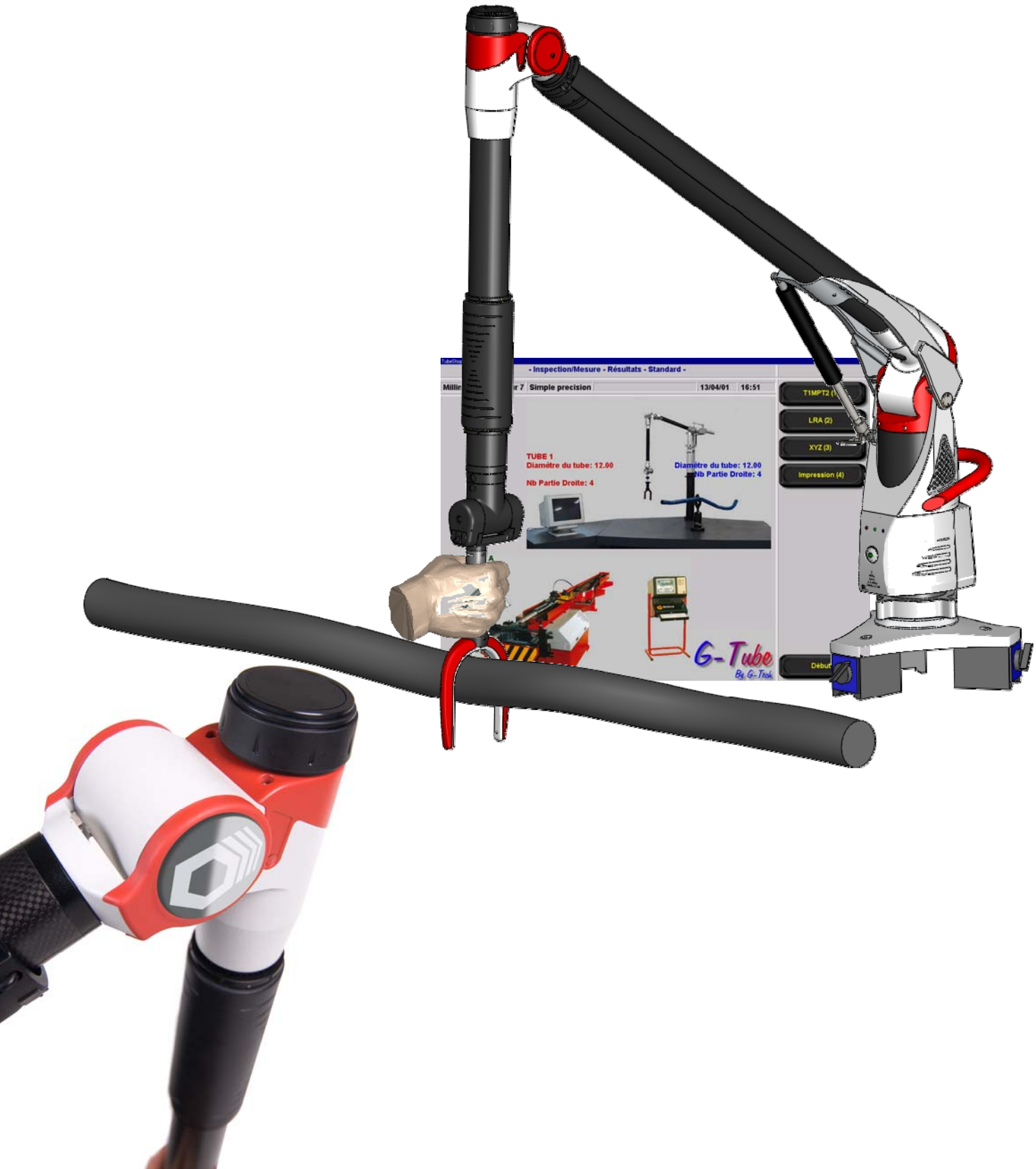
GTube

GTube V4.0.12

User Manual



User Manual

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INTRODUCTION

Dear customer, thank you for purchasing a HEXAGON METROLOGY product. Before starting any operation about your new software, please read carefully those instructions.
You will find here a guide to use the software and manipulate the device, and how to use it in best conditions.
For any other device or option, not described in this manual, please refer to the different complete manuals (RDS Manual, Software manual, options …) available on the "Romer Product" DVD-Rom".

For any further question, please contact your local Hexagon Metrology agent (see in Appendix).

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PATENT NOTICE

Products described in this manual may be covered by one or more of the following U.S. patents 5,829,148; 6,598,306; 7,003,892; 7,568,293; and other U.S. and foreign patents pending.

TABLE OF CONTENTS

- How to use this manual

This manual is designed not only to assist with the use of the G-Tube software, but also to explain certain theories, as well as tube manufacturing principles.

It also describes certain basic rules relating to measurement and procedure…

- Explanation of presentation, colour,…

In the manual, when a function is specified, it is often followed by a number in brackets: this is a function code.

When the term “click” is used, this is understood to mean “left click”. Right clicks will be explicitly described.

Tables enable the different functions to be seen rapidly.

Logical diagrams facilitate understanding of processes.

The colours used in G-tube are also used in the pictures: Red for theoretical, blue for measured.

A- GETTING STARTED WITH G-TUBE

A.1. About the software

G-Tube's main menu has 4 sections

- Tubes
- Measurement / Inspection
- Benders
- Auto / Manual

Tubes: allows the theoretical part of a tube to be entered, managed and modified

Measurement / Inspection: allows a tube to be measured, to inspect a measured tube compared to a theoretical tube, and to display inspection results.

Benders: enables benders to be managed, with or without connection.

Auto / Manual: allows access to automatic control mode, linked to benders

A System Menu allows the software to be configured

When benders are configured in G-Tube, the operator goes directly to Auto mode when the software is started.

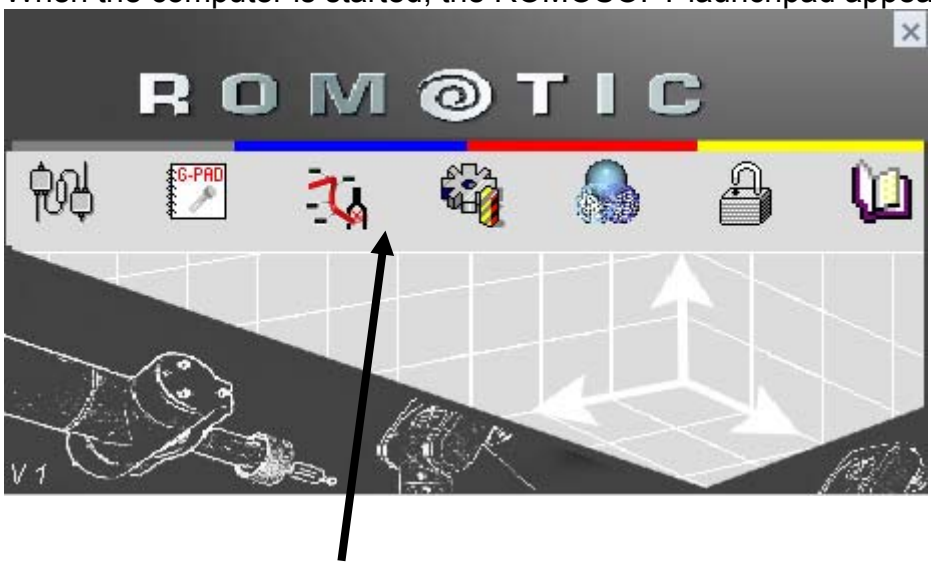
A.2. Installing the software

To install the software, please read ROMOSOFT's installation instructions.

