Casing Annulus Packers and Accessories

• Stop Annular Gas Migration
• Multiple Stage Cementing
• One Trip–Cement the Radius Horizontal Completions
• Zone Isolation
• Scab Liners

TAM INTERNATIONAL
Inflatable and Swellable Packers

ISO 9001: 2008 Certified Company
Product Profile

TAM International manufactures and services one of the widest ranges of inflatable Casing Annulus Packers (CAP™) and accessories. TAM products and services enable more effective and efficient zone isolation in a wide spectrum of downhole conditions and operational requirements.

TAM inflatable Casing Annulus Packers range from 1.90-in. to 20-in. with seal lengths from 3-ft to 35-ft. TAM packer applications include a variety of drilling, completion and workover operations. In addition to standard products as described in this brochure, TAM has developed a reputation for designing, verifying and manufacturing special customer-specific products.

What is a CAP?

Casing Annulus Packers (CAP) are inflatable down hole tools installed on the outside diameter of a pup joint of casing or casing mandrel. The CAP includes an inflation control valve mechanism to inflate the element and create a seal between the casing mandrel and open hole or previously set casing string.

Why run a CAP?

Casing Annulus Packers (CAP) are superior for a wide variety of applications where a seal is required between casing and open hole (or previous casing string). Casing Annulus Packers can inflate to greater than 2.5 times their run-in diameters. Casing can be reciprocated with CAP in the string. The greatest advantage is that Casing Annulus Packers enhance customer flexibility in planning a completion.

A CAP can be inflated by straddling the inflation port with a variety of packer setting tools or by simply applying pressure to the entire casing string.

ISO 9001: 2008 Certified

All TAM locations provide quality service and thorough product support. Every customer inquiry is carefully screened by a select team of professionals. Quality system guidelines certified to ISO 9001: 2008 requirements are used to determine which jobs are practical, proper tool selection and field procedures.

To assure product quality and reliable operations, Casing Annulus Packers undergo function testing before shipment. All components are traceable and each product serialized in compliance with ISO requirements down to the maintenance of electronic pressure recordings of all tests with the serial number file.

Two Distinct CAP Constructions

TAMCAP™ and LONGCAP™ Construction

The TAMCAP and LONGCAP products use high strength stainless steel slats to reinforce the full length of the inflatable element. TAMCAP and LONGCAP are available with standard 3-ft (0.9m) and 10-ft (3m) seal lengths. A pliable, oil-resistant elastomer covers the steel reinforcement for effective sealing in open hole. One end of the packer element slides while maintaining a seal to the casing mandrel. TAMCAP and LONGCAP best suit vertical well and low build rate deviated well applications.

XTRACAP™ Construction

The XTRACAP product is partially reinforced with stainless steel slats extending 20-in. from each end of the inflatable element. The slats improve differential pressure capacity and provide extrusion resistance for the elastomer at elevated temperature.

The center section of the inflatable element is a pliable, oil-resistant elastomer bonded to the casing mandrel. The center section design reduces damage from drag loads exerted when passing through the build section of horizontal wells.

The XTRACAP is available with standard seal lengths of 5-ft (1.5m), 10-ft (3m), 20-ft (6.1m) and 35-ft (10.7m). The XTRACAP is the standard product for most horizontal and high Dogleg Severity deviated well applications.

COMMON CAP APPLICATIONS

- For multiple stage cementing in vertical wells, Casing Annulus Packers are placed below the stage tool to support the cement column while it cures.
- To prevent annular gas migration, Casing Annulus Packers above the gas source stop the migration and ensure the integrity of the cement job.
- To separate horizontal wells into segments, slotted liner, screens and blank casing are selectively placed between CAPs. The TAM XTRACAP™ is specially designed for zone isolation below the build section.

CAP, SafeLok, TAMCAP, LONGCAP, XTRACAP & XTRALONGCAP are trademarks of TAM INTERNATIONAL.
General Running Procedure
Casing Annulus Packers make up into the casing string using the same tongs and make up torque as the rest of the string. The casing tally and log correlation determine the correct location of the CAP in the string. Open hole caliper logs also aid in proper location of the CAP with respect to hole conditions.

