td>
<td>CBS-6-2-N-24S</td>
<td>KBM-6-2-N-1-35-V1</td>
<td>KBC-062-1A</td>
<td>CBR-6-2-N-1-****</td>
</tr>
<tr>
<td>6-3-N</td>
<td>CBS-6-3-N-24S</td>
<td>KBM-6-3-N-1-35-V1</td>
<td>KBC-063-1A</td>
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</table>

*** Denotes final hole diameter to be determined by customer.
1. To select a Standard Tool Diameter Number, refer to Table 8.3A.

2. With the STDN, select the system of Standard Tooling from the Table 8.4B.

3. Refer to Section 2.0 Detailed Tooling for complete description of part.

4. To replace ****, refer to the subsection on Gage Finish Reamers in Section 2.0 Detailed Tooling.

Table 8.4B
Standard CsCx Tooling

<table>
<thead>
<tr>
<th>Standard Tool Diameter Number (STDN)</th>
<th>Starting Drill</th>
<th>Starting Reamer</th>
<th>Combination Gage</th>
<th>Mandrel Gage</th>
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<td>CBSR-14-0-N-1</td>
<td>CBG-14-0-N-1</td>
<td>CBMG-14-0-N</td>
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Continued on next page...
# 8.4 Standard Tooling

**Table 8.4B (Continued)**

### Standard CsCx Tooling

<table>
<thead>
<tr>
<th>Tool Diameter Number (STDN)</th>
<th>Straight Sleeve</th>
<th>Countersink Mandrel</th>
<th>Countersink Nosecap</th>
<th>Gage Finish Reamer</th>
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</tbody>
</table>

**** Denotes final hole diameter to be determined by customer.
For complete ForceMate engineering specifications please contact your nearest FTI Representative. Product specifications include a system overview, structure requirements, installation procedure, and a tooling selection guide.
Fatigue Technology’s patented ForceMate® system (FmCx™) provides an alternative to traditional interference fit bushing installation methods. The FmCx system consists of integrated technology and tooling, including FmCx bushings, mandrels, nosecaps, gages, support assemblies, cutting tools, puller units, special fixturing, as well as product training. Successful implementation and process effectiveness are ensured through use of the complete FTI FmCx system. Benefits include:

- **Reduced Installation Costs:**
  - Eliminates the need for cryogenic liquids
  - Significantly reduces installation labor.

- **Significant Fatigue Life Enhancement:**
  - Beneficial residual compressive stresses are created around the hole when the bushing is installed with high interference.

- **Increased Corrosion Resistance:**
  - High interference fit precludes the intrusion of corrosion materials between the bushing and the hole wall.
  - Initial clearance fit ensures that corrosion protection coatings (e.g., cadmium plating) remain intact.

- **High Resistance to Rotation and Pushout:**
  High interference fit provides greater resistance to rotation or pushout than conventional bushing installation techniques.

The FmCx system can be used wherever interference fit bushing installation is required, regardless of fatigue enhancement requirements. Although the system has been primarily designed for use in metallic materials, FmCx has also demonstrated effectiveness in composite materials.

The FmCx system involves drawing an oversize mandrel through a pre-positioned clearance-fit bushing, internally pre-lubricated by an FTI proprietary process. The bushing is then reamed to the required hole diameter. The resulting interference fit of the bushing, coupled with simultaneous cold working of the metal surrounding the hole, produces a typical fatigue life improvement of 300 percent or better.

The FmCx system consists of two processes:

- **The ForceMate Standard System**
- **The ForceMate Special System**

The FmCx Standard System consists of technology that provides installations in aluminum structure that are equivalent in size to the National Aerospace Standards (NAS) for straight and flanged press-fit bushings in both standard and metric sizes.

The FmCx Special System consists of technology that allows implementation of the FmCx system for unique applications. Both of these systems are described completely in Fatigue Technology’s ForceMate Specification FTI-9901.
9.1 SYSTEM OVERVIEW

Use of the FmCx system involves cold expanding an initially clearance fit bushing into a prepared starting hole. A specially sized bushing, with a proprietary lubricant on the inside surface, is placed over a tapered expansion mandrel. The attachment end of the mandrel is inserted into a puller unit. The mandrel/bushing assembly is then placed in the hole, and the puller unit is activated to pull the mandrel through the bushing. The expansion of the bushing by the mandrel cold works the base material while the bushing is simultaneously installed with high interference.

The inside surface of the bushing after FmCx processing has a slightly tapered profile. After the mandrel is pulled through the bushing, the bushing is reamed to the desired final inside diameter. The reaming operation also removes the lubricant residue from the bushing. If the condition of the final bushing inside diameter after FmCx processing is acceptable, the final sizing operation may be eliminated.
1. Prepare starting hole.

2. Place bushing onto mandrel.

3. Insert mandrel into puller unit. Place mandrel and bushing into the workpiece.

4. Activate puller unit to install the bushing.

5. Machine bushing inside diameter to final size.
For complete ForceTec engineering specifications please visit our online technical library at [www.fatiguetechnology.com/technical-library.asp](http://www.fatiguetechnology.com/technical-library.asp) or contact your nearest FTI Representative. Product specifications include; a system overview, structure requirements, installation procedure, and a tooling selection guide.
The ForceTec System is designed to quickly and consistently install rivetless nut plates with high interference using Split Sleeve Cold Expansion Technology. The ForceTec System is designed to expand a retainer into a single starting hole, eliminating the need for satellite rivet holes, countersinking, or swaging. The retainer is capable of holding a range of common thread locking nuts. The fatigue life of the hole is enhanced due to the elimination of the satellite holes and the expansion of the retainer into the hole, imparting residual compressive stresses into the surrounding material. The ForceTec Standard System can accommodate 3/16, 1/4, 5/16, 3/8, 7/16, and 1/2-inch fastener diameters in material as thin as 0.060 inch for the 3/16 inch size retainer, and thickness up to 1.5 inch for open configuration and 1.49 inch for sealed configuration. If you have any questions regarding ForceTec or size requirements outside these parameters, please contact our Customer Service Department.
1. Check the starting hole using blade end of the combination gage.

