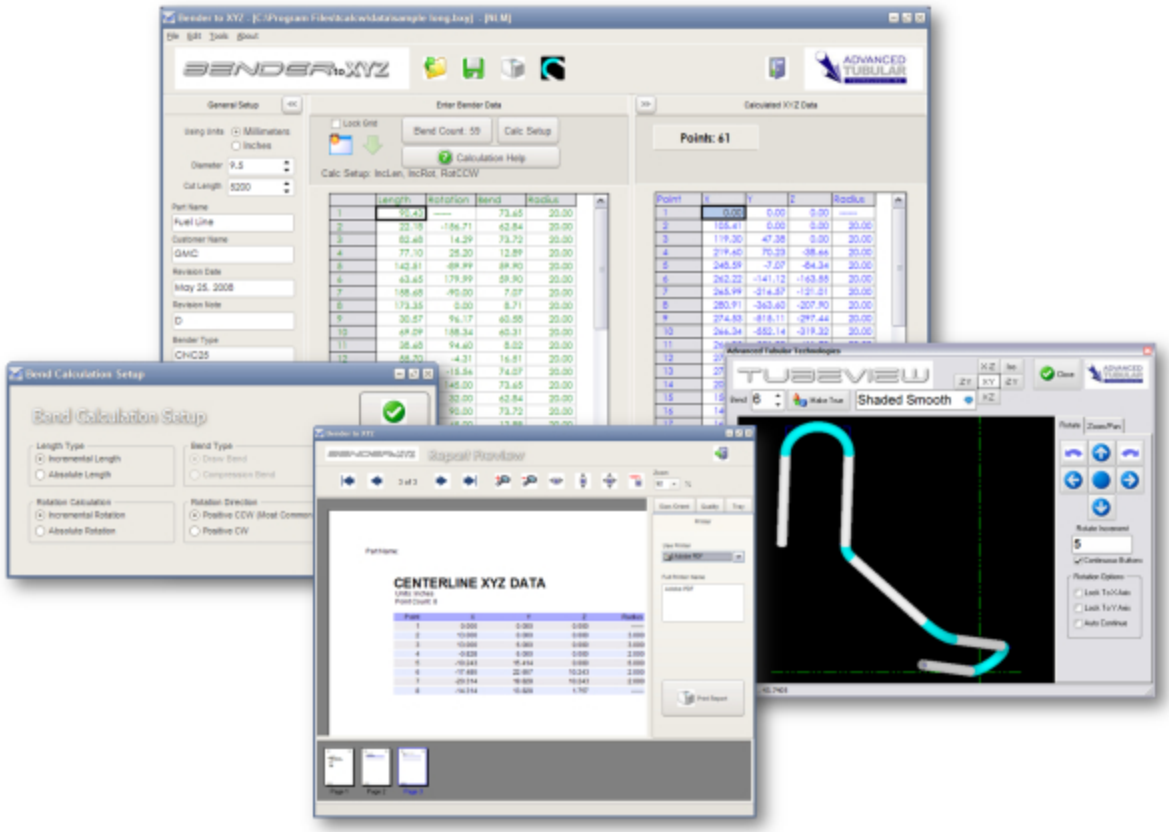
# BENDER to XYZ




ADVANCED TUBULAR TECHNOLOGIES, INC


# Bender to XYZ
# User Guide

*Converts Bender data to Centerline XYZ data.*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# Bender to XYZ Calculator



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# Table of Contents

BENDER to XYZ

# Part I

# 1 Introduction

Bender to XYZ is the most flexible calculator in the world for calculating data from an assortment of bender data types to centerline XYZ coordinates. In fact, there are 12 possible combinations of bender data types.

The choices for bend data entry depend on the following factors:

1. Is the LENGTH data Incremental or Absolute?
2. Is the ROTATION data Incremental or Absolute?
3. Is the BENDING type DRAW or COMPRESSION?
4. Is the ROTATION DIRECTION positive Counter Clockwise or Clockwise?

These four factors control all the possible combinations of bender data that can be entered into Bender to XYZ.

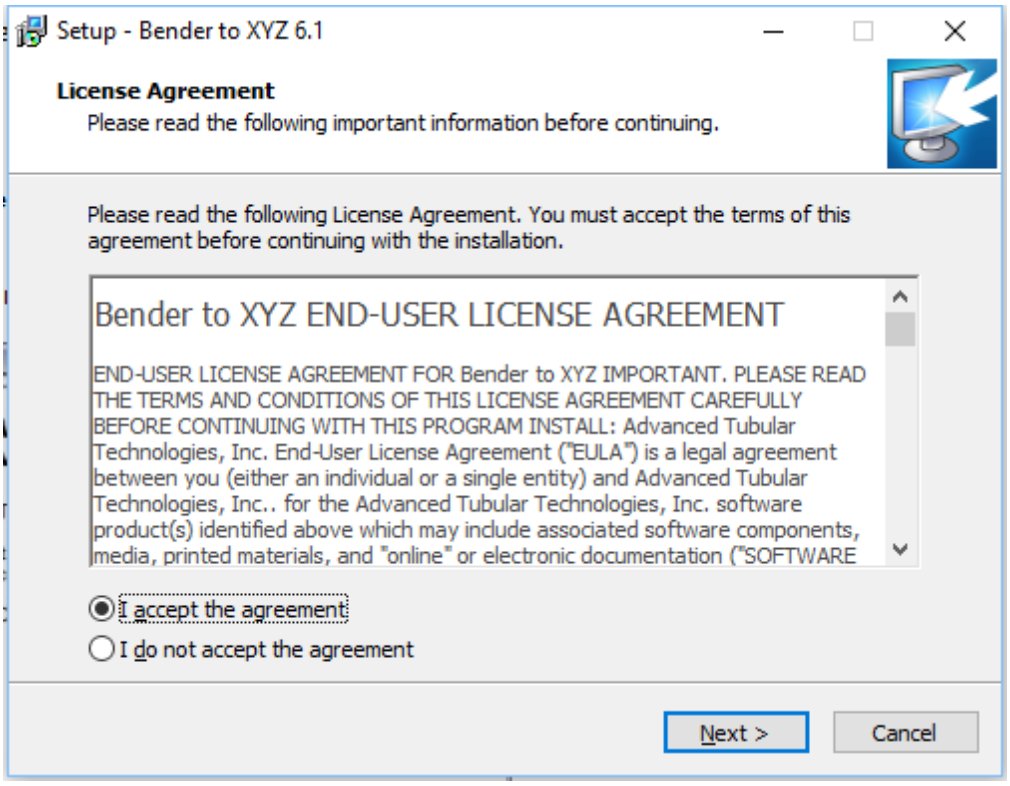
## 1.1 How to Install The Benderlink Software

### STEP 1

Run the setup.exe program.