To use GTube with RDS (ROMER Absolute Arm or Cimcore Arm), it is necessary to install GDSOCX V1.9.1 patch as well as a minimum version of RDS V3.1.1

A.3. Starting G-Tube

When the computer is started, the ROMOSOFT launchpad appears automatically.



Click on the G-Tube icon to start the software:
The following window appears:

This window concerns G-Tube's graphical interface: do not close this window, even if it reappears when using G-Tube (if this happens, click next to this window to return to G-Tube).

Next, you are connected to the Measurement System, requesting that the arm axes are reset (see the system instructions).

G-Tube then passes directly to Auto/Manual mode, or to the main menu if no bender has been configured.

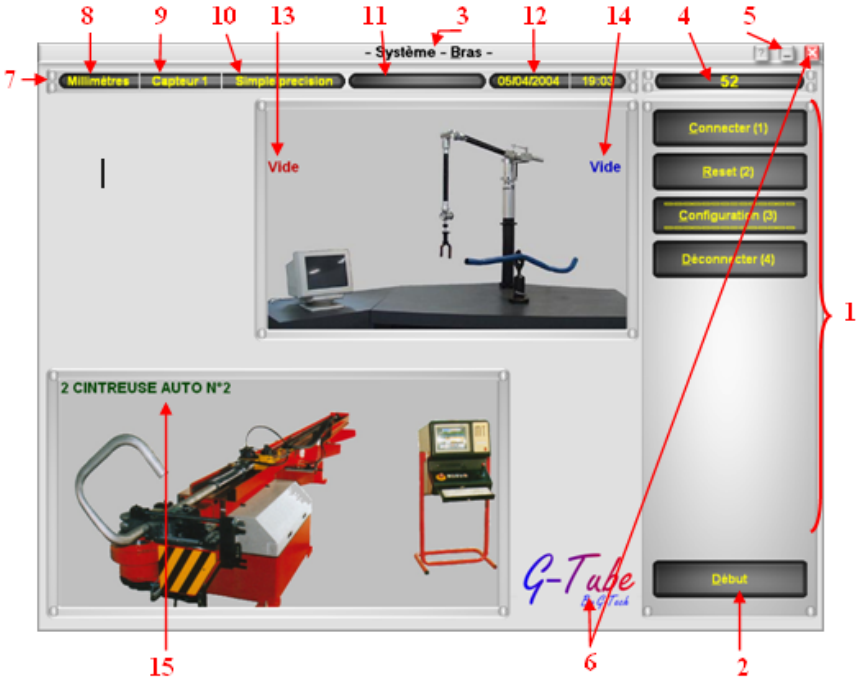
NB: G-Tube can also be started directly from G-Pad (optional): to do so, click on the 'Bender' button 

A.4. Interface (screen) description

A.4.a. Main screen:

G-Tube's main screen has 3 key zones:
A zone showing the menu buttons
A zone showing various information
A zone showing the tubes and bender.

Apart from Auto/Manual mode, this screen remains the same. For some functions, an entry or results window may appear in the middle of the screen.



1	**Menu Buttons**	give access to G-Tube's different menus and functions
2	**"Home" button**	allows you to go back to the main menu
3	**Active menu**	**(tree structure)** shows which menu you are in, showing the full tree structure
4	**Active menu Access Code**	shows the numbers of buttons to select to go to the active menu from the main menu
5	**"Minimize"**	minimizes G-Tube to the Windows task bar
6	**Close**	Enables G-Tube to be closed quickly
7	**Status bar:**	
8	**Active units**	shows the selected unit of measure (millimetres or inches)
9	**Active probe**	shows the selected non contact probe
10	**Active means of measurement**	shows the selected means of measurement (single precision / double precision)
11	**Messages**	displays various information messages (standby, communication, …)
12	**Date and Time**	displays computer date and time
13	**Theoretical Tube (key information)**	displays the selected tube theoretical reference (or allocated to a bender as theoretical), as well as its diameter, ends if there is one of more overhang and / or shaping, and the number of straight sections; If a new tube has been programmed but not saved, the line reserved for the tube name is blank
14	**Measured Tube (key information)**	displays the name of the measured tube (or the tube open for measurement: memory inspection), as well as its diameter, ends if there is one of more overhang and / or shaping, and the number of straight sections If no tube measurement has been saved, the line reserved for the tube name is blank, and the diameters, ends and number of theoretical straight sections are displayed.
15	**Selected Bender**	Displays the selected bender (with image if it has been changed)

A.5. Navigating in G-Tube

G-Tube (selecting menus, functions, data entry, …) can be used with a **mouse** (computer mouse, mouse driven by a measuring arm, touch screen, …) or a **keyboard**.

The mouse enables the pointer to be moved around the screen and to click on different places (all clicks are left clicks except if noticed).

Using the keyboard is recommended, since the different buttons can be selected very quickly.

A.5.a. Main Menu

Menus and functions are selected using menu **buttons**. As you navigate through the different menus, G-Tube displays all the buttons selected to get to the current menu (tree structure). In this way, you know exactly which you are in at any time.
In addition, each button corresponds to a number (1 to 9) and G-Tube also displays the numbers of buttons required to reach the current menu. It is therefore easy to memorise the **code numbers** to access the most used menus and functions from the main menu.

Each Menu or Function can be protected by a common or different password. By default, 2 functions can have a common password (Tube-Save and Tube-Delete) but the other buttons can also have password(s) (contact your ROMER agent).

The "**System**" Menu, which is not used very often, is hidden in order not to overload the main menu, and can only be accessed using the keyboard, by pressing the "Ctrl" (control) and 0 (zero) keys at the same time or by the 5 key. Throughout this manual and in G-Tube, when the "System" menu is referred to, number **5** is used

.
The mouse and the keyboard can be used interchangeably; the list below describes the different ways of navigating through the menus:

Action	**Keyboard**	**Mouse**
Menu / function selection	Enter the button Code (number)	Click on the button
Return to the previous menu	Backspace key ←	
Return to the main menu	- Esc key - 0 (zero) key	Click on "Home"
Exit G-Tube	Enter the System-Quit menu code 5-4 (Ctrl0 – 4)	- Click on the star on the top left -Click on the G-Tube logo
Access the System menu	Press Ctrl + 0 (zero) at the same time or 5	
Change a password	Press Alt + the button code at the same time	Push the Alt key and click on the button

A.5.b. Auto / Manual Menu

For an explanation of Auto/Manual mode, and how to use it, refer to the Auto/Manual chapter.