2. Slide the split sleeve over the tapered mandrel.

3. Insert the retainer into the starting hole from the back and insert the mandrel/sleeve assembly through the retainer from the front.

4. Seat the nosecap firmly against the workpiece and activate the puller unit to pull the mandrel through the sleeve/retainer assembly.

5. Remove and discard the used split sleeve.

6. Check the final hole diameter using the round end of the combination gage.

7. If required, trim the protruding portion of the retainer to length using the trimming tool.

8. Install the nut into the retainer without removing the clip.
11.0

For GromEx overview, process, and engineering specifications please contact your nearest FTI Representative. Product specifications include a system overview, structure requirements, installation procedure, and a tooling selection guide.
### TOOLING KITS

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<td>12.6 Mobile Tooling Cabinets</td>
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</table>
Enhanced Stop Drill Repair

Stop drilling of a hole at the tip of a fatigue crack is frequently used to temporarily retard the propagation of the crack until a permanent repair is made. As a result of extensive research and development using Split Sleeve Cold Expansion technology, the StopCrack Enhanced Stop Drill Repair (ESDR) System offers an improvement over traditional stop drilling techniques, substantially reducing the likelihood that a stop drilled crack will reinitiate at the hole.

StopCrack does not replace stop drilling. Designed as a complete kit for efficient use by mechanics and maintenance personnel, StopCrack uses a unique system to cold expand a stop drilled hole. This process shields the hole from the effects of cyclic tensile loads by imparting residual compressive stresses around the circumference of the hole. This is accomplished without adding weight to or changing the metallic characteristics of the structure.

StopCrack Kit FTI Part Number: FTI-SCK-A1

Included in each StopCrack kit is everything required to stop drill and cold expand 3/16 inch, 1/4 inch, and 17/64 inch holes. For a complete list of kit contents and specifications please contact our Customer Service Department and request FTI Spec 2009-02, StopCrack Enhanced Stop Drill Repair of Cracks in Aluminum.
12.2 SERVICE BULLETINS

Service Bullet Kits and Support
Fatigue Technology provides custom Service Bulletin Kits designed for specific aircraft rework applications. Fatigue Technology is the endorsed and approved supplier of Service Bulletin Cold Working Kits for the following aircraft manufacturers:

* Boeing  
* Airbus  
* Aerospatiale  
* Fokker  
* Lockheed Martin  
* British Aerospace Airbus  
* Airbus Industries  
* ATR

Kits are sold complete with all necessary capital and expendable tooling. Capital tooling may also be rented and is subject to availability. FTI maintains a complete inventory of cold expansion tooling, and can custom design specialized tooling to accommodate any aircraft configuration. All kits are packaged in durable storage containers and are marked for identification in accordance with your requirements. Complete instructions for each Service Bulletin Rework Procedure are included in all kits and training can be provided on-site or at our facility in Seattle (if needed).

For details of all custom tooling kits available or assistance in preparing kits for specific applications, please contact our Customer Service Department at 206-246-2010.

* NOTE: FTI is the only approved source for service bulletin tooling and support for these commercial aircraft manufacturers.
Custom Tooling Kits

Fatigue Technology has in-house tool design and fabrication capabilities that enable us to offer Custom Tooling Kits for easy implementation of the Split Sleeve Cold Expansion System. These kits can be designed for specific applications based on customer-supplied documents, Commercial Service Bulletins, Military Air Frame Changes or Tech Orders, or Engineering Change Proposals. All kits are packaged in durable storage containers and are marked for identification in accordance with your requirements.

- Custom Tooling Kits can be ordered to include any of the following:
- Capital Tooling
- Expendable Tooling
- Instructions for installation or rework procedures
- Training on-site or at our facility in Seattle, Washington
- Kit Proof Engineering Support

For details of all custom tooling kits available or assistance in preparing kits for specific applications, please contact our Customer Service Department at 206-246-2010.
Cold Expansion (Cx) Overhaul and Repair Kits

Most repair and overhaul facilities are now using FTI’s Split Sleeve Cold Expansion (SsCx) System for fatigue life enhancement of fastener holes. The FTI Cx Overhaul and Repair Kits are specifically designed to meet the special requirements of these customers. These kits contain all of the tooling required to cold expand existing hole diameters and allow repair of up to 100 holes of any one diameter (kits are configured to accommodate a specific hole size or sizes).

Additionally, each kit contains our enhanced stop drill repair kit, StopCrack (except CxORK-3 and CxORK-4). This process improves the fatigue life of stop-drilled holes by at least 20:1.