Click on "I accept the agreement"

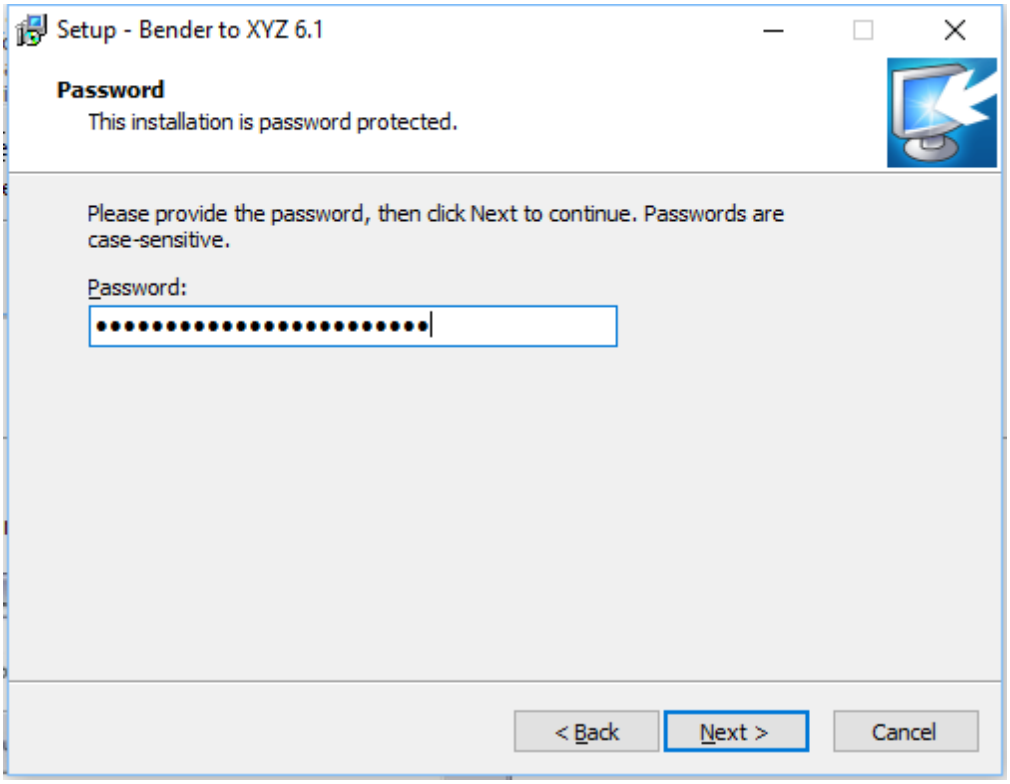
**Press Next**



## STEP 2

Copy the password supplied to you by email. Click on the Password field, then press "Ctrl-V" key combination to paste the password.

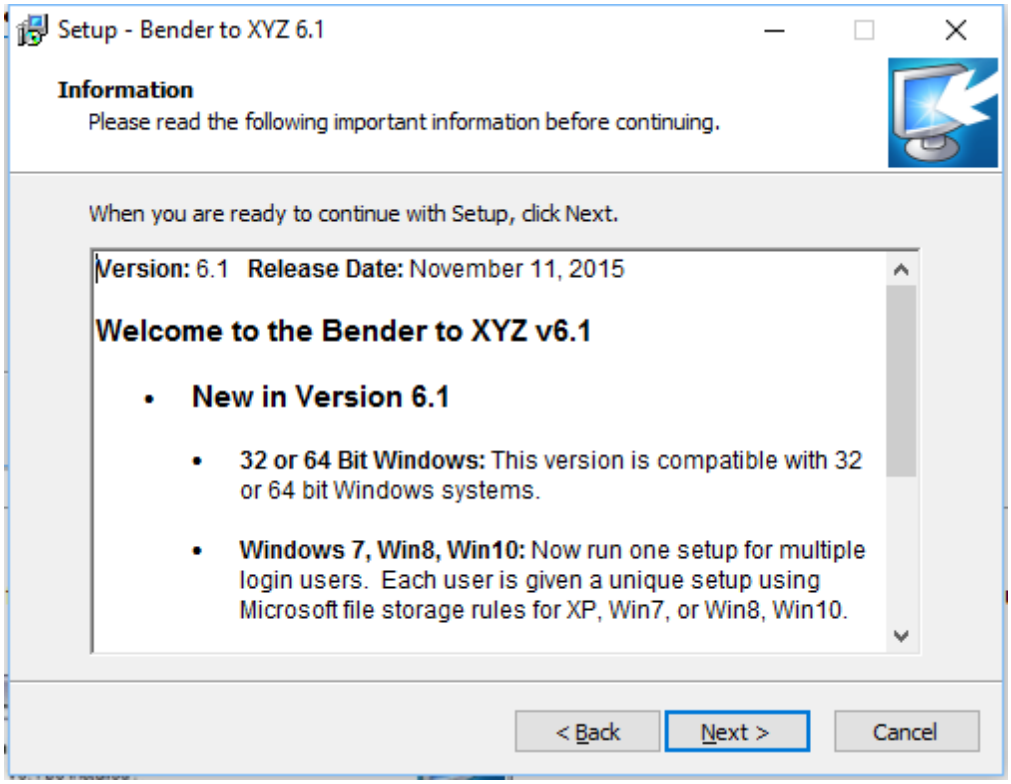
### Press Next



## STEP 3

This window contains revision notes.

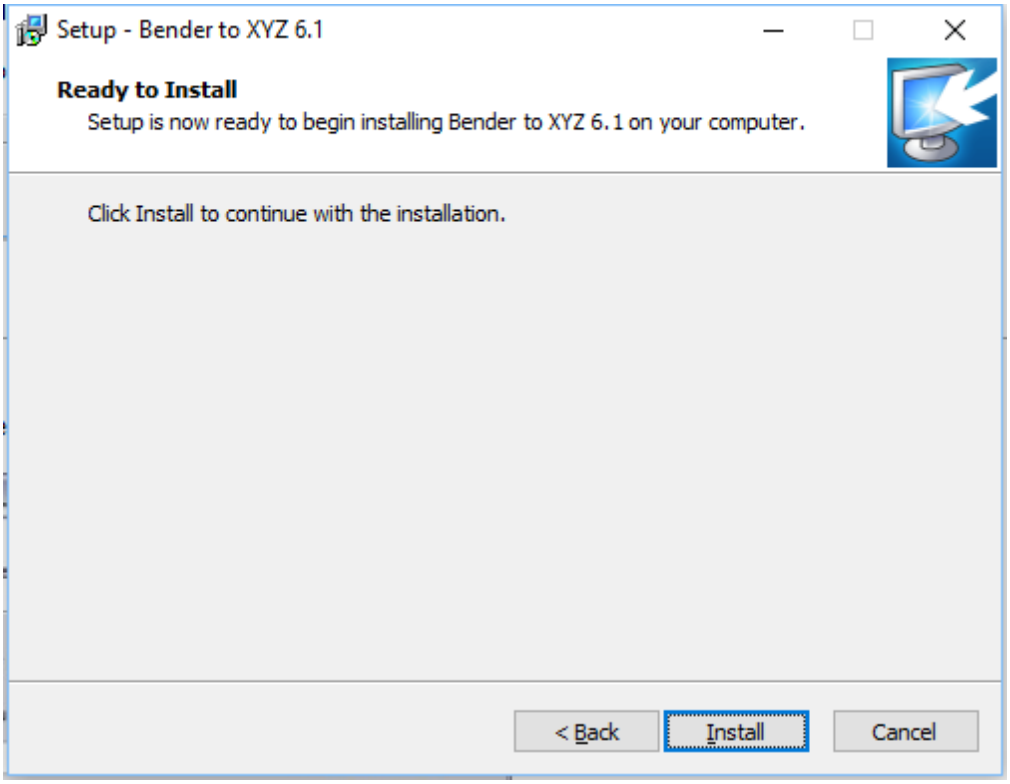
### Press Next



## STEP 4

The program will install when you press Install.