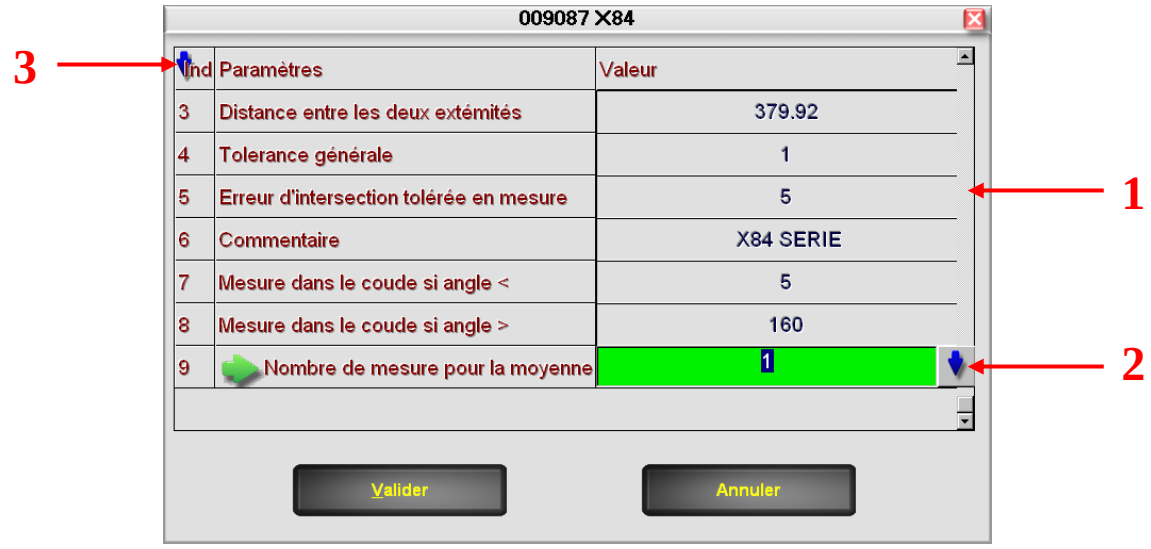
Access to the Auto/Manual menu is through button selection (code 4) in the main menu.

Here too, you can either use the keyboard or the mouse.

Action	**Keyboard**	**Mouse**
Selecting the 1st bender	- Enter the bender number or - Highlight the bender using the arrow keys	Click once on the bender
Selecting another bender	- Press Delete and enter the bender number or - Highlight the bender using the arrow keys	Click once on the other bender
Run Auto Control (after selecting the bender)	-Press ◄┘ (Enter)	Click on the bender a second time
Return to the main screen	-Press Esc	RIGHT click the bender

A.6. Entry and results windows

Many functions open automatically in a Window (**Table**), in which you can either enter or change values, or view values or results.
The values can be numeric, alphanumeric, or selection lists.
A small arrow displays where there is a selection list (**2**): click on it to display the list and select the value required.



1 : Scroll Bar
2 : Selection list
3 : Additional functions

The list may contain more lines than can be displayed in the window: in this case, a scroll bar (**1**) is shown on the right of the window to move the table up or down.

These windows have some additional functions (**3**) accessible using the keyboard or mouse. They all correspond to keyboard function keys (F2, F3, …F8) and allow access to different actions, functions or second-level windows, which can also have additional functions (printing, settings, …).

2nd level windows follow the same rules, and use the same “OK” and “Cancel” buttons.

Among the various additional functions, one is available for all windows: Print (F8)

Action	Keyboard	Mouse
Select an entry box	Highlight the box using the arrow keys	Click the box directly
Enter a value	Enter the value directly using the keyboard	
Replace one value with another	Press Del and enter the value	
Change a value	Use the Backspace key ← to delete the last figures and enter the modification	
Move up and down the table	Use the up/down arrow keys or the Page Up / Page Dn keys	- Click on the desired line - If there is a scroll bar, click on the square and move it up or down
Access the additional functions menu	Press the + key	Place the mouse over the blue arrow (top left) and RIGHT click
Exit the additional functions menu	Press the - key	Move the mouse away from the additional functions menu
Select an additional function	Press the corresponding function key	Access the additional functions menu and click on the function
Open a selection list	Press the space bar	Click on the cell and select the value
Select from a list	Move using the up, down and ← Backspace keys	Click on the value

NB: Windows Copy-Cut-Paste functions operate in all these entry windows

A.7. The different operating modes (Manual/Windows/Auto)

When inspecting a tube, there are three distinct operating modes:

- **Manual Mode**: operation without bender, all actions (measurement, inspection, view results) must be selected manually: inspection is only carring out matching the measured tube with theoretical data, results are viewed independently.

- **Semi-Auto Mode** : operation with a bender: measurement and inspection must be selected manually, but inspection after matching calculation here gives access to the results and the correction process, however the results can also be redisplayed manually as in manual mode.

- **Auto Mode**: operation with a bender through the “Auto/Manual” screen: here, all selections are automatic: as soon as measurement is completed, matching is carried out and the results and correction processes appear automatically. As in semi-auto mode, it is possible to redisplay the results manually.

A.8. Printing in G-Tube

Three print modes are available in G-Tube:

- **Quick Print**, launched using additional function F8, prints directly or through Excel
- Direct printing of data or results
- Producing an inspection report in **Excel**

A.9. G-Tube Configuration

G-Tube is software for a specific purpose (tube inspection). There are therefore few configuration changes possible.
Configuration essentially relates to technical aspects associated with the Tube arm
The main possible changes are:

- Units (mm or “):cf. §C.4.j
- Bender images: cf. § E.2
- Bender parameters : cf. § E.2
- Measurement system (GDSDLL) : cf. §G.4
- Language: cf. § G.1
- See printing : §A.8
- Passwords (contact your ROMER agent)

B- INTRODUCTION TO TUBES AND MEASUREMENT

B.1. What is a tube?

In industry, there are different types of tubes: pipes, bent tubes, shaped tubes, cables…
Here, we are only going to consider straight sections bent tubes (pipes) and cables.

A tube is an element which is usually circular, with a diameter measuring from a few millimetres up to several hundred millimeters, hollow or filled (in which case it is a “cable”), consisting of a succession of straight sections and curved sections - bends- which can have identical arcs (Bending Radius) or different arcs.

B.2. Different tube characteristics

A tube is always described in terms of the axes of its straight sections: this is known as Neutral Fibre.
The bending radius is the curve radius of this neutral fibre.

A tube can be represented geometrically in different ways, each with a clear purpose:

- **intersection points**, or **XYZ**: These are intersection points between each of the straight sections making up the neutral fibre, to which the two ends of the neutral fibre are attached.
  These points are usually given by the CAD, in any case they represent the theoretical tube path.

- **LRA**: these are tube technical data and correspond to tube manufacture
  - L: length of each straight section
  - R: rotation of each bend (= the angle between two successive planes)
  - A: bending angle (= total angle between two successive straight sections)

- **Tangency (Pitch) points**, or **T1MpT2**: These are the points at the end of each straight section and each bend. They represent the tube envelope, and can be compared as a control jig, which verifies if the straight sections fall within a tolerance envelope.
  These are the inspection data, which enable a tube to be declared suitable or not.