Features

- All tooling is based upon the Rework SsCx System - allowing optimal airframe rework parameters.
- Tooling comes packaged in a sturdy, mobile cabinet with locking wheels.
- Kits contain additional space for special tooling sets (service bulletin or other modification kits).
- Instructions and specifications are included.
- One day of training is included in the price of the kit (not including airfare).
- Includes tooling for nominal hole sizes as well as corresponding oversizes.
- Tooling may also be used for cold expanding reduced edge margin holes, stop drilled holes, countersunk holes, attachment holes in repair doublers, etc.
- Cutting tools, gages, mandrels, nosecaps, and sleeves to treat holes of each size are included.
- Most restricted access holes can be treated using the LBOA offset adapter and extension nosecaps.
- Includes Little Brute Puller Unit and lightweight FT-20 PowerPak.
- Overall dimensions are 42”H X 28”W X 28”L.

See page 190, this section for an example of a typical CXORK Kit (contents list).
Table 12.4A lists all Overhaul and Repair Kits currently available from FTI. The kits are broken down into three categories:

1. CB Tooling Series (Aluminum of Mild Steel)
2. CR Tooling Series (Aluminum Rework)
3. CA Tooling Series (Titanium and High Strength Steel)

The CXORK-1A and 2A kits are complete kits, including countersink tooling. The CXORK-1B and 2B kits do not contain countersink tooling, but can be upgraded to a CXORK-1A or 2A by purchasing the supplemental countersink tooling kits, CXORK-1C or 2C.

*CXORK-1C and 2C contain only supplemental countersink tooling sets.
**CXORK-3A includes second oversize tooling.

For additional information on standard tooling kits, please contact our Customer Service Department.

Fatigue Technology reserves the right to change the configuration of standard kits at any time as part of our product improvement policy. Please contact FTI for the latest kit configurations.
The contents of CXORK - 1A/2A are listed below as an example of a typical CXORK Kit. Additional kits are available for specific applications.

**CXORK - 1A/2A**

1. Four drawer mobile cabinet
2. LB-20 Little Brute hydraulic puller unit
3. FT-20 lightweight hydraulic PowerPak
4. LBOA-20 offset puller adapter
5. Enhanced Stop Drill Repair Kit (StopCrack) for 3/16, 1/4, and 17/64 inch hole diameters

Each StopCrack kit contains:

- 1 HP-20 mechanical puller
- 2 Extension nosecaps
- 8 Starting drills
- 6 Starting reamers
- 3 Combination gages
- 3 Mandrels
- 3 Mandrel gages
- 110 Split sleeves
- 6 Gage finish reamers (rivet holes)
- 6 Gage finish reamers (lockbolt holes)
- 8 Tooling Sets
  - (5/32 inch - 3/8 inch, existing holes diameter range)

Each tooling set contains:

- 1 Tooling set container
- 2 Starting drills (twist)
- 2 Starting reamers
- 1 Combination gage
- 1 Mandrel gage
- 3 Mandrels
- 1 Standard nosecap assembly
- 100 Split sleeves (flared)
- 2 Gage finish reamers
- 1 Final hole gage
- 1 Offset adapter jaw
- 1 *Countersink nosecap
- 100 *Split sleeves (straight)
- 20 *Backup Blocks

*Note:* These items make up the supplementary countersink tooling sets for CXORK-1C/2C.
Figure 12.5A
Tooling Case - FT-BX-C1

Keep individual tooling sizes separate and organized
Holds a complete tooling set up to 14-3-N tooling size:
- 1 Starting Drill
- 1 Starting Reamer
- 1 Combination Gage
- 1 Mandrel Gage
- 1 Mandrel
- 1 Nosecap Assembly
- 1 Finish Reamer

Sleeves:
- 100 Sleeves up to 12-3-N or
- 50 Sleeves 14-x-N

Convenient carry handle for ease of bringing to shop floor
15w” x 11d” x 2.25h” (381mm x 279.4mm x 57.15mm)
Plastic, lightweight and portable

Figure 12.5B
Tooling Case - FT-BX-C2

Keep individual tooling sizes separate and organized
Holds a complete tooling set up to 30-3-N tooling size:
- 1 Starting Drill
- 1 Starting Reamer
- 1 Combination Gage
- 1 Mandrel Gage
- 1 Mandrel
- 1 Nosecap Assembly
- 1 Finish Reamer

Sleeves:
- 200 Sleeves up to 22-3-N or
- 100 Sleeves of larger sizes

Convenient carry handle for ease of bringing to shop floor
15w” x 11d” x 5h” (381mm x 279.4mm x 127mm)
Plastic, lightweight and portable

Double-sided, 1 side open compartment and 1 side comes with dividers identical to FT-BX-C1
### Figure 12.6A
**Mobile Tooling Cabinet - FT-BX-A8**

Holds individual FT-BX-C1 and FT-BX-C2 kit boxes

Holds Capital Tooling equipment
- Capacity with Capital Tooling:
  - 8 FT-BX-C1
  - 4 FT-BX-C2

- Capacity without Capital Tooling:
  - 11 FT-BX-C1
  - 5 FT-BX-C2

Wheels are included for portability

35h” x 28w” x 16d” (889mm x 711.2mm x 406.4mm)
53 lbs stand alone (24.04kg)
Wood construction, plastic coating

### Figure 12.6B
**Mobile Tooling Cabinet - FT-BX-A9**

Holds individual FT-BX-C1 and FT-BX-C2 kit boxes

Holds Capital Tooling equipment
- Capacity with Capital Tooling:
  - 3 FT-BX-C1
  - 1 FT-BX-C2

- Capacity without Capital Tooling:
  - 6 FT-BX-C1
  - 3 FT-BX-C2

Wheels are included for portability

34h” x 17w” x 16d” (863.6mm x 431.8mm x 406.4mm)
41 lbs stand alone (18.6kg)
Wood construction, plastic coating
*Figure 12.6C  
Mobile Tooling Cabinet - 1010-002