The valve sub can be located on either end of the inflation element to run in the up or down position. The CAP is inflated by pressuring the casing ID either against a bumped plug or by straddling the inflation port with a Combination Tool. Applied pressure shears the Opening Valve shear pin. Inflation fluid expands the packer element until sufficient pressure inside the element closes the Delta P Valve. Removing pressure from the casing ID activates the SafeLok™ (See page 6) feature, permanently locking the Opening Valve in the closed position.

No Weld One-Piece Mandrel Design
TAM constructs all Casing Annulus Packers using a one-piece casing mandrel with NO hidden internal connections. There is NO welding to the casing mandrel during construction.

This one-piece mandrel construction allows TAM to provide the longest mandrel length of any casing packer.

A long one-piece mandrel reduces side loads when passing through the build section. It also assures premium thread consistency throughout the string and optimum casing physical, tensile and torsional properties.

Built-to-Order CAP
Many customers supply premium threaded pup joints of their casing to TAM and the inflatable Casing Annulus Packers are built on their pipe. This maintains complete integrity and traceability in their string, especially for critical well completions using exotic metals.
Two Distinct CAP Constructions

Couplings are the same as those on the rest of the casing string. Outer layer of oil resistant elastomer. Inflation fluid is pumped between the casing mandrel and the bladder. Thick elastomer layer bonded to casing.

TAMCAP and LONGCAP are fully stainless steel reinforced end-to-end and best suit vertical well and low build rate deviated well applications.

TAM XTRACAP long one-piece mandrel construction reduces side loads when passing through build section.

Full bore opening through the packer.

Couplings are the same as those on the rest of the casing string.
The TAM XTRACAP is partially steel reinforced with 20” stainless steel slats that extend from each end. The center section of the inflatable element is a pliable oil resistant elastomer bonded to the casing mandrel.

The pliable center section of the XTRACAP adapts to the rugged contour of the open hole.
CAP Inflation Valves

SafeLok™ Inflation Valve System

Thousands of difficult CAP installations prove the TAM SafeLok Inflation Valve System’s reliability. TAM uses a proprietary computer program to analyze down-hole conditions and recommend the proper Opening and Delta P (closing) shear pins for any well application. TAM inflation valve systems can be run above or below the inflation element.

Run-In Position

This unique system consists of an Opening Valve (Normally Closed) and a Delta P Valve (Normally Open) as shown in the Run In position drawing. An optional break off rod extends into the casing ID to reduce premature plugging of the inlet ports.

Inflating Position

As shown in the Inflating position drawing, sufficient pressure applied to the casing ID shears the Opening Valve pin and initiates inflation of the packer element.

Inflated (Set) Position

When proper inflation pressure is achieved as determined by a choice of Delta P shear pins, the Delta P valve closes and permanently locks closed by hydraulic forces. This step is shown in the Inflated position drawing.

Locked Set Position

By removing (bleeding) the applied pressure from the casing ID, the Opening Valve mechanically separates and permanently locks in the Closed position as shown in the Locked Set position drawing.
TAM has conducted extensive research on inflation fluid characteristics including water, mud, gases and cement to determine specific application selection.

TAM conducts ongoing research on the CAP product line to define the long-term effects of differential pressure and temperature changes downhole, torsion and tensile load variations and side loading when running through high Dogleg Severity sections of horizontal wells. Research continues with the objective of fully utilizing the CAP product to solve customer problems.

A complete computerized analysis is performed on each CAP application, including the product’s ability:

- To pass through the maximum Dogleg Severity without damage to the CAP (horcomp.xls)
- To function at the bottom-hole conditions of the well (temperature, pressure, fluid exposure) (capsel.xls)
- To expand and seal in the borehole (capsel.xls)
- To control expected differential pressure (capsel.xls)

A minimum 3/8” clearance between open hole ID and CAP OD is recommended.