In addition to these basic data, other data are used:

- **Delta LRA (ΔLRA)**: This is the difference between measured and theoretical LRA

- **CLRA**: Can be close to LRA: these are corrected bending data; unlike LRA which are set theoretical data, CLRA are data based on the LRA but modified in order to obtain the correct tube (taking bending defects into account). CLRA are calculated based on previous CLRA and Delta LRA

- **YBC – CYBC**: on some benders, YBC name is used instead of LRA: it is exactly the same data and values but the name refers to bender movements based on its own reference data:
  - Y (=L): Carriage movement through the Y axis
  - B (=R): Mandrin rotation through B (Y movement)
  - C (=A): Bending, rotation through C (Z movement)

- **180°bends**: These present an additional problem because they do not have any intersection point: in this particular case, the bend is divided (splitted) virtually into two equal parts, which gives us two intersection points instead of one. In G-Tube, these points must be defined as points on a splitted bend. On the other hand, the LRA do not pose any problems and a single bend is retained (which should in any case be recorded as a divided bend).

B.3. Tube manufacture

All industrial benders use the same procedure (more or less):
The tube is introduced into the mandrin, which draws back through the total specified length (load position).
The following movements occur for each bend:

- The carriage moves through the length of the straight section (L)
- The tube is rotated (R)
- The tube is bent (A)

NB: during the bending process, the tube advances through the length of the curved section.

Some benders are described as “Left hand” (or “clockwise”), others are “Right hand” (or “anti-clockwise” or sometimes “Trigo”): this is because bending occurs to the left or the right. This must be specified correctly in the communication parameters (34).

Some benders differ in that it is not the tube that rotates, but the bending body; this does not affect G-Tube operation.

B.4. Testing a tube

Tubes are usually tested on rigs, on which the straight sections must fit within a U. It is difficult to know which value to correct to obtain a suitable tube.

The T1MpT2 reuse the principle of testing straight sections to know if the tube envelope falls within a certain tolerance.
WARNING: Only pitch point data enable a tube to be tested, IN NO CASE do the XYZ or LRA enable you to determine whether the tube is correct or not. In this case, data accuracy depends on lengths and angles. In addition, these are VIRTUAL data and do not represent the tube envelope. Only T1MpT2 are points which actually pertain to the tube.

C- THE “TUBES” FUNCTION (1)

C.1. Creating a tube (11)

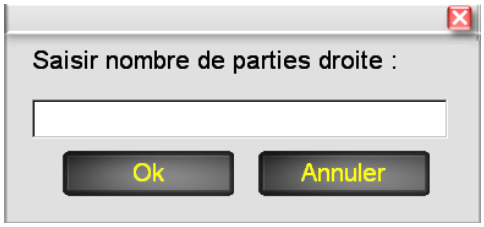
To enter a tube’s theoretical coordinates, it is possible either to enter intersection point coordinates (XYZ) or bending data (LRA).
Both are done in the same way:

When the function is selected (111 for XYZ; 112 for LRA), a parameters table appears: these are **general tube parameters.** (see C-4-a)
When entering data, it is necessary to enter the tube **diameter** and important to enter tube **general tolerance**, the number of measurements (for the average), as well as **comments**.

The tube length, as well as the distance between the ends will be calculated automatically and cannot be modified.

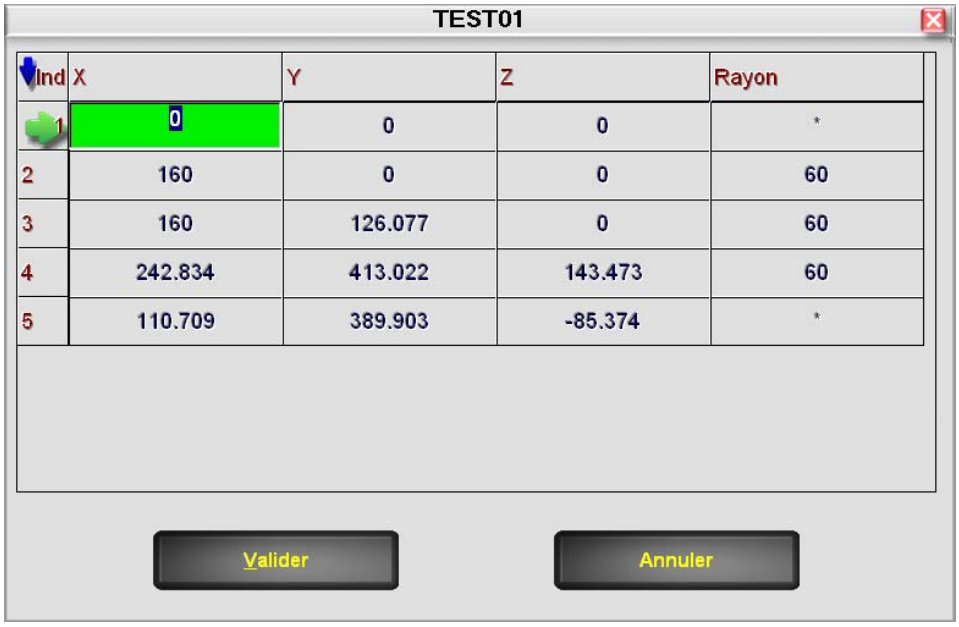
All these parameters can subsequently be modified.

Once the table has been validated, G-Tube asks for the number of straight sections



The data entry table then appears.

Enter all the values



WARNING: ENSURE THAT DATA ARE ENTERED USING THE UNIT OF MEASURE CONFIGURED FOR G-TUBE.

- XYZ: Enter **XYZ** values in order, then the tube **bending radius** (by default, the first value is applied to all bends).
  Tolerance can be modified for each of the points in X, Y and Z.

- LRA: enter **length**, then **rotation**, then bending **angle** and finally the **bending radius** (by default, the first value is applied to all bends).
  A **displacement T** can be specified and whether corrected values or not noticed.

Then validate the tube: in the Master zone, the number of straights and the diameter appear.

DO NOT FORGET TO SAVE THE TUBE

C.2. Tube management

C.2.a. Open a Tube (12)

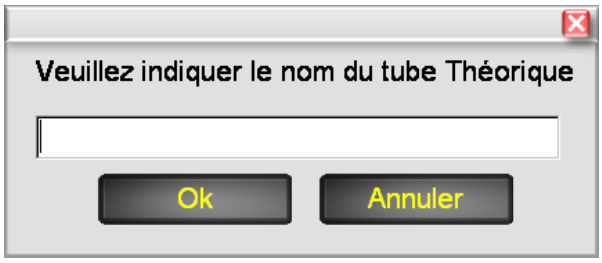
You must "**open**" (12) a tube in order to modify the different parameters and values:
The list of the first 100 tubes appears: you can either select

- by scrolling through the list
- by typing the first characters, then confirming.
- By using « ? » or « * » characters, if you don't know all characters (* for a string of characters, ? for only one character)
  Ex : the liste contains "toto1", "toto2", "titi1", tito2".
  If you enter "to", the lists is reduced with the files that start with "to", > "toto1" and "toto2".
  If you enter "*o2", the list is reduced with the files that contains the string "o2", forgetting what is before, > "toto2" and "tito2".
  If you enter "?o??1", the list is reduced with the files that contains "o" at 2nd position and "1" at 5th position, > only "toto1"; as only one file is in this reduced list, it is then automatically selected.

Warning: Opening in this way automatically deactivates the current bender (cf §E.2). It cannot therefore be used in semi-automatic or automatic mode.

C.2.b. Save a Tube (14)

Saving a Tube (14) enables you to save data or modifications carried out on a tube.
If this is a new tube, a window appears to enter the name.