2 fixed and 2 swivel 6” x 2” casters with wheel locks

Tubular steel handles for easy mobility

Individual drawer latches

100% extension drawers

4 drawers
13”, 6”, 4”, and 3” depth (330.2mm, 152.4mm, 101.6mm, and 76.2mm)
29w” x 29d” x 42h” (736.6 x 736.6 x 1066.8mm)
332 lbs stand alone (150.6kg)
Metal construction

*Figure 12.6C is of a CXORK-2A tooling kit (see section 12.4)
### ACCESSORIES

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</tr>
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</tbody>
</table>
13.1
ADAPTER KITS

Figure 13.1A
Assembled Nosecap Adapter and Mandrel Adapter

- Tables 13.1A, 13.1B, 13.1C, and 13.1D list puller unit adapters for converting various pullers to FTI associated nosecaps and mandrels.
- Each puller unit adapter assembly includes a nosecap adapter and/or mandrel adapter.

Table 13.1A
Nosecap Adapters

<table>
<thead>
<tr>
<th>Puller Unit</th>
<th>Model Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB-XX</td>
<td>LB/MB-CBC-A2</td>
<td>Allows MB Nosecap to fit LB Pullers</td>
</tr>
<tr>
<td>ST1350A-0XX</td>
<td>ST1350A/CBC-1</td>
<td>Allows FTI LB Nosecap to fit Boeing ST1350A Puller</td>
</tr>
<tr>
<td>MB-XX</td>
<td>MB/BB-CBC-1</td>
<td>Allows BB Nosecap to fit MB Pullers</td>
</tr>
</tbody>
</table>

Table 13.1B
Mandrel Adapters

<table>
<thead>
<tr>
<th>Puller Unit</th>
<th>Model Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB-XX</td>
<td>FTI-MB/LB-A1</td>
<td>Allows Little Brute Mandrel and Nosecap to attach to Medium Brute Puller Unit</td>
</tr>
</tbody>
</table>

Table 13.1C
Nosecap/Mandrel Adapter Sets

<table>
<thead>
<tr>
<th>Puller Unit</th>
<th>Model Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST1350A-XX</td>
<td>ST1350A/LB-1</td>
<td>Adapts FTI Mandrels (-1) and LB Nosecaps to ST1350A-XX Puller</td>
</tr>
<tr>
<td>MB-XX</td>
<td>ST1350C/LB-2</td>
<td>Adapts FTI Mandrels (-1) and LB Nosecaps to -5 MB mandrel adapter/LB nosecap to MB-Z/XX puller</td>
</tr>
</tbody>
</table>
## Table 13.1D
### Adapters for Little Brute, Little Brute Offset, Medium Brute, Medium Brute Offset, and Big Brute

<table>
<thead>
<tr>
<th>Puller Unit</th>
<th>Model Number</th>
<th>Description</th>
<th>Mandrel Thread</th>
<th>Mandrel/Chuck Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Little Brute</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-D10</td>
<td>Threaded Adapter</td>
<td>7/16&quot; x 20 UNF</td>
<td>-1A-HOA</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-D10A</td>
<td>Threaded Adapter</td>
<td>1/2&quot; x 20 UNF</td>
<td>-1A</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-1</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .0730-.0859</td>
<td>-10A</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-2</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .0860-.0989</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-3</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .0990-.1119</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-4</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .1120-.1249</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-5</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .1250-.1379</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-6</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .1380-.1639</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-7</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .1640-.1899</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-8</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .1900-.2159</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-PC-9</td>
<td>Pintail Chuck assy</td>
<td>Mandrel &quot;B&quot;, .2160-.2499</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-CA-4</td>
<td>Tang Chuck assy</td>
<td>Mandrel &quot;B&quot;, .2000-.2999</td>
<td>-1</td>
</tr>
<tr>
<td>LB-XX</td>
<td>LB-CA-6</td>
<td>Tang Chuck assy</td>
<td>Mandrel &quot;B&quot;, .3000-.3999</td>
<td>-1</td>
</tr>
<tr>
<td><strong>Little Brute Offset</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LBOA-XX</td>
<td>5130-001</td>
<td>Pintail Adapter</td>
<td>12-28 UNF</td>
<td>Pintail</td>
</tr>
<tr>
<td>LBOA-XX</td>
<td>LBOA-SA-NUT</td>
<td>Self Alignment Nut</td>
<td>7/16&quot; x 20 UNF</td>
<td>-10A</td>
</tr>
<tr>
<td><strong>Medium Brute</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB-XX</td>
<td>MB-D17</td>
<td>Threaded Adapter</td>
<td>5/8&quot; x 18 UNF</td>
<td>-2, -2OA</td>
</tr>
<tr>
<td>MB-XX</td>
<td>MB-D18</td>
<td>Threaded Adapter</td>
<td>7/8&quot; x 18 UNF</td>
<td>-54</td>
</tr>
<tr>
<td>MB-XX</td>
<td>MB-CA-8</td>
<td>Chuck Assembly</td>
<td>Mandrel &quot;B&quot;, .4000-.5999</td>
<td>-</td>
</tr>
<tr>
<td>MB-XX</td>
<td>MC-CA-11</td>
<td>Chuck Assembly</td>
<td>Mandrel &quot;B&quot;, .6000-.7999</td>
<td>-</td>
</tr>
<tr>
<td>MB-XX</td>
<td>MB/LB-CBM-A2</td>
<td>Threaded Adapter</td>
<td>7/16&quot; x 20 UNF</td>
<td>-1 to 2</td>
</tr>
<tr>
<td>MB-XX</td>
<td>ST1350AC/LB-A</td>
<td>Threaded Adapter</td>
<td>7/16&quot; x 20 UNF</td>
<td>-1 to 2</td>
</tr>
<tr>
<td>MB-XX</td>
<td>-2579001</td>
<td>Threaded Adapter</td>
<td>1/2&quot; x 20 UNF</td>
<td>ST1350 to -2</td>
</tr>
<tr>
<td><strong>Medium Brute Offset</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBOA-XX</td>
<td>2519-001</td>
<td>Threaded Adapter</td>
<td>7/16&quot; x 18 UNF</td>
<td>-5, -4</td>
</tr>
<tr>
<td>MBOA-XX</td>
<td>2519-002</td>
<td>Threaded Adapter</td>
<td>5/8&quot; x 18 UNF</td>
<td>-2, -2OA</td>
</tr>
<tr>
<td>MBOA-XX</td>
<td>2519-003</td>
<td>Threaded Adapter</td>
<td>7/16&quot; x 20 UNF</td>
<td>-1, -1OA, -HOA</td>
</tr>
<tr>
<td><strong>Big Brute</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-A-D35</td>
<td>Threaded Adapter</td>
<td>7/8&quot; x 14 UNF</td>
<td>-5, -4</td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-C-D35</td>
<td>Threaded Adapter</td>
<td>1&quot; x 14 UNS</td>
<td>-</td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-E-D35</td>
<td>Threaded Adapter</td>
<td>5/8&quot; x 18 UNS</td>
<td>-2, -2OA</td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-CA-11</td>
<td>Chuck Assembly</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-CA-16</td>
<td>Chuck Assembly</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>BB-XX</td>
<td>BB-CA-20</td>
<td>Chuck Assembly</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