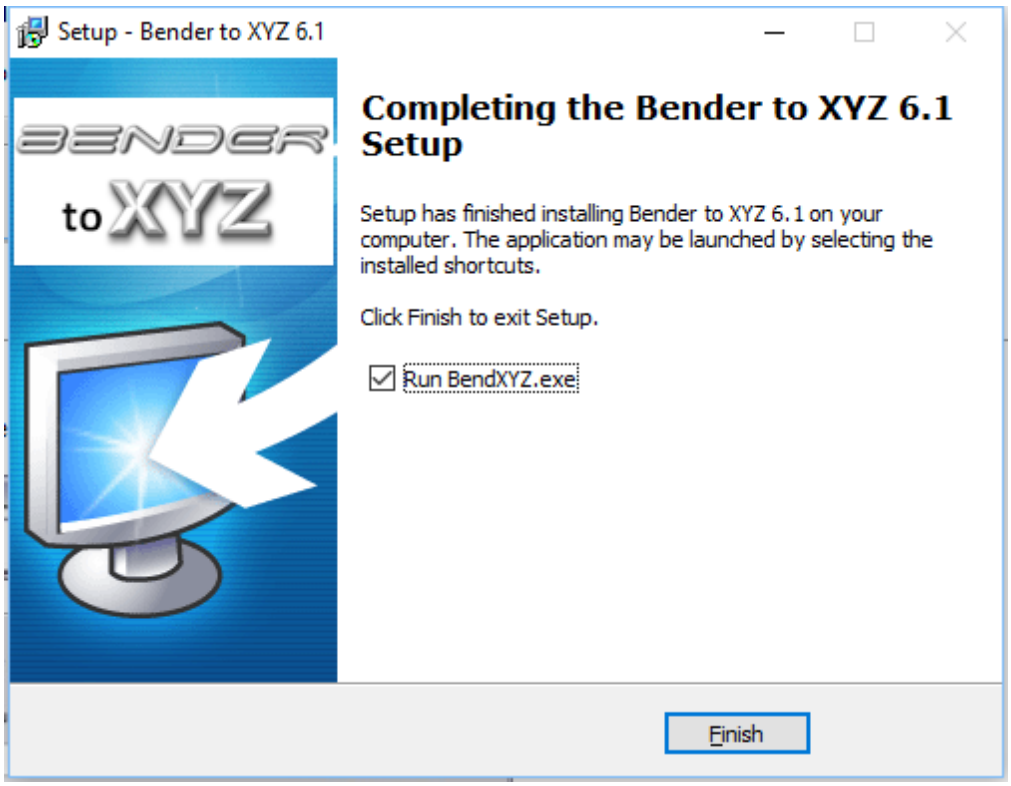
### Press Install



## STEP 5

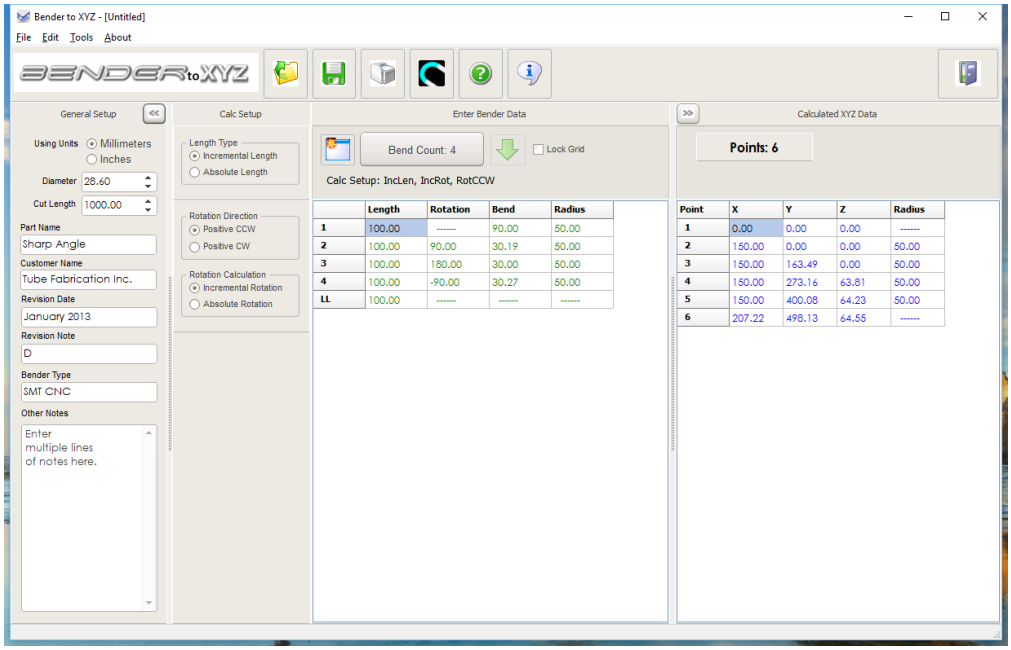
This is the final screen. Insert the hardware key into an available USB port then...

### Press Finish



## STEP 6

The program will display if the hardware key is found and license is verified.



# 1.2 Bend Data

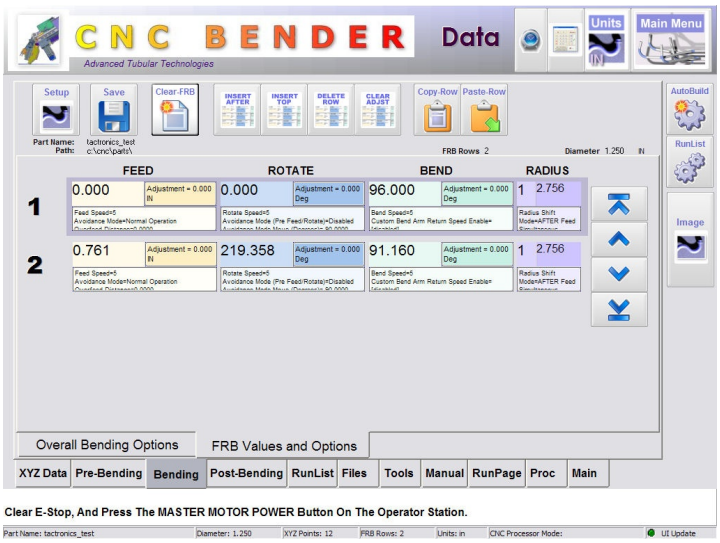
## INCREMENTAL BEND DATA

Incremental data is the most common bender data format used in the tube fabrication industry to program bend data.