* Contact the nearest TAM office for a complete computer analysis.

---

**CAP Inflation Process Pressure Chart**

1. OPENING PIN pressure to initiate inflation
2. CLOSING PIN pressure to lock packer inflated

- A Plug bump pressure
- B Bleed pressure to check float and shoe for backflow
- C Pressure up and establish volume marker in displacement tank
- D Increase pressure slowly to shear OPENING PIN valve to inflate
- E Stop pumping, pressure declines and stabilizes as packer inflates
- F Increase pressure to above CLOSING PIN pressure to lock packer set
- G Bleed pressure to same level as C to determine inflation volume
- H Bleed pressure and verify no backflow, job complete
Differential Pressure Rating

Use the chart by drawing a horizontal line from the casing or open hole ID on the right side of the chart to intersect the curve corresponding to selected CAP casing size (OD). Drawing a vertical line to the bottom of the chart from the intersection of the specific CAP curve defines the rated working pressure of the CAP. Where anticipated differential pressures exceed the rated working pressure, the CAP must be inflated with a solidifying fluid such as cement or operations changed to reduce applied differential.
## Casing Size

<table>
<thead>
<tr>
<th>Casing OD A</th>
<th>Product OD B</th>
</tr>
</thead>
<tbody>
<tr>
<td>in.</td>
<td>mm</td>
</tr>
<tr>
<td>1.90</td>
<td>48</td>
</tr>
<tr>
<td>2.38</td>
<td>60</td>
</tr>
<tr>
<td>2.88</td>
<td>73</td>
</tr>
<tr>
<td>3.50(1)</td>
<td>89</td>
</tr>
<tr>
<td>3.50</td>
<td>89</td>
</tr>
<tr>
<td>4.00</td>
<td>102</td>
</tr>
<tr>
<td>4.50</td>
<td>114</td>
</tr>
<tr>
<td>5.00</td>
<td>127</td>
</tr>
<tr>
<td>5.50</td>
<td>140</td>
</tr>
<tr>
<td>5.50(2)</td>
<td>140</td>
</tr>
<tr>
<td>6.63</td>
<td>168</td>
</tr>
<tr>
<td>6.63(2)</td>
<td>168</td>
</tr>
<tr>
<td>7.00</td>
<td>178</td>
</tr>
<tr>
<td>7.63</td>
<td>194</td>
</tr>
<tr>
<td>8.63</td>
<td>219</td>
</tr>
<tr>
<td>9.63</td>
<td>244</td>
</tr>
<tr>
<td>10.75</td>
<td>273</td>
</tr>
<tr>
<td>11.75</td>
<td>298</td>
</tr>
<tr>
<td>13.38</td>
<td>340</td>
</tr>
<tr>
<td>16.00</td>
<td>406</td>
</tr>
<tr>
<td>18.63</td>
<td>473</td>
</tr>
<tr>
<td>20.00</td>
<td>508</td>
</tr>
</tbody>
</table>

(1) Ultra Slim  (2) Dual Layer

### TAMCAP = TC
- full steel reinforced
- 3 ft. inflation element

### LONGCAP = LC
- full steel reinforced
- 10 ft. inflation element

### XTRACAP = XC
- partially reinforced
- 5, 10, or 20 ft. inflation element

---

**Partially Reinforced XTRACAP**

<table>
<thead>
<tr>
<th>5' Seal</th>
<th>10' Seal</th>
<th>20' Seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>C=5' (1.5m)</td>
<td>C=10' (3.1m)</td>
<td>C=20' (6.1m)</td>
</tr>
<tr>
<td>F=15' (4.6m)</td>
<td>F=18'6&quot; (5.7m)</td>
<td>F=30' (9.2m)</td>
</tr>
</tbody>
</table>
**Inflation Tool**

The TAM Inflation Tool is similar to the TAM Combo Tool. The Inflation Tool uses self-energizing seals positioned inside a slightly restrictive polished bore rather than seal cups inside the casing ID. This tool system facilitates all applications where cement or other solidifying fluids are required for inflation of the CAP. A pressure actuated sleeve between seals assures that cement remaining inside the work string is not lost to the wellbore as the tool is pulled uphole to inflate additional Casing Annulus Packers.