---

**Accessories**

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13.2 SUPPORT FIXTURES

Figure 13.2A
Expandable Screw Type Support Assembly

Figure 13.2B
Wedge Type Support Assembly
(For multiple lugs)

- Contact FTI Customer Service for assistance in selecting Support Assemblies.

13.3 STROKE LIMITER

Figure 13.3A
Stroke Limiter

Figure 13.3B
Adjustable Stroke Limiter

- Artificially reduces stroke of puller unit in restricted access areas.
- Contact FTI Customer Service for assistance in selecting Support Assemblies.
13.4 Seal Kits and Rework Kits

Table 13.4A
Seal Kits

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB-SK</td>
<td>Little Brute Seal kit</td>
</tr>
<tr>
<td>MB-SK</td>
<td>Medium Brute Seal Kit</td>
</tr>
<tr>
<td>BB-SK</td>
<td>Big Brute Seal Kit</td>
</tr>
</tbody>
</table>

- Contains all wear seals and o-rings for specified puller units.

Table 13.4B
Rework Kits

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB-RK</td>
<td>Little Brute Rework kit</td>
</tr>
<tr>
<td>MB-RK</td>
<td>Medium Brute Rework Kit</td>
</tr>
<tr>
<td>BB-RK</td>
<td>Big Brute Rework Kit</td>
</tr>
</tbody>
</table>

- Contains seal kit (wear seals and o-rings for specified puller units), plus wear parts for trigger, new hydraulic adapter, and air seal adapter.

13.5 Replacement Hoses and Extension Hoses

Table 13.5A
Replacement Hose Assemblies

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IWZY-10</td>
<td>10' Replacement Hose</td>
</tr>
<tr>
<td>IWZY-20</td>
<td>20' Replacement Hose</td>
</tr>
<tr>
<td>IWZY-25</td>
<td>25' Replacement Hose</td>
</tr>
<tr>
<td>IWZY-30</td>
<td>30' Replacement Hose</td>
</tr>
</tbody>
</table>

Table 13.5B
Extension Hose Assemblies

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5005-001</td>
<td>10' Extension Hose</td>
</tr>
<tr>
<td>5005-002</td>
<td>30' Extension Hose</td>
</tr>
</tbody>
</table>

- Used to extend existing hose.
- Features two air lines and one hydraulic line.
- Not recommended for use with FT-20 PowerPak due to increased amount of hydraulic fluid required with additional hose length.
Table 13.6A
HOA Hose Reversal Kit

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2816-001</td>
<td>HOA-6 Reversal Kit</td>
</tr>
<tr>
<td>2816-002</td>
<td>HOA-7 Reversal Kit</td>
</tr>
<tr>
<td>2816-003</td>
<td>HOA-8 Reversal Kit</td>
</tr>
</tbody>
</table>

For use with HOA series of adapters.

- Allows hydraulic hose to be connected at top of adapter in restricted access situations.
- Kit also includes plugs to seal holes on bottom of adapter where hose usually connects.

Figure 13.6A
HOA Reversal Assembly

Figure 13.7A
Remote Trigger

- Part number 2049-007
- For use with FTMP-XX, SB-2A, JB-XX, SB-300X
Figure 13.8A
Bushing Removal Tooling

- Conveniently removes interference fit installed bushing/insert.
- Removes bushings up to 2 inches in diameter.
- Does not damage surrounding structure.
- Compatible with FTI hydraulic puller units.
- Captures the bushing once removed to prevent bushing from being lost inside structure.
- Manufactured from high-strength steel alloy for function and durability.