Incremental data is usually referred to with an acronym that directly relates to three axes on a standard horizontal CNC Bender. LRA, FRB, YBC, FPB, PRB, are all variations of the incremental bender formats used in the industry. All of them can be entered into the Bender to XYZ software.

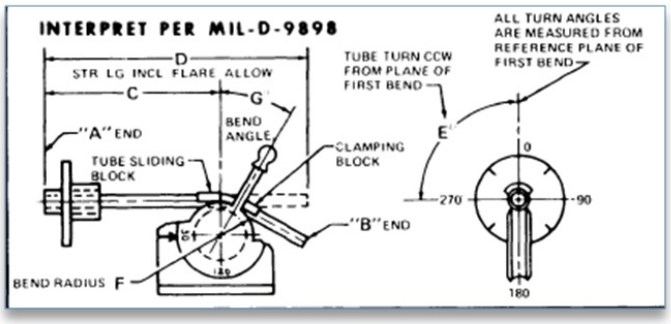
For "LRA", "L" refers to LENGTH, "R" refers to ROTATION, and "A" refers to bend ANGLE.

This is an example of **FRB** data in Advanced Tubular's CNC Bender software:



## ABSOLUTE BEND DATA

The other (and less common) format is **Absolute** bender data. Absolute bender data is common in military charts using MIL-D-9898 as shown here:




Also, Conrac benders (no longer manufactured - but still available in the industry) use absolute lengths and rotations.

## DESCRIBED in BEND DATA ELEMENTS

Both incremental and absolute formats are described in this document.

# 1.3 Data Types Combinations

## FLEXIBLE BENDER TYPE COMBINATIONS

Bender to XYZ is the most flexible converter in the world because it allows you to choose the type of data that is entered in each *column* of data.

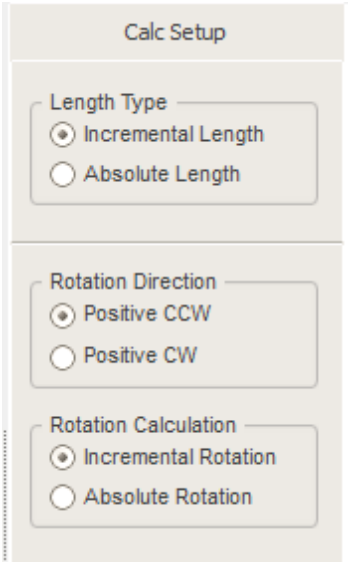
Because of this column setup approach, the software can calculate at least 12 different combinations of data (12 different styles of bender data charts)

| | LENGTH TYPE | ROTATION TYPE | BEND TYPE |
|---|---|---|---|
| 1 | Incremental Lengths | Incremental Rotations CCW | Draw Bend |
| 2 | Incremental Lengths | Incremental Rotations CW | Draw Bend |
| 3 | Incremental Lengths | Absolute Rotations CCW | Draw Bend |
| 4 | Incremental Lengths | Absolute Rotations CW | Draw Bend |
| 5 | Absolute Lengths | Incremental Rotations CCW | Draw Bend |
| 6 | Absolute Lengths | Incremental Rotations CW | Draw Bend |
| 7 | Absolute Lengths | Incremental Rotations CCW | Compression Bend |
| 8 | Absolute Lengths | Incremental Rotations CW | Compression Bend |
| 9 | Absolute Lengths | Absolute Rotations CCW | Draw Bend |
| 10 | Absolute Lengths | Absolute Rotations CW | Draw Bend |
| 11 | Absolute Lengths | Absolute Rotations CCW | Compression Bend |
| 12 | Absolute Lengths | Absolute Rotations CW | Compression Bend |

# 1.4 Bend Calculation Setup

## SETUP for BENDER DATA TYPE

The Calc Setup button on the main screen allows you to load the Bend Calculation Setup dialog to control each of the data types. This is an image of the dialog:




Each of these type settings is explained in the different topics of this document.

# 1.5 Errors Display

## ERROR DISPLAY METHOD

**Bender to XYZ** changes the color of a bender cell to **red** if it senses a problem that needs to be resolved before continuing. Other sections of this manual explain how to understand the problems that could occur and how to resolve them.

| | Length | Rotation |
|---|---|---|
| 1 | 100.00 | ------ |
| 2 | abc | 90.00 |
| 3 | 100.00 | 180.00 |
| 4 | 100.00 | -90.00 |
| LL | 100.00 | ------ |

So - remember that red-filled cells indicate a problem in the bender data grid. These are guidelines how to resolve data entry problems.

BENDER to XYZ

# Part II

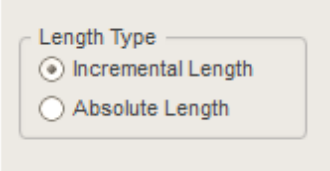
# 2 Bender Data Elements

This section explains the various lengths and angle types possible in Bender to XYZ.

## 2.1 Incremental Length

Incremental lengths is simply the *lengths between bends* . So if you know that your bender data indicates that the length **between** bends 1 and 2 is (for example) 100 millimeters, then you would use the incremental length setup to enter data.

**SETUP**
The incremental length type can be set by clicking on the Calc Setup button in the main screen, then choosing the Incremental Length radio button like this:




**NON-NUMERIC VALUES**

| | Length | Rotation |
|---|---|---|
| 1 | 100.00 | ------ |
| 2 | abc | 90.00 |
| 3 | 100.00 | 180.00 |
| 4 | 100.00 | -90.00 |
| LL | 100.00 | ------ |

It is possible to enter a non-numeric value in the field. For example, try typing a negative sign in any field and watch what happens. A "-" symbol by itself is not a proper number, so the field turns red until you enter a number after the negative sign.

**Alpha** characters are not legal in the length field. Change the value to a floating point number only.

**Note about NEGATIVE LENGTH VALUES**

A **negative** incremental length value is not a useful real value in the real world. For real-world tube fabrication situations, incremental lengths must be ZERO or POSITIVE. (In the case of ZERO, then the two bends would touch each other at the tangent points.) If your data shows a negative length value, then you will want to adjust the data so that the length is equal to or greater than zero.

## 2.2 Absolute Length

The best way to visualize **absolute lengths** is to think of distances along the length of the bed of a bender using a tape measure stretched from one end of the bender to the other end.

Older Conrac benders actually used metal tape measures riveted along the bed of the bender. The start of the tape is placed at the tangency of the bend die (where the bending begins). The end of the tape is stretched toward the back of the bender along the bender bed. The further the carriage is from the bend die, the higher the carriage position is on the tape.