The Inflation Tool's special cement wiper plug allows placement of multiple slugs of cement and exact displacement control of inflating fluids. Like the Combo Tool, the same spring-loaded dogs enable depth control accuracy when used in conjunction with a Locator Sub or for manipulation of a Port Collar for stage cementing.
Combination Tool

The TAM Combo Tool features dual opposing seal cups for sealing with the casing ID and spring-loaded dogs to accurately land in a Locator Sub or operate a Port Collar. The Combo Tool contains an internal bypass from above to below the seal cups for ease of running in and out of the well. The Combo Tool can inflate multiple CAP with mud or water and be run as a part of the inner string for “One Trip” completion methods. To achieve circulation through the Combo Tool, a ball or wiper plug is placed on a seat below the tool. A special design Combo Tool with premium tubing threads is available, providing higher tensile and torque strength.

The Combo Tool seal cups seal efficiently inside API casings. Internal polished bores or restrictions are not required in the casing/tubing string.
**Accessories**

**Locator Sub**
Locator Subs provide exact depth control required for locating and inflating multiple CAP. The profile in the full bore inside diameter of the Locator Sub is the same as in the Port Collar. Locator Subs can be run in multiples and in conjunction with Port Collars. The spring-loaded dogs of the Combo Tool or Inflation Tool latch into the recessed profile providing exact positioning of the tool. Applying overpull or slack off assures that the inflation tool is properly positioned.

**Port Collar**
Port Collars offer several unique advantages over conventional stage tools. The full bore Port Collar eliminates the need to “drill out” once the cement is placed. They can be opened and closed multiple times and pressure tested on closure. For corrosive environments and critical casing strings the Port Collar is available with **metal-to-metal** seals.

Rotational type Port Collars (Left hand torque to open - Right hand torque to close) are available for casing sizes 9 5/8” and larger. All other sizes use a sliding sleeve that is opened and closed by applying up and down mechanical forces.

The recessed locator profile in the Port Collar is the same as in Locator Subs and full bore for the pipe weight selected, allowing use of the same Combo Tool or Inflation Tool for CAP inflation and stage cementing. This “One Trip” completion system was developed by TAM in 1990 and has been used in hundreds of horizontal completions.

**Choke Sub**
The Premium Threaded Choke Sub is run with the TAM Premium Combo Tool to stop fluid movement below the Combo Tool.

Once a setting ball is pumped to seat in the Choke Sub, circulation through the tool is stopped, allowing fluid to be directed through the inflation/cementing ports on the Combo Tool.

A secondary seat allows a larger ball to be used in additional operations or in case of premature shearing of the primary ball seat.
Hydraulic Release with Inner String Connection

A modified version of the TAM Hydraulic Release developed in 1984 for coiled tubing operations provides a mechanism for running liners without a conventional liner hanger. The TAM Hydraulic Release allows circulation through the end of the slotted liner or screen and rotating and reciprocating the liner while running into the well. The Hydraulic Release disconnects the liner from the running string at the bottom of the well. While pulling the inner string and Packer Inflation tool up hole, CAP can be inflated and Port Collars can be operated to cement specific sections of the liner. All of these operations and features are standard with the TAM “One Trip” horizontal well completion system.

Wiper Darts

A unique design of cement wipers and landing darts with near 100% displacement efficiency allows the use of a multiplicity of darts. The TAM wiper system pumps through drill pipe, tubing, coiled tubing, inflation tools or any combination of these tubulars.

The landing dart’s proven seal technology provides a bubble-tight seal once the system lands below the inflation tool. A special shearable collet design provides a means to expel the dart and then pump additional darts for continued operations.

Dart Catcher

The Dart Catcher is used in conjunction with the Premium Combo Tool to allow the use of Wiper Darts for accurate fluid placement when cement inflating CAP, and/or performing cement operations through a Port Collar.