For additional information on bushing removal tooling please reference your tip sheet or contact FTI's Customer Service Department.
### Table 13.8A

**Bushing Removal Tooling**

<table>
<thead>
<tr>
<th>Bushing Inside Diameter (inches)</th>
<th>Puller Unit Options</th>
<th>Rod Model Number</th>
<th>Collar Model Number</th>
<th>Nosecap Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/16 (.188)</td>
<td>Little Brute</td>
<td>BRR-3-4-1</td>
<td>BRC-3-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>7/32 (.219)</td>
<td>Little Brute</td>
<td>BRR-3OS-4-1</td>
<td>BRC-3OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>1/4 (.250)</td>
<td>Little Brute</td>
<td>BRR-44OS-4-1</td>
<td>BRC-4-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>9/32 (.281)</td>
<td>Little Brute</td>
<td>BRR-44OS-4-1</td>
<td>BRC-4OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>5/16 (.313)</td>
<td>Little Brute</td>
<td>BRR-55OS-4-1</td>
<td>BRC-5-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>11/32 (.344)</td>
<td>Little Brute</td>
<td>BRR-55OS-4-1</td>
<td>BRC-50OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>3/8 (.375)</td>
<td>Little Brute</td>
<td>BRR-66OS-4-1</td>
<td>BRC-6-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>13/32 (.406)</td>
<td>Little Brute</td>
<td>BRR-66OS-4-1</td>
<td>BRC-6OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>7/16 (.438)</td>
<td>Little Brute</td>
<td>BRR-78OS-4-1</td>
<td>BRC-7-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>15/32 (.476)</td>
<td>Little Brute</td>
<td>BRR-78OS-4-1</td>
<td>BRC-7OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>1/2 (.500)</td>
<td>Little Brute</td>
<td>BRR-78OS-4-1</td>
<td>BRC-8-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>17/32 (.531)</td>
<td>Little Brute</td>
<td>BRR-78OS-4-1</td>
<td>BRC-80OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>9/16 (.563)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-9-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>19/32 (.594)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-9OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>5/8 (.625)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-10-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>21/32 (.656)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-10OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>11/16 (.688)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-11-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>23/32 (.719)</td>
<td>Medium Brute</td>
<td>BRR-911OS-4-1</td>
<td>BRC-11OS-50</td>
<td>BRN-L-*</td>
</tr>
<tr>
<td>3/4 (.750)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-12-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>25/32 (.781)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-12OS-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>13/16 (.813)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-13-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>27/32 (.844)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-13OS-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>7/8 (.875)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-14-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>29/32 (.906)</td>
<td>Medium Brute</td>
<td>BRR-1214OS-4-2</td>
<td>BRC-14OS-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>15/16 (.938)</td>
<td>Medium Brute</td>
<td>BRR-1523OS-4-5</td>
<td>BRC-15-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td>31/32 (.969)</td>
<td>Big Brute</td>
<td>BRR-1523OS-4-5</td>
<td>BRC-15OS-50</td>
<td>BRN-M-*</td>
</tr>
</tbody>
</table>

* There must be at least .030 inch of clearance between the bushing outside diameter (flange if applicable) and nosecap inside diameter. Refer to Table 13.8E for nosecap inside diameter.
Table 13.8A (Continued)
Bushing Removal Tooling

<table>
<thead>
<tr>
<th>Bushing Inside Diameter (inches)</th>
<th>Puller Unit Options</th>
<th>Rod Model Number</th>
<th>Collar Model Number</th>
<th>Nosecap Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1.000)</td>
<td>Medium Brute</td>
<td>BRR-1523OS-4-2</td>
<td>BRC-16-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-16-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>33/32 (1.031)</td>
<td>Medium Brute</td>
<td>BRR-1523OS-4-2</td>
<td>BRC-16OS-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-16OS-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>17/16 (1.063)</td>
<td>Medium Brute</td>
<td>BRR-1523OS-4-2</td>
<td>BRC-17-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-17-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>35/32 (1.094)</td>
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<td>BRR-1523OS-4-2</td>
<td>BRC-17OS-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-17OS-50</td>
<td>BRN-B-*</td>
</tr>
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<td>BRC-18-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>37/32 (1.156)</td>
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<td>BRR-1523OS-4-2</td>
<td>BRC-18OS-50</td>
<td>BRN-M-*</td>
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<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-18OS-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>19/16 (1.188)</td>
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<td>BRR-1523OS-4-2</td>
<td>BRC-19-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
<td>Big Brute</td>
<td>BRR-1532OS-4-5</td>
<td>BRC-19-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
<td>39/32 (1.219)</td>
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<td>BRR-1523OS-4-2</td>
<td>BRC-19OS-50</td>
<td>BRN-M-*</td>
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<td>BRC-19OS-50</td>
<td>BRN-B-*</td>
</tr>
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<td>BRC-20-50</td>
<td>BRN-M-*</td>
</tr>
<tr>
<td></td>
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<td>BRR-1532OS-4-5</td>
<td>BRC-20-50</td>
<td>BRN-B-*</td>
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<td>BRC-20OS-50</td>
<td>BRN-B-*</td>
</tr>
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<td>21/16 (1.313)</td>
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<td>BRC-21-50</td>
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</tr>
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<td>BRC-21OS-50</td>
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<td>BRC-23-50</td>
<td>BRN-B-*</td>
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</table>