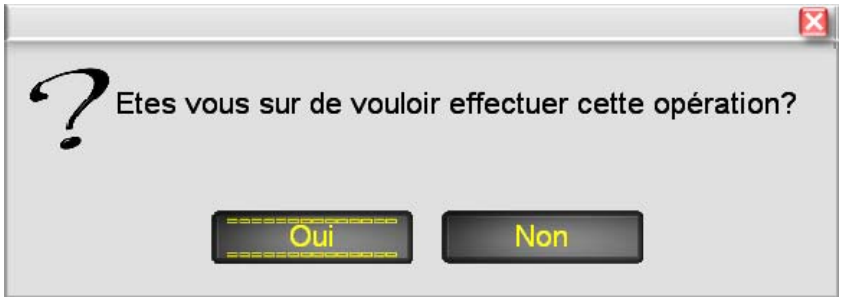


If you are updating, or if the name already exists, a message asks whether it should be overwritten (“OK”) or if the operator should enter a new name (“Cancel”)

NB: To enter a new name while delete the previous name (**rename**), press the Ctrl key at the same time as using the “Save” function.

C.2.c. Delete a Tube (13)

The Delete (13) function allows you to delete a Tube:
When selected, a list of all tubes appears: select the chosen tube and “OK”. A confirmation message is displayed.



C.3. Tube Import/Export (15/16)

Tube data can be imported or exported using a file from other software (G-Pad, SupraVision, Laser vision, BLM).

C.3.a. G-Pad

! To do this, G-Tube must have been started from within G-Pad.

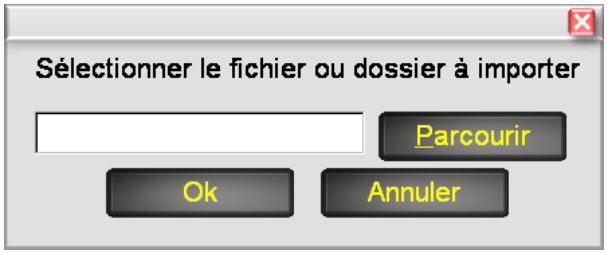
To import from G-Pad, select the tube to export in G-Pad, then in G-Tube, select “Import > G-Pad” (151). It appears in the list of Tubes.

To export to G-Pad, first open the tube (12) then select “Export > G-Pad” (161). Then return to G-Pad to use the tube.

NB: A measured tube can be exported in the same way, or can be transferred to G-Pad as a measured tube with its reference data.

C.3.b. Other imports/exports

To import one or more tubes from one or several file(s), in the SupraVision, LaserVision or BLM format, select the desired function (152, 153 or 154), then in the “browse” window select the tube file (SV), FIF file (LV) or a complete tube folder (SV or LV). The tube(s) appears in the list of tubes.



It is possible to export only in SupraVision or LaserVision (FIF) format: first open the tube (12) then select “Export > SupraVision (or LaserVision)” (162).
Select the destination folder.
NB: SV files MUST have the ***.$$$** extension and LV files the ***.ASC** extension

NB: see SV format appendix

C.4. Editing/Modifying a Tube (17)

One or more Tube parameters or values can be changed at any time

C.4.a. General Parameters (171)

These parameters are usually entered when a new tube is entered or measured.

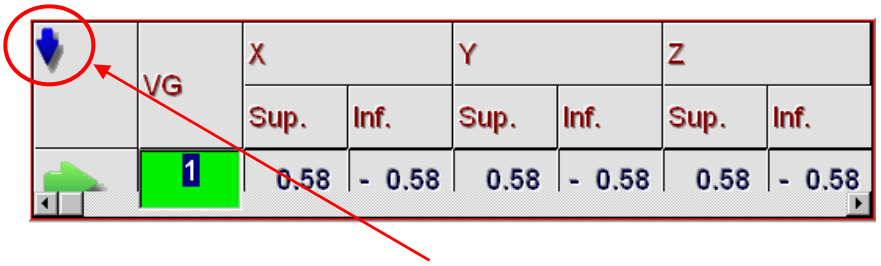
- **Tube diameter**: always External diameter
- **Developed length** (calculated, non modifiable): total length of the tube, including curves. This length is a theoretical length and does not take springback into account.
- **End distance** (calculated, non modifiable): the distance in volume from the centre of end A to end B. This length is a theoretical length and does not take springback into account.
- **General Tolerance**: Tube control tolerance applied to the XYZs and tangency Points
- **Tolerated intersection error measurement:** The maximum authorised distance in a measurement between 2 successive straight sections
- **Mini Angle** for measurement in the bend: This is the minimum value below which G-Tube automatically requests measurement of a point in the middle of the bend.
- **Maxi Angle** for measurement in the bend: This is the maximum value above which G-Tube automatically requests measurement of a point in the middle of the bend.
- **Number of measurements:** The number of times that the operator must measure the tube each time, in order to obtain an averaged result. The "Free" value allows the operator to decide when to stop measuring (at the end of each run, he is asked "Another Measurement?")
- **Comments**: These comments appear on the 3D view
- **Length Tolerance**: Length tolerance at the ends
- **Angle Tolerance**: Angle tolerance at the ends
- **Correction Type**: Choice of correction (full, partial or optimized) for the bending data (CLRA) : GTube automatically select the values to correct, partially, or not. (cf § E.1.c) according to the 2 following values :
- **Minimum length for correction**.
- **Minimum angle for correction**.

C.4.b. XYZ (172)

XYZ values are the **intersection point** coordinates.
Any coordinate change automatically impacts the intersection point LRAs and any associated parameters.

Additional functions:

- F2: **Tolerances**: by default the general tolerance (general parameters) is applied to all intersection points, but it is possible to specify another tolerance for any point, in X, Y and Z (symmetrical or not) or in FS (absolute value)



This window also has additional functions which enable tolerances to be easily modified:

- F2: Copy
- F3: Paste (only if another point has already been copied)
  These 2 functions enable a tolerance to be copied from one point to another
- F4: Duplicate: copies the selected point tolerance to all following points
- F5: Calculate: recalculates XYZ tolerances based on full size (FS) tolerance

- F3: **Parameters**: “Point Type”: (normal or divided): The bend can be split into two parts if there is a large angle: if the point is “divided”, it is one of the 2 intersection points
- F8: **Print**

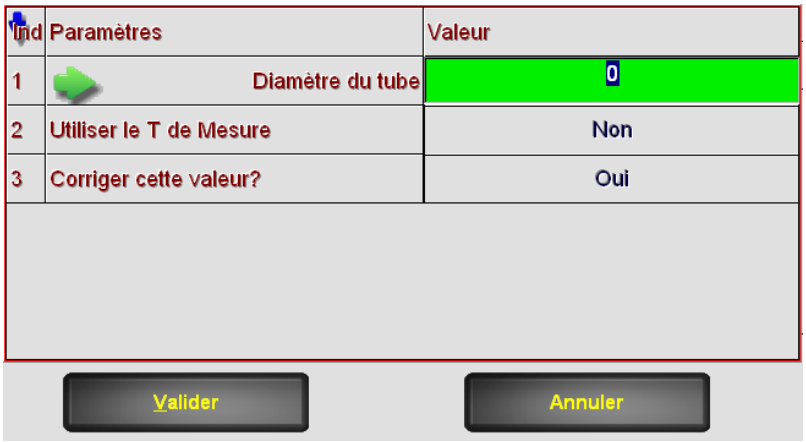
C.4.c. LRA (173)

LRA values are bending data.
Any change to them automatically impacts XYZ and intersection points. G-Tube requests confirmation beforehand: “Do you want to recalculate the XYZs?”