It has an integral landing profile for the Wiper Dart to land and latch into that provides a positive indication of when the Wiper Dart lands. Additional pressure shears the Wiper Dart through the profile allowing cement to be pumped around the dart via by-pass ports in the Dart Catcher.
The migration of annular fluids during the cement curing process can leave voids and flow paths in the cement column thus creating interzone communication and even flow of fluids to the surface. Numerous chemical solutions have been developed to combat this problem. The addition of a mechanical seal (CAP) greatly enhances the success rate of stopping fluid migration.

**Without a CAP**

Based on an SPE paper (0149-2136/0081-1206) shown graphically, annular pressure at or near a permeable formation may decline after displacement due to partial cement gel strength development and/or fluid loss from the slurry. If such annular pressure declines to or below the formation pressure, fluid flow from the formation can occur. If such flow continues, permanent flow channels are left in the annular cement thus allowing long term migration of formation fluids.

**With a CAP**

By inflating a CAP immediately after bumping the wiper plug, and thus providing full hydrostatic support, annular pressure decline is rapid but the annular pressure achieves equilibrium with the formation pressure before gel strength develops in the cement and thus no long term flow can occur nor permanent flow channels left in the cured cement column.
**Problem:** Completion requires 2nd stage cementing.

**Solution:** Run HATCH packer. Perform 1st stage cement. Bump plug and inflate CAP. Operate Port Collar. Perform 2nd stage cement job.

**Problem:** Isolate production zone without primary cement.

**Solution:** Run straddle CAP to above and below production zone. Set packer. Perforate pipe & formation.

**Problem:** Annular gas migration.

**Solution:** Run CAP above gas zone. Perform cement job. Bump plug. Inflate CAP.
**Problem:** Selective completion required for production testing.

**Solution:** Run CAP and cement inflate. Operate PC for testing and stimulation.

**Problem:** Open hole bridge plug required to shut off water.

**Solution:** Run CAP with Plug-Retainer Kit. Inflate CAP and release work string. Spot cement on top of plug.
**Problem:** Horizontal well producing water in center of lateral.  

**Solution:** Run scab liner with CAP. Blank pipe to straddle water zone.

**Problem:** Open hole bridge plug required to shut off water.  

**Solution:** Run CAP with Plug-Retainer Kit. Inflate CAP. Release work string. Spot cement on top of plug.
A. Run liner with inner string as shown
   Rotate, reciprocate and circulate as required
B. Circulate ball to choke below inflation tool
C. Pressure up to release from liner
D. Pick up into Locator Sub
E. Pressure up to inflate CAP
F. Release from Locator Sub and move to next CAP
G. Repeat steps D through F as required
H. Locate and open Port Collar
I. Circulate to condition and cement as required
J. Close Port Collar and test
K. Pick up to top of liner and reverse excess cement
L. Complete well
Heavy Duty – Dual Layer CAP
A special design is available which utilizes a dual layer of slats, thus increasing the differential pressure rating more than 2:1 over standard CAP products. In excess of one hundred of these Dual Layer Casing Annulus Packers have been run in horizontal wells over the last two years with only one packer failure.

Differential Pressure Rating
5.50” VE CAP
7 1/2” OD

FREECAP™
In addition to inflatable Casing Annulus Packers described in this brochure, TAM also provides Fluid Reactive Expanding Elastomer Casing Annulus Packers (FREECAP) which expand to provide zone isolation after contact with wellbore fluids. For specific information, refer to the FREECAP brochure.

PLUG-RETAINER KIT
TAM provides a kit that can be adapted to any CAP to convert it to a bridge plug or cement retainer. Uses for this system are shown in application in this brochure. For specific information, contact the nearest TAM office or visit the web site at www.tamintl.com

TAM INTERNATIONAL
Inflatable and Swellable Packers

Phone: 1-800-462-7617  Fax: 1-713-462-1536
1-713-462-7617  E-mail: info@tamintl.com

Worldwide sales and service contacts available at www.tamintl.com