The image below is a sample of how the lengths appear for a sample tube. The cut length of the tube shape is 1800 millimeters, and the position of the carriage to place the tube forward in position for the first bend is "1710". So the first straight is equal to 1800mm - 1710mm, or **90 millimeters in length**. In an incremental length cell, we would enter "90", but here the proper value is 1710. Both values create the same part. The difference is the setup is changed from incremental to absolute length.

| | Length |
|---|---|
| 1 | 900.00 |
| 2 | 721.46 |
| 3 | 595.11 |
| 4 | 468.93 |
| LL | 100.00 |

**CUT LENGTH is IMPORTANT**
The CUT LENGTH value in General Setup is an important part of the calculation for Absolute Lengths. Without a proper cut length, it is not possible to interpret and calculate true Absolute values.

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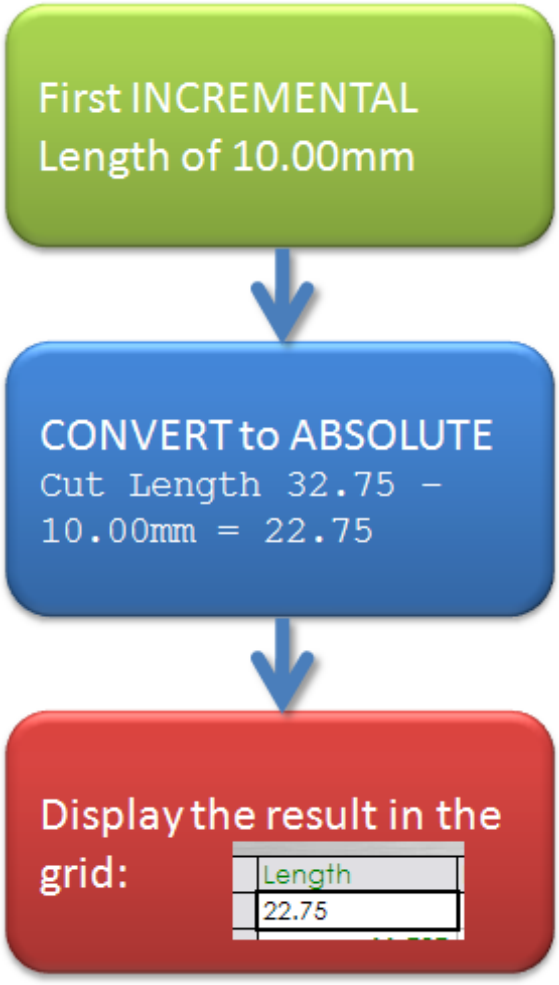
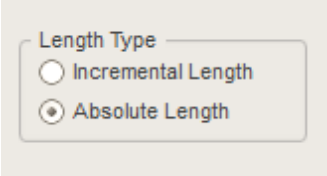
This is an example of how an incremental length is converted to an absolute length. Note the effect that cut length has on the calculation of the first straight. (Straight-length calculations after the first straight are more complex - but this example will give you a demonstration of why cut length is important for absolute lengths.)



**SETUP**
The Absolute Length type can be set by clicking on the Calc Setup button in the main screen, then choosing the Absolute Length radio button like this:




**SOLVING NEGATIVE VALUES**
Often these negative errors are due to the **CUT LENGTH** not large enough. Remember that the CUT LENGTH should logically be greater than (or longer than) any of the values in the absolute length data that is displayed in the ABSOLUTE Length mode. Increase the CUT LENGTH in the general setup menu until none of the lengths in the bender data are negative.

**Letters** are not legal in the length fields.

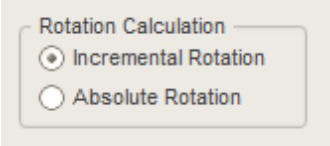
## 2.3 Incremental Rotation

Incremental rotations are twist angles between bends that can be any numeric value. Each rotation is measured between only two adjacent bends. There is no accumulation of values as there is with Absolute rotations. So think of the rotation value as the actual twist between the **current bend plane** and the **next bend plane**.

Sample Incremental Rotation Type (See the rotation column):

| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 900.00 | ------ | 90.00 | 50.00 |
| 2 | 721.46 | 90.00 | 30.19 | 50.00 |
| 3 | 595.11 | 180.00 | 30.00 | 50.00 |
| 4 | 468.93 | -90.00 | 0.27 | 50.00 |
| LL | 100.00 | ------ | ------ | ------ |

**SETUP**
The Incremental Rotation type can be set by clicking on the Calc Setup button in the main screen, then choosing the Incremental Rotation radio button like this:




**ENTRY RANGE:-360 to +360**
Any value that *exceeds* the range of -360 to +360 degrees is automatically reduced to within that range and is therefore not considered an error.

**NEGATIVE VALUES are OK**
Negative values are acceptable.

**NON-NUMERIC VALUES are OK**
Special non-numeric values can be used to indicate a **degree-minute-second** format. This is how to use this format:

1. The letter "d" follows the degree value
2. An apostrophe (') follows the minute value
3. A quotation mark (") follows the second value

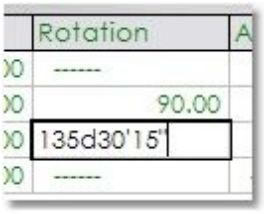
For example: **90d25'20"** is a valid angle and is converted to 90.4222222222222 internally before displaying "9.42" in the cell.

Other valid ways to enter data are:

**90d**
**90d25'**

**90d20"**
**90d25'20"**

Sample angle using this format:




**PROPER ORDER**
Any combination of these symbols ***in the proper order*** is acceptable. If they are out of order (like 25'90d) then an error will occur. Correct the order, and the value will become legal.

Any other letters or symbols are invalid.

## 2.4 Absolute Rotation

Absolute rotations are twist angles between bends that can be any numeric value. Each rotation is dependent on the values of all preceding rotations because they accumulate from all preceding rotations. These rotations are also, like incremental rotations, used to measure between two adjacent bends. But remember that they accumulate from all preceding bend rotations.

**Compare Incremental to Absolute Rotations**
Compare the two rotation types in these two samples:

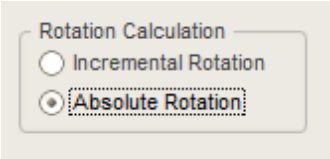
Sample Incremental Rotation Type (see the rotation angles):

| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 900.00 | ------ | 90.00 | 50.00 |
| 2 | 721.46 | 90.00 | 30.19 | 50.00 |
| 3 | 595.11 | 180.00 | 30.00 | 50.00 |
| 4 | 468.93 | -90.00 | 0.27 | 50.00 |
| LL | 100.00 | ------ | ------ | ------ |

The same data with Absolute Rotation Type (see the rotation angles)

| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 900.00 | ------ | 90.00 | 50.00 |
| 2 | 721.46 | 90.00 | 30.19 | 50.00 |
| 3 | 595.11 | 270.00 | 30.00 | 50.00 |
| 4 | 468.93 | 180.00 | 0.27 | 50.00 |
| LL | 100.00 | ------ | ------ | ------ |

**SETUP**
The Absolute Rotation type can be set by clicking on the Calc Setup button in the main screen, then choosing the Absolute Rotation radio button like this:




**RANGE:-360 to +360**
Any value that *exceeds* the range of -360 to +360 degrees is automatically reduced to within that range and is therefore not considered an error.