- **OK**: the XYZs are recalculated using the new LRAs and are automatically based on a first point in (0,0,0), a first straight section on the (X) axis and a first section on the (Z) axis.
- **Cancel**: changes to LRAs are not taken into account.

Additional functions:

- F2: parameters (on L):
  - **Tube diameter**: additional T square diameter (not necessarily same as tube diameter)
  - “**Use measuring T-Square**?”: allows you to specify that a T has been added to a long straight section for displacement during measurement (cf § D.3.d)
  - “**Correct this value**?” allows normal, optimised or no correction of CLRA values. (cf § E.1)



- F2: parameters (on R)
  - “**Correct this value**?” allows normal, optimised or no correction of CLRA values (cf § E.1)

- F2: parameters (on A)
  - “**Correct this value**?” allows normal, optimised or no correction of CLRA values. (cf § E.1)
  - “Bend Type”: (normal or divided): The bend can be split into two parts if there is a large angle: if the angle value is more than 179°, the bend is automatically splitted; if it is less, it can be manually splitted (force) (cf § B.2)

- F8: Print

NB: In the same way as XYZ, the parameters have Copy (F2), Paste (F3) and duplicate F4) as second-level additional functions.

C.4.d. Ends (174)

These functions enable managing of offsets and expanded (or reduced) diameters present at tube ends and which need to be taken into account when measuring. (cf § B.2 and § D.3.b).

To define an end (on A or B), select “Add” (17411 for A / 17421 for B). A window opens: 3 parameters can be entered

- Expanded/reduced length: Shape length at the end
- End diameter: Shape diameter at the end
- End Offset: enables the measured point to be offset if it does not correspond to the theoretical end (the offset value must be known)

WARNING, even if there is no shaping (the diameter at the end is the same as the tube diameter), the correct diameter must be given, if not the specified end will not be taken into account.

To **change** an existing end, select “Edit” (17413 for A / 17423 for B) which takes you to the previous window.

It is also possible to **delete** an end (17412 pour A / 17422 pour B).

C.4.e. Reference Method (1751)

When you inspect a measured tube compared to another tube, the default method used to align (Method and Reference) both tubes is the **Optimised Best Fit** method.
However, it can be useful to specify another method for certain tubes. (cf §D.6)
Several methods are available (17511):

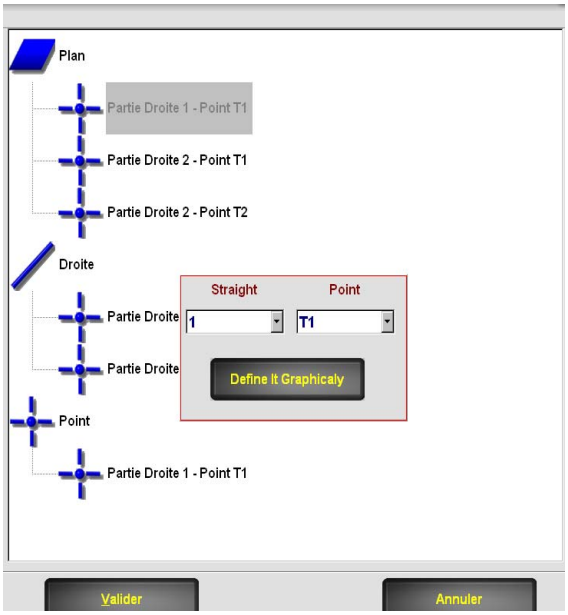
- **Best-Fit** (175111)
- **Plane-Line-Point** (175112)
- **3-2-1** (175113)
- **3 points Hard Point** (175114)
- **4 points Hard Point** (175115)
- **Optimised Best-Fit** (175116) (default)

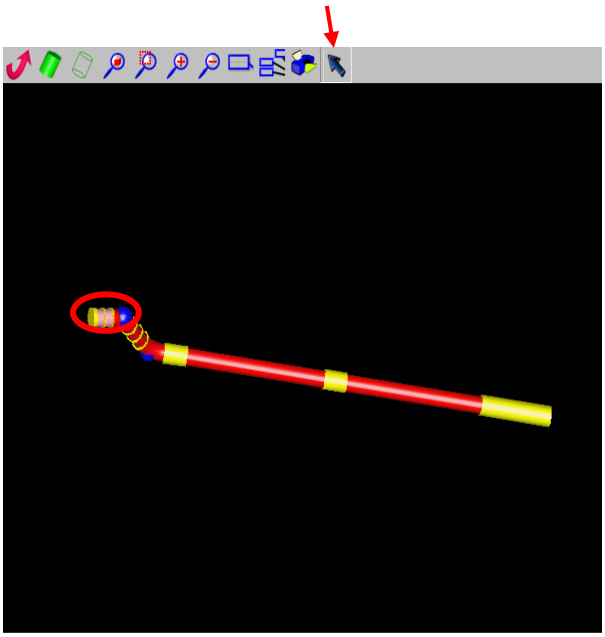
- The Best-Fit method adjusts the measured and theoretical tubes as well as possible on each straight section's T1 and T2, but without taking the ends into account.
- The Optimised Best-Fit method also adjusts the measured T1 and T2 but based on their projection on theoretical neutral fibre . In this case, the ends are taken into account.

Apart from the Best-Fit methods (no customisation), all the methods open a window in which the tube reference points must be entered.

- Plane-Line-Point: shows the 3 points used to create the Reference plane, the 2 points used to create the reference line, and the reference point.
- 3-2-1: show the 3-2-1 order (XYZ, XZY, ZYX, …) and the points used for these axes
- 3 point Hard Point: shows the first hard point, then the other 2
- 4 point Hard Point: shows the 3 adjusted points, then the hard point

In each case, to select a point, click on the point to be defined and then select the straight section and the point to be used for this straight section (X1, X2, T1, Mp, T2), or click on “Define Graphically”, in order to select the point directly on the 3D view (click on the selection arrow).





The reference method can be changed at any time (including by returning to Best-Fit) or the points can be changed (17512).

C.4.f. T1MpT2 (1752)

The T1MpT2 pitch points are automatically calculated using entered XYZ or LRA, and cannot be changed. However, they can be viewed (1752).

Additional functions:

- F2: **Tolerances**: as with the XYZs, by default the general tolerance (general parameters) is applied to all pitch points, but it is possible to specify another tolerance for any point, in X, Y and Z (symmetrical or not) or in FS (absolute value)
- F3: **Parameters**:
  - **Elbow restriction** The limit of the measurement window (bend side) is fixed by default on the pitch point ; to reduce more the risk of measurement in the bend, this window can be moved, in which case, enter a positive value.
    To allow measurement more in the bend , enter a negative value
  - **Measurement window** (cf § D.1.d) : by default, each point's measurement window corresponds to half of the corresponding straight section. This measurement area can be increased or reduced.(0 value disactivates this window, but the point must still be taken out of the bend)
  - **Point type** (normal or divided): in case of a large angle (cannot be modified in this window)

- F8: Print

NB: In the same way as XYZ, the parameters and tolerances have Copy (F2), Paste (F3) and duplicate F4) as additional second-level functions.