* There must be at least .030 inch of clearance between the bushing outside diameter (flange if applicable) and nosecap inside diameter. Refer to Table 13.8E for nosecap inside diameter.
### Table 13.8A (Continued)
**Bushing Removal Tooling**

<table>
<thead>
<tr>
<th>Bushing Inside Diameter (inches)</th>
<th>Puller Unit Options</th>
<th>Rod Model Number</th>
<th>Collar Model Number</th>
<th>Nosecap Model Number</th>
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<td>25/16 (1.563)</td>
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<td>13/8 (1.625)</td>
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<td>BRC-26-50</td>
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<td>53/32 (.1.656)</td>
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<td>BRC-26OS-50</td>
<td>BRN-B-*</td>
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<td>BRR-1532OS-4-5</td>
<td>BRC-27-50</td>
<td>BRN-B-*</td>
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<td>55/32 (1.719)</td>
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<td>BRR-1532OS-4-5</td>
<td>BRC-27OS-50</td>
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<td>7/4 (1.750)</td>
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<td>BRC-28-50</td>
<td>BRN-B-*</td>
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<td>BRC-28OS-50</td>
<td>BRN-B-*</td>
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<td>29/16 (1.813)</td>
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<td>BRR-1532OS-4-5</td>
<td>BRC-29-50</td>
<td>BRN-B-*</td>
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<td>59/32 (1.844)</td>
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<td>BRC-29OS-50</td>
<td>BRN-B-*</td>
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<td>15/8 (1.875)</td>
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<td>BRC-30-50</td>
<td>BRN-B-*</td>
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<td>BRC-30OS-50</td>
<td>BRN-B-*</td>
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<td>BRC-31OS-50</td>
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</tr>
<tr>
<td>2 (2.000)</td>
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<td>BRC-32-50</td>
<td>BRN-B-*</td>
</tr>
<tr>
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<td>BRC-32OS-50</td>
<td>BRN-B-*</td>
</tr>
</tbody>
</table>

* There must be at least .030 inch of clearance between the bushing outside diameter (flange if applicable) and nosecap inside diameter. Refer to Table 13.8E for nosecap inside diameter.

---

**Figure 13.8B**
**Bushing Removal Rod**

Model Number

```
BRR - 12 14OS - 4 - 2
```

- **Rod**
- **Puller unit attachment code**
  1 = Little Brute
  2 = Medium Brute
  3 = Big Brute
- **Bushing length in 1/2-inch increments**
  (maximum 2 inches)

Note: Separate Bushing Removal Rods are required for 3/16 and 7/32 inside diameter bushings. For other sizes, the rods are common to more than one size.
13.8
BUSHING REMOVAL TOOL

**Figure 13.8C**
Bushing Removal Collar

<table>
<thead>
<tr>
<th>Model Number</th>
<th>BRC - 8 - 50</th>
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</thead>
<tbody>
<tr>
<td>Collar</td>
<td></td>
</tr>
<tr>
<td>Minimum bushing wall thickness</td>
<td></td>
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</tbody>
</table>

**Figure 13.8D**
Bushing Removal Nosecap

<table>
<thead>
<tr>
<th>Model Number</th>
<th>BRN - L - 1.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nosecap</td>
<td></td>
</tr>
<tr>
<td>Nosecap barrel diameter</td>
<td></td>
</tr>
<tr>
<td>Puller unit attachment code</td>
<td></td>
</tr>
<tr>
<td>L = Little Brute</td>
<td></td>
</tr>
<tr>
<td>M = Medium Brute</td>
<td></td>
</tr>
<tr>
<td>B = Big Brute</td>
<td></td>
</tr>
</tbody>
</table>

Knurled for hand tightening
Threaded for attachment to the rod
Direction of pull
Step which reacts removal force
Inside diameter of barrel
Threads for puller unit attachment

Accessories
Page 204
### Table 13.8E
BRT Nosecap Inside Diameter

<table>
<thead>
<tr>
<th>Applicable Puller Unit Size</th>
<th>Nosecap Inside Diameter</th>
<th>Nosecap Model Number</th>
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<tbody>
<tr>
<td>Little Brute</td>
<td>.75</td>
<td>BRN-L-.75</td>
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<td>BRN-L-1.00</td>
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<tr>
<td>Little Brute</td>
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<td>BRN-L-1.50</td>
</tr>
<tr>
<td>Little Brute</td>
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<td>BRN-L-2.00</td>
</tr>
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<td>BRN-M-1.00</td>
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<tr>
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<td>BRN-M-1.50</td>
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<tr>
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<td>BRN-B-1.50</td>
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<tr>
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<td>BRN-B-2.00</td>
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<td>BRN-B-2.50</td>
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<td>BRN-B-3.00</td>
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<tr>
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<td>BRN-B-3.50</td>
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<tr>
<td>Big Brute</td>
<td>4.00</td>
<td>BRN-B-4.00</td>
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</table>
## Appendix A

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.1 Glossary of Terms</td>
<td>207</td>
</tr>
<tr>
<td>A.2 STDN Metric Conversion Table</td>
<td>210</td>
</tr>
<tr>
<td>A.3 Subject Index</td>
<td>212</td>
</tr>
</tbody>
</table>
**Applied Expansion:** The total expansion of the hole during cold expansion, expressed as a percentage of the starting hole diameter.

**Back Taper:** The portion of the mandrel that allows the mandrel to gradually enter a hole when cold expanding.

**Backside Clearance:** The distance from the back of the hole to the nearest obstruction.

**Base Material:** The material in which the hole is to be cold worked using the Split Sleeve Cold Expansion or the ForceMate Systems.