**NEGATIVE VALUES are OK**
Negative values are acceptable.

**NON-NUMERIC VALUES are OK**
Special non-numeric values can be used to indicate a **degree-minute-second** format. This is how to use this format:

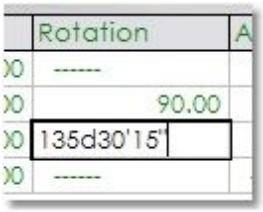
1. The letter "d" follows the degree value
2. An apostrophe (') follows the minute value
3. A quotation mark (") follows the second value

For example: **90d25'20"** is a valid angle and is converted to 90.4222222222222 internally before displaying "9.42" in the cell.

Other valid values are:

**90d**
**90d25'**
**90d20"**
**90d25'20"**

Sample angle using this format:



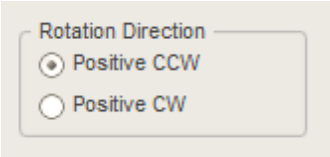

**PROPER ORDER**
Any combination of these symbols ***in the proper order*** is acceptable. If they are out of order (like 25'90d) then an error will occur. Correct the order, and the value will become legal.

Any other letters or symbols are invalid.

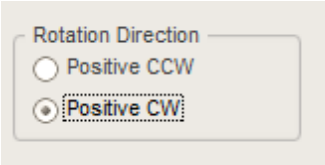
## 2.5 Rotation Direction


On most benders, in setting the direction of the rotation, it is often assumed that the positive angle values rotate consistently in one direction (*see note 1 below* ). The question is then, "in which direction is the positive rotation rotating?"

Most benders seem to use the same direction as general CAD programs like AutoCAD. They rotate the positive Counter Clockwise when the collet is viewed from the front of the bender.




However, there are cases where a bender may consider CW the "positive" direction. If the bender data you are converting to XYZ coordinates is one of those benders, then it is important that you choose the Positive CW radio button option.


## EFFECT OF SWITCHING the DIRECTION

The effect of switching between CCW positive and CW positive rotations, is the inversion of all the Z values. Inversion is multiplying the all values by negative 1 - which changes the sign of the value.

See the effect of changing the meaning of "positive rotation" in these two XYZ data charts.

This is with positive rotations set to CCW (see the Z values):

| Point | X | Y | Z | Radius |
|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | ------ |
| 2 | 150.00 | 0.00 | 0.00 | 50.00 |
| 3 | 150.00 | 163.49 | 0.00 | 50.00 |
| 4 | 150.00 | 273.16 | 63.81 | 50.00 |
| 5 | 150.00 | 400.08 | 64.23 | 50.00 |
| 6 | 207.22 | 498.13 | 64.55 | ------ |

This is with positive rotations set to CW (see the Z values):

| Point | X | Y | Z | Radius |
|---|---|---|---|---|
| 1 | 0.00 | 0.00 | 0.00 | ------ |
| 2 | 150.00 | 0.00 | 0.00 | 50.00 |
| 3 | 150.00 | 163.49 | 0.00 | 50.00 |
| 4 | 150.00 | 273.16 | -63.81 | 50.00 |
| 5 | 150.00 | 400.08 | -64.23 | 50.00 |
| 6 | 207.22 | 498.13 | -64.55 | ------ |

## Benders that Switch Rotation Directions in the Middle of a Part

Most benders don't switch the meaning of positive or negative rotations in the middle of a part. It is more logical to leave the definition of the rotation positive plus and minus the same direction - even if running a dual head bender.

However watch out for dual-head benders do switch the rotation meaning of positive depending on the head being used. For example, the Schwarze-Robitec dual-head benders does this reversal. The bender is designed to use one carriage assembly with two bend arms as shown in the image below.

Also, older (pre-2016) dual-head SOCO benders would switch the rotation depending on which head was bending. SOCO fixed this issue as of 2016.

## Schwarze-Robitec "Typ CNC 60 E Twin TB MR - teilelektrisch" bender:

## 2.6 Bend Angle

Bend angles are degrees of bend and are positive values only.

**RANGE: Positive Values Only**
Any value that is negative is considered an error. Change the value to a zero or a positive value.

**NON-NUMERIC VALUES are OK**
Special non-numeric values can be used to indicate a **degree-minute-second** format. This is how to use this format:

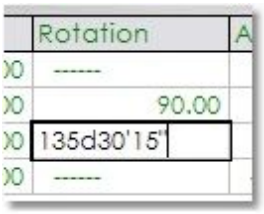
1. The letter "d" follows the degree value
2. An apostrophe (') follows the minute value
3. A quotation mark (") follows the second value

For example: **90d25'20"** is a valid angle and is converted to 90.4222222222222 internally before displaying "9.42" in the cell.

Other valid values are:

**90d**
**90d25'**
**90d20"**
**90d25'20"**

Sample angle using this format:

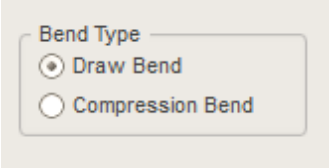



**PROPER ORDER**
Any combination of these symbols ***in the proper order*** is acceptable. If they are out of order (like 25'90d) then an error will occur. Correct the order, and the value will become legal.

Any other letters or symbols are invalid.

# 2.7 Bend Type

## DRAW BEND or COMPRESSION BEND

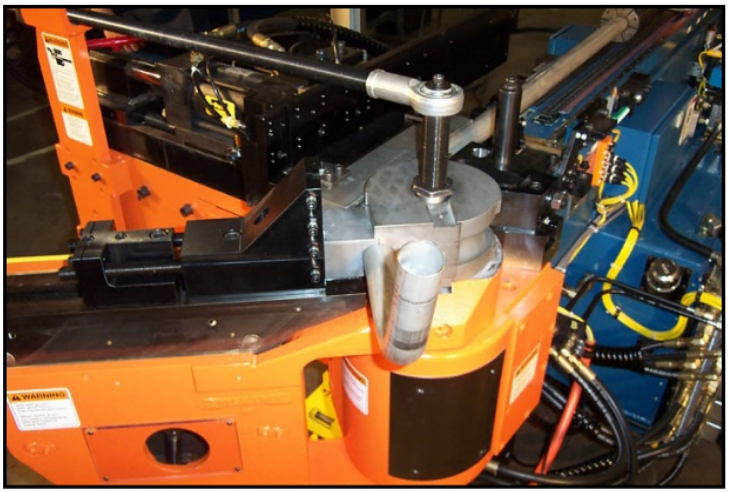



The bend type can be either DRAW or COMPRESSION when the ABSOLUTE LENGTH radio button is checked. The type of bend has an impact on the calculation of the ABSOLUTE LENGTH data in a bend data set with absolute lengths. When the INCREMENTAL Length button is checked, then there is no choice - the bend type is not significant to the length calculations.

## Draw Bend

A DRAW bend is a bend where the bend die rotates and draws the tube shape into the die for bending. This type of bending controls the flow of the material with more precision than compression bending.