C.4.g. Bend Insertion/Deletion (1761/1762)

When a tube is modified, it is possible to insert or delete a bend, using an intersection point (17611 to insert / 17612 to delete), or LRA line (17621 pour insérer / 17622 pour supprimer).

On insertion, G-Tube first requests the straight section before which the bend must be inserted. The entry window then appears, with a new line to be completed.

On deletion, G-Tube simply asks for the number of the bend to be deleted.

C.4.h. Move intersection points (17613)

Only intersection points can be moved, in several directions:

- **Following straight 1** (176131) : the intersection point will be translated using the straight preceding this point (- towards the previous point / + the opposite).
- **Following straight 2** (176132): the intersection point will be translated using the straight following this point (+ towards the previous point / - the opposite).
- **Left / Right** (176133): the intersection point will be translated in a direction perpendicular to the bend
- **Inside / Outside** (176134): the intersection point will be translated using a section bisecting the previous and following sections (+ towards the inside of the bend / -towards the inside)

C.4.i. Mirror image / reverse (1763/1764)

In order to produce or check a tube whose symmetry is already stored in memory, a mirror image can be obtained.

In addition, for bending purposes (end problems), or for other reasons, it is possible to reverse the tube measurement (and bending) direction.

NB : Mirror or Reverse take effect as soon as the function is selected.

C.4.j. Units (177)

Select the function according to the desired unit: Millimetres (1771) or inches (1772)

NB: Any changes made in G-Pad are applied to G-Tube, and vice versa.

C.5. Printing Tube characteristics (18)

The print function (18) enables you to print all key information (general parameters, XYZ, LRA, T1MpT2) in one step.

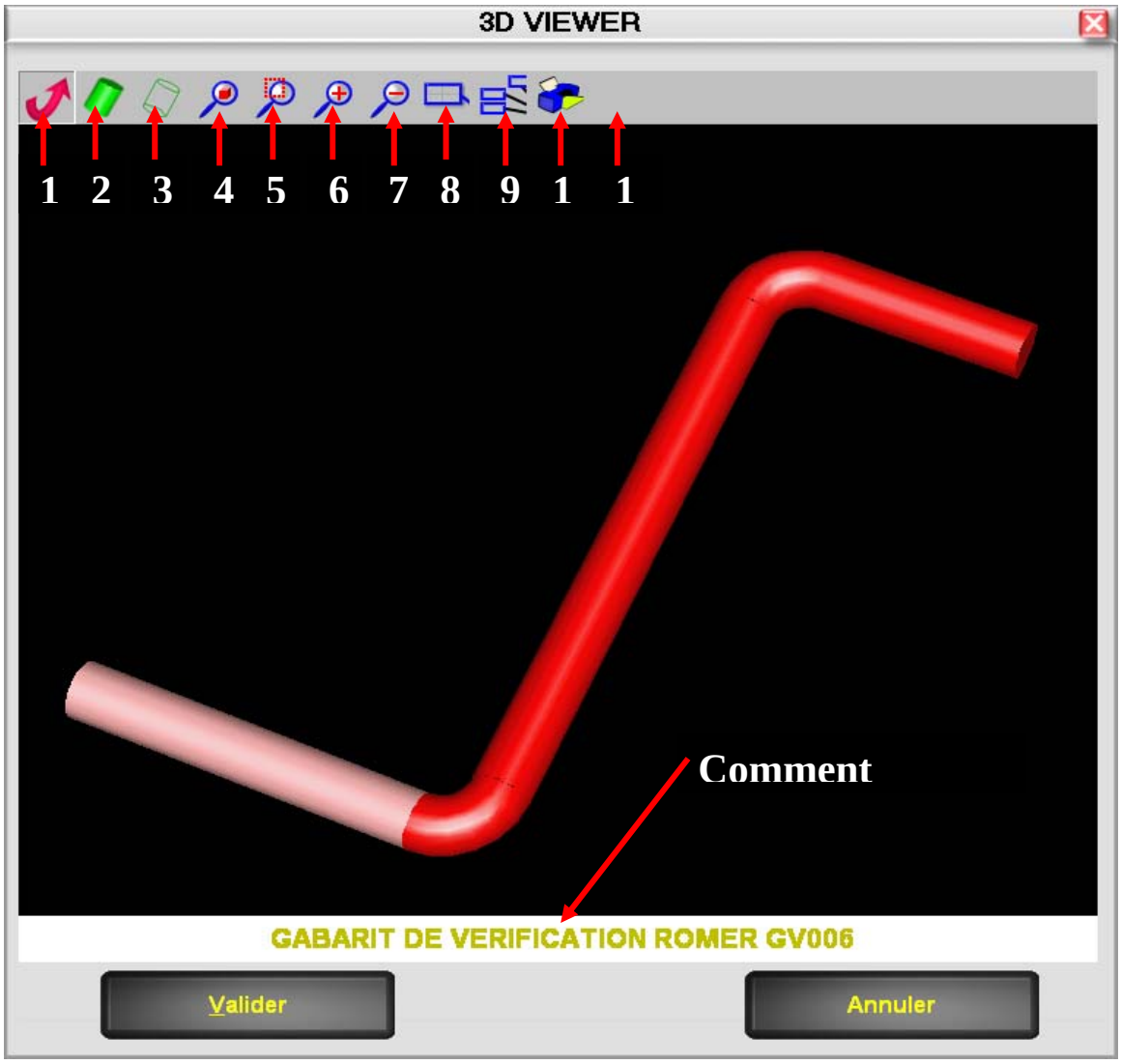
C.6. Graphical Tube view (19)

C.6.a. Introduction

The 3D tube view can be accessed from different parts of the software:

- To view the theoretical tube
- To view the measured tube
- To view theoretical and measured tubes aligned during inspection.

The light area represents the 1st straight section.
By default, the tube is displayed in shaded view, and fit to screen size.
Different buttons and functions enable the view to be changed:



- 1 : **Dynamic Rotation:** To turn the 3D view, click on the button, then click on the 3D view and move the mouse while holding down the mouse button.

- 2 : **Shaded View**: click on the button to change to rendering tube view

- 3 : **Wireframe view**: click on the button to change to wireframe tube view

- 4 : **Zoom All**: click on this button to fit to screen the whole tube.

- 5 : **Window Zoom**: click on this button to Zoom in on a part of the view: click on a corner of the zoom window then move the pointer to the opposite corner while holding down the mouse left button

- 6 : **Zoom +**: click on this button to zoom in

- 7 : **Zoom –**: click on this button to zoom out

- 8 : **Label configuration:** allows you to change the configuration of labels displayed during an inspection. (see next paragraph)

- 9 : **Label display**: displays/removes labels during an inspection
(selecting a label displays the line connecting it to the corresponding point in green)

- 10 **: Print**: prints the 3D view as displayed on the screen (prints the view on a white background).

- 11 : **Select** intersection or pitch points for reference.

- **Comments**: displays the comments entered into tube parameters (see §C.4.a)

- **Colours**: A measured tube is displayed in blue, a theoretical master tube in red. On each one, the tube's first straight section is displayed in the same colour, but clear.