**CA:** Model number prefix for tooling used in titanium and high strength steel.

**Capital Tooling:** Includes puller units, PowerPaks, and adapters.

**CB:** Model number prefix for tooling used in aluminum or mild steels.

**Cold Expanded Hole Diameter:** The diameter of a hole after cold expansion, defined as the minimum diameter measured along an axial line oriented 90 degrees from the location of the axial ridge left by the split in the sleeve.

**Cold Expansion System (Cx):** A series of patented systems used to extend the fatigue life of metal structures (SsCx, Cx2s, CsCx, FmCx, ScCx, RwCx, FtCx, GrCx, BlCx).

**Cold Expansion to Size (Cx2s):** A process whereby holes are cold expanded and final sized in one operation, without the need for post sizing (final reaming).

**Cold Working (Cold Expansion):** A process whereby fatigue or crack growth life of a hole is improved due to the creation of residual compressive stresses around the hole.

**Controlling Documents:** The engineering specifications used to document the Cx processes.

**Countersink Cold Expansion (CsCx):** Split Sleeve Cold Expansion of an existing countersunk hole in aluminum.

**CR:** Model number prefix for tooling used in rework applications in aluminum.

**Critical Tooling Dimensions:** Any tooling dimension that contributes to the applied expansion of a hole or to a related quality assurance inspection.

**CsCx:** Trademark used to indentify the FTI Split Sleeve Countersink Cold Expansion system.

**Cx:** Trademark used to indentify all the FTI Cold Expansion systems.

**Cx2s:** Trademark used to indentify the FTI Cold Expansion to Size system.

**Durable Tooling:** Includes cutting tools, mandrels, nosecap assemblies, combination gages, and mandrel gages.

**Enhanced Stop Drill Repair:** A system using FTI’s StopCrack procedure, which extends the fatigue life of stop drilled holes.

**Existing Hole Diameter (EHD):** The inside diameter of the hole prior to any operation involved in the Cx process.
Expendable Tooling: Includes all split sleeves and backup blocks.

Fatigue: The failure of metal structure due to cyclic tensile stresses which are usually far less than the yield strength of the material and due to stress concentrations such as fastener holes.

Fatigue Life Enhancement: A process that improves the fatigue life of metal structures.

Final Hole Diameter (FHD): The inside hole diameter of the base material after Cx processing and final sizing operations are complete.

FmCx: Trademark used to identify the FTI ForceMate system.

ForceMate (FmCx): A system of tooling used to install bushings with high interference while simultaneously cold working the material surrounding the bushed hole.

ForceTec (FtCx): A system of tooling used to install a rivetless nut plate while simultaneously cold working the material surrounding the hole.

Front Taper: The portion of the mandrel that allows the sleeve to slide on easily.

Front Side Clearance: The distance from the front of the hole to the nearest obstruction.

FtCx: Trademark used to identify the FTI ForceTec system.

FTI: Fatigue Technology (a Registered Trademark).

GrCx: Trademark used to identify the FTI GromEx system.

GromEx (GrCx): A grommet installation system designed to use low applied expansion to install grommets to protect fastener holes in composites.

KB: Model number prefix for tooling used for countersunk applications in aluminum (mandrels and nosecaps only).

KB2: Model number prefix for tooling used for Split Sleeve Cold Expansion to Size in aluminum.

Lateral Clearance: The distance from the edge of the hole to the nearest obstruction.

Mandrel Flat: The length of the major diameter of a mandrel.

Mandrel Nose: The section of the mandrel beyond the stackup portion. Consisting of the back taper, major diameter, and front taper.

Mandrel "B" Diameter: The minor diameter of a mandrel, also where the sleeve is placed prior to cold expanding a hole.

Mandrel "D" Diameter: The major diameter of a mandrel.

Material Stackup: The combined thickness of a structure through which a hole is located; also the total length of a hole.

OAL: Overall length.

Overall Length (OAL): The total length of a tool.
Pull Force: The amount of force required for a puller unit to pull a mandrel through a hole.

ScCx: Trademark used to indentify the StopCrack Split Sleeve Cold Expansion system.

Short Front Taper: A shortened nose length on a mandrel for severely restricted back-side clearance problems.

Split Sleeve Cold Expansion (SsCx): Deep cold expansion of the metal around a hole using FTI’s system of tooling.

SsCx: Trademark used to indentify the FTI Split Sleeve Cold Expansion system.

Standard Tool Diameter Number (STDN): The tool code used to identify a specific size of tooling.

Starting Hole Diameter (SHD): The specified hole diameter, in the base material, before using one of the Cx processes.

STDN: Standard Tool Diameter Number.

StopCrack (ScCx): A system for significantly improving the effectiveness of the stop drill technique used to retard propagation of cracks in structural components.
For complete information on Cx2s engineering requirements, refer to Process Specification FTI-8201.

*Note:* When there are two tooling numbers for the same size reference fastener, the tooling number with the smallest existing fastener diameter should be used if a high fastener interference is desired.

### Table A.2A
**Metric Conversion**

<table>
<thead>
<tr>
<th>Reference Final Fastener (in MM)</th>
<th>Standard Tool Diameter Number</th>
<th>Existing Fastener Diameter (in MM)</th>
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<td>3.5</td>
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*Note:* When there are two tooling numbers for the same size reference fastener, the tooling number with the smallest existing fastener diameter should be used if a high fastener interference is desired.

For complete information on Cx2s engineering requirements, refer to Process Specification FTI-8201.
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