This is a draw bender pulling the tube around the bend die:

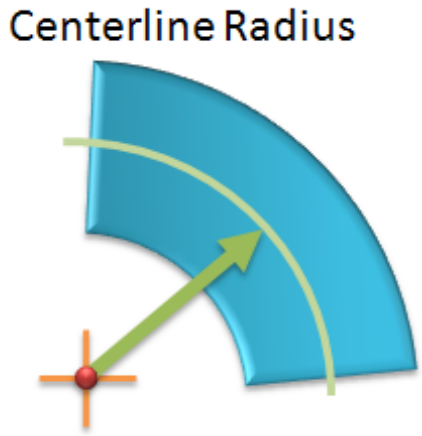


## Compression Bend

A COMPRESSION bend is a bend where the bend die is stationary during bending and the tube is compressed or wiped around the die. In this style of bending, the bend die does not rotate, but the clamp that holds the tube to the die rotates around the die to form the bend.

Compression bending is often used on dedicated bending machines that bend a single shape. The tube is placed in the machine, then the bends are placed on the tube from the outside toward the middle. The value of compression bending is speed - it is very fast.

## 2.8 Centerline Radius




Centerline radius values follow same rules as length values. The represent the radius values from the nominal centerline of the tube to the center of the bend radius.

**NEGATIVE VALUES**
A **negative** radius value is not a useful real value when the LRA data. Negative radii cannot exist. In this case, you will want to adjust the data so that the length is equal to or greater then zero.

**NON-NUMERIC VALUES**

**Alpha** characters are not legal in the length field. Change the value to a floating point number only.

BENDER to XYZ

# Part II

# 3 Foundational Data

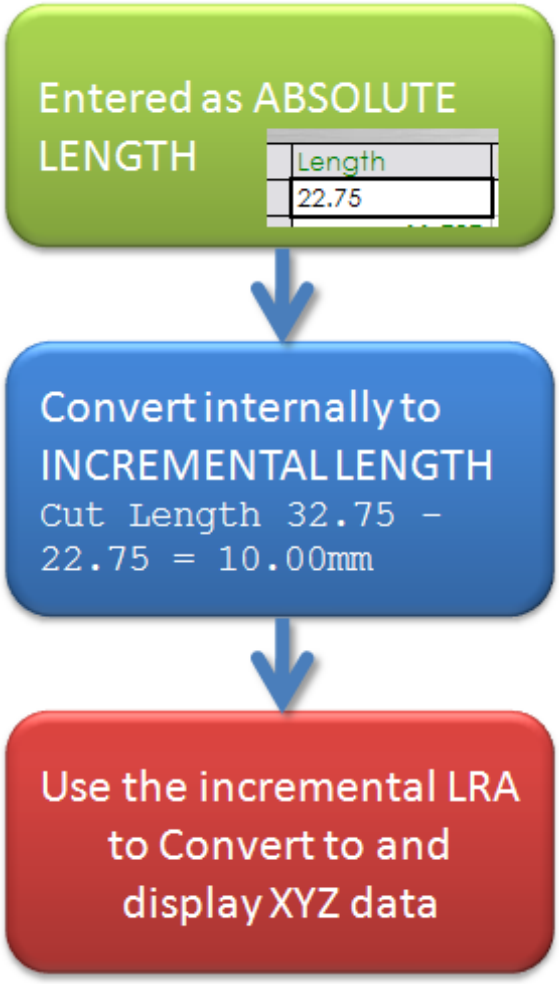
"Foundational data" is the data that is stored at its lowest level internally by Bender to XYZ data. As you will see here, the only data that is stored - either in memory or in files - is incremental data.

### DATA STORAGE INTERNALLY

If any column of data is displaying ABSOLUTE data, and you enter a change, then an automatic conversion occurs in real-time (as you type) to the equivalent incremental data. This means that the conversion happens automatically every time you change a digit in any of the numbers on the screen.

This same incremental bender data is stored to disk and used for recall in the future sessions. Using only incremental data for storage means that the file data will present a consistent set of incremental LRA data for any other program that loads and uses the Bender to XYZ data file.

This is an example of how this conversion occurs with ABSOLUTE LENGTHS:



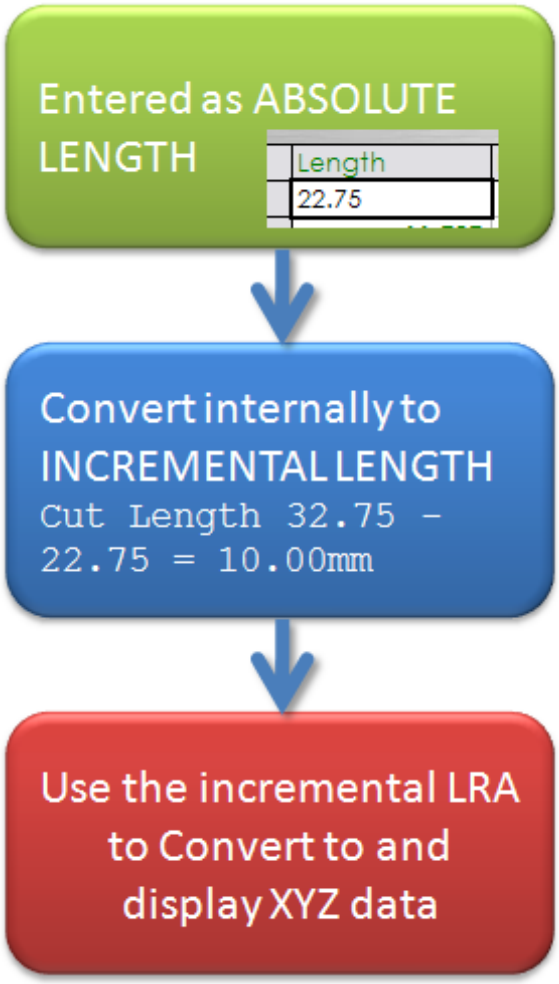
### SENDING DATA to the DISPLAY

When data is displayed, conversion happens in the opposite direction. The data is converted from the internal incremental data to the screen data, the calculator converts the data into the format that is appropriate based on the Bend Calculation Setup dialog state.

## 3.1 Conversion of Values

Absolute values are always converted to incremental values for storage internally before the XYZ data is calculated. This is a demonstration of how this principle works with the first length entry made using ABSOLUTE mode.

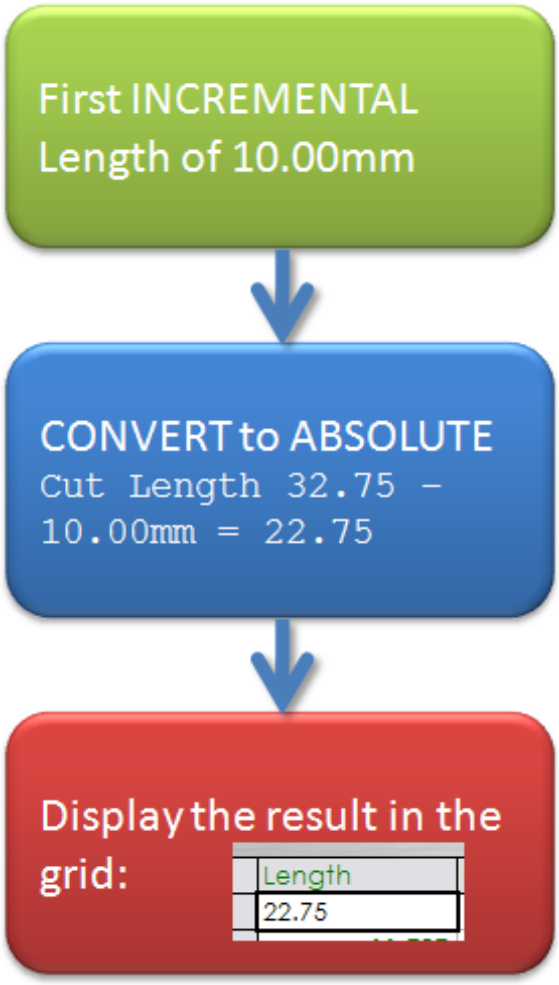
**ENTERING DATA in the GRID**
Examine what happens when you enter data when the length column is displaying data in ABSOLUTE mode.




**UPDATING the GRID DISPLAY from the DATABASE**
This is nearly the opposite process shown above.

- The incremental length of 10 mm is stored internally.
- Bender to XYZ knows that it needs to upgrade the data in the grid.
- The data setup indicates that the length data is to be displayed in ABSOLUTE mode.
- So an automatic calculation must occur before the data is displayed on the screen.

This is how the process works internally:



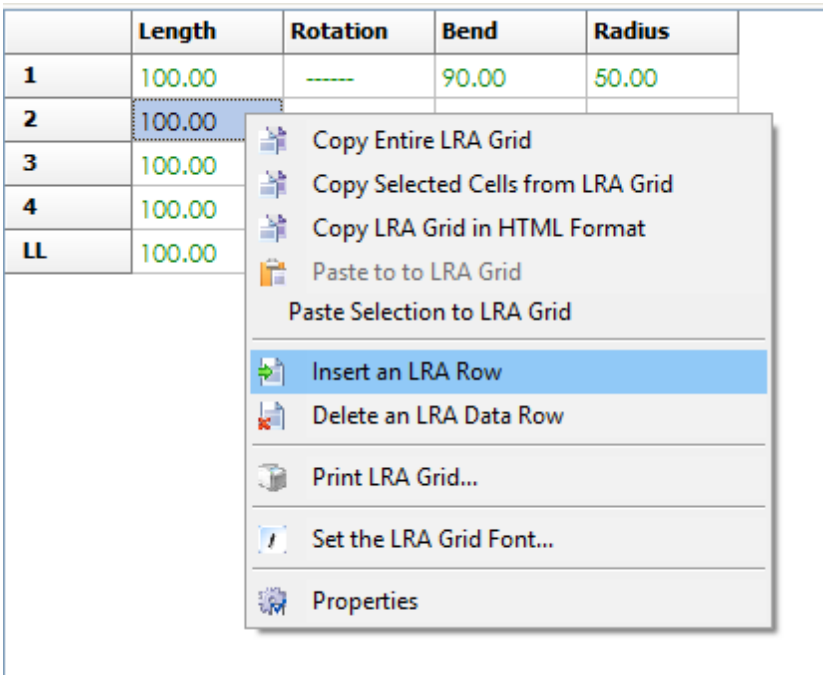

While the calculations are more complex for other values, the principle is the same.

## 3.2 Inserted Rows Results

**UNEXPECTED INSERTION RESULTS**
Because of the way Bender to XYZ calculates data from a foundation of incremental data, inserting rows with ABSOLUTE data displayed can cause the unexpected result of a non-zero value in the newly created row. This is normal and not an error.

**INCREMENTAL DATA ROW INSERTION - EXPECTED ZEROS**
Inserting empty rows of data is as simple as using the pop-up Insert an LRA row option. See this example:

**Before insert:**




**After Insert:**

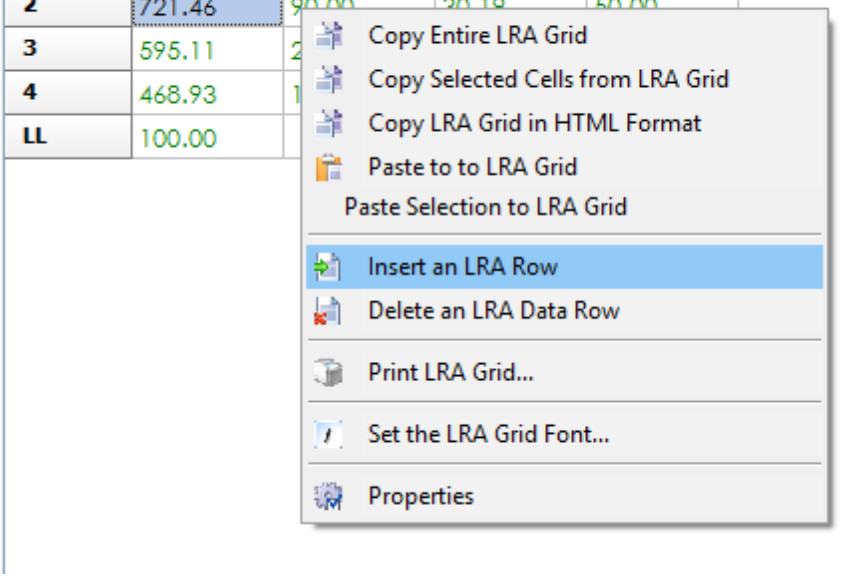
| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 100.00 | ------ | 90.00 | 50.00 |
| 2 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | 100.00 | 00 | 30.19 | 50.00 |
| 4 | 100.00 | 270.0 | 30.00 | 50.00 |
| 5 | 100.00 | 180.00 | 30.27 | 50.00 |
| LL | 100.00 | ------ | ------ | ------ |

**ABSOLUTE DATA ROW INSERTION - UNEXPECTED**
Now if we change the Bend Calculation Setup to Absolute LENGTHS and perform the same insert, the results may be unexpected. In stead of "0.000" for the length, the inserted row shows "9.823".

This non-zero result is because the Absolute data is calculated from the foundational data of INCREMENTAL LRA data, and ABSOLUTE data depends on all previous rows of data for its calculation. This non-zero calculation is normal and should be expected.

**Before Insert:**

| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 900.00 | ------ | 90.00 | 50.00 |
| 2 | 721.46 | 90.00 | 30.19 | 50.00 |
| 3 | 595.11 | 2 | | |
| 4 | 468.93 | 1 | | |
| LL | 100.00 | | | |




**After Insert:**

| | Length | Rotation | Bend | Radius |
|---|---|---|---|---|
| 1 | 900.00 | ------ | 90.00 | 50.00 |
| 2 | 821.46 | 0.00 | 0.00 | 0.00 |
| 3 | 721.46 | [illegible] | 30.19 | 50.00 |
| 4 | 595.11 | 270.00 | 30.00 | 50.00 |
| 5 | 468.93 | 180.00 | 30.27 | 50.00 |
| LL | 100.00 | ------ | ------ | ------ |

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