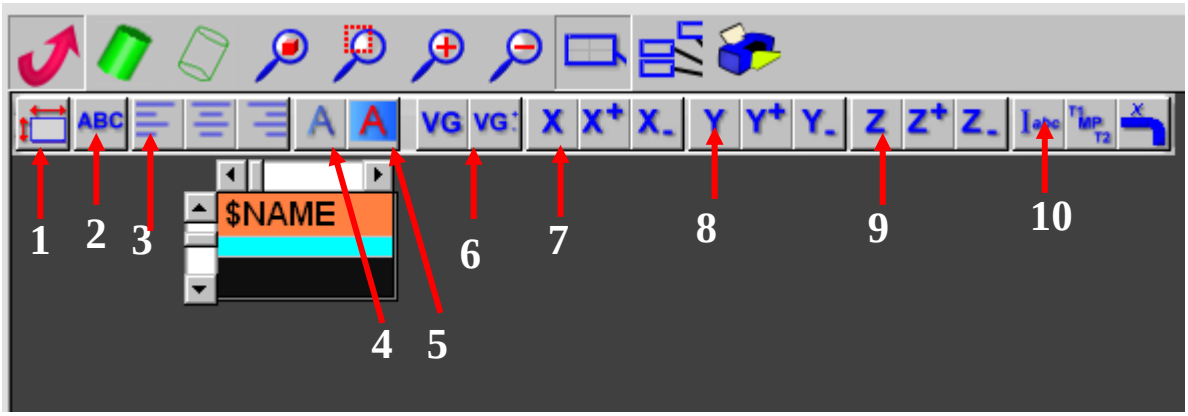
- **OK**: closes the 3D view keeping the changes

- **Cancel**: closes the 3D view, but without keeping the changes

C.6.b. Label configuration

The labels displayed on the 3D view during an inspection can be changed:

To do so, click on the button  , a table appears with boxes for each label; the change functions are the same for each cell:



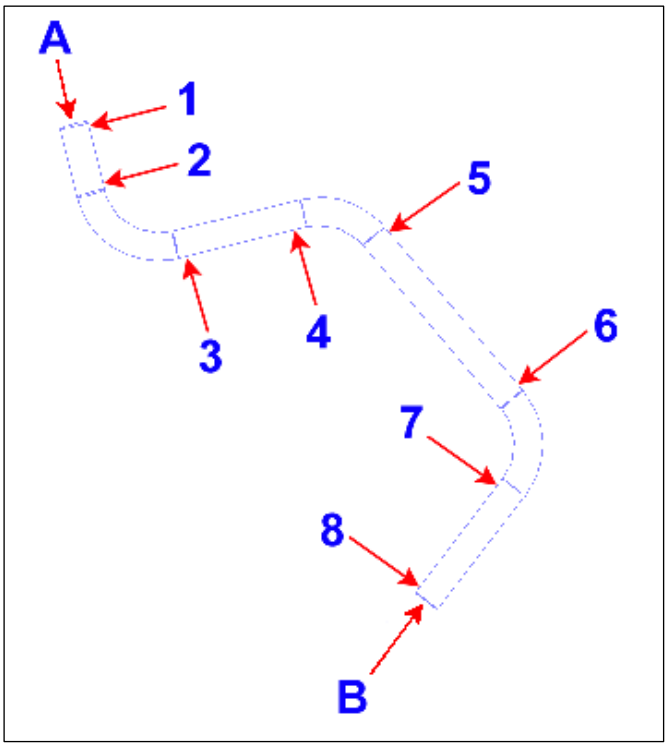
- 1 : Opens 2 cursors to change the width of the selected column or height of the selected line.
- 2 : Enables to select the font to be used
- 3a: Aligns all the text on the left of the cell
- 3b: Centres the text in the middle of the cell
- 3c: Aligns the text on the right of the cell
- 4 : Text colour
- 5 : Selected cell background colour
- 6a: Displays the deviation from the pitch point in real size
- 6b: Displays the general tolerance of pitch points
- 7 : Displays the pitch point deviation in X (7a) and tolerance in + (7b) or – (7c)
- 8 : Displays the pitch point deviation in Y (8a) and tolerance in + (8b) or – (8c)
- 9 : Displays the pitch point deviation in Z (9a) and tolerance in + (9b) or – (9c)
- 10a: Displays comments (identical to all labels)
- 10b: Displays the point name (T1, Mp, or T2)
- 10c: Displays the bend number

D.1. Principle of tube measurement

Since a tube consists of straight sections, tube measurement consists of measuring the successive straight sections, as well as the two ends A and B.

The way to measure is the following:

- Measurement of the 1st straight section
- Measurement of the 1st end
- Measurement of the 2nd straight section
- …
- Measurement of the last straight section
- Measurement of the 2nd end



In some cases, (small and wide angles), measurement of a point in the middle of the bend is also requested automatically.

Taking points is done with a non-contact V-probe.
This probe has two infrared (or laser) beams plus a plane laser beam on some probes.

The plane laser beam serves solely as a visual guide to assist the operator in taking the point at the desired location.

The 2 crossed infrared beams cut off when the probe reaches the tube: the point is automatically recorded as soon as the 2 beams are cut; no press on the Switch button is necessary.

D.1.a. Measurement of straight sections

Measurement of a straight section is done by taking 2 points.
Some measurement rules must be followed:

- It is important to distribute the 2 points over the maximum length of the straight section to obtain the best results.
- The 1st point must be taken on the 1st half of the straight section and the 2nd point taken in 2nd half. (cf § D.1.d).
- Each point must be taken on the straight section and not in the bend. Otherwise, G-Tube will detect this and force the operator to measure the straight again.
- The measurement must be taken with the probe perpendicular to the Tube
- The points must be taken in logical order

Points can be taken in two ways: Single and double precision. (cf §D.1.c)

D.1.b. Sounds during measurement

When a tube is measured, the measuring arm makes sounds to tell the operator which measurement to operate. These sounds are very useful and mean that the operator doesn't need to watch the screen to know which measurement to take.

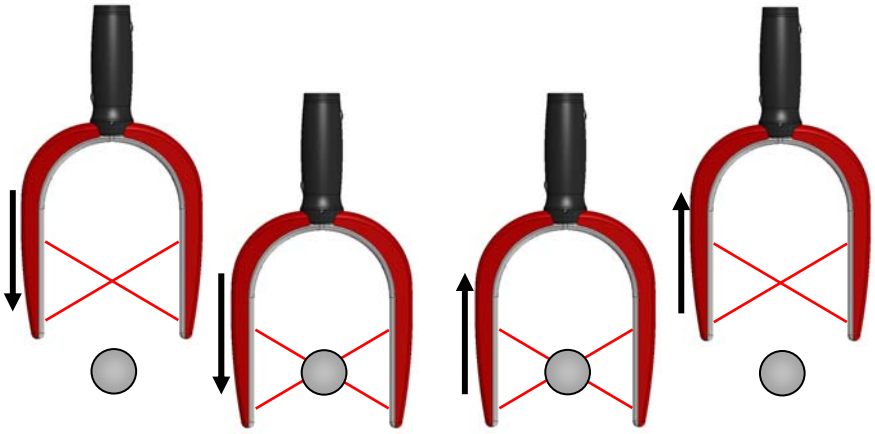
- Crackling: G-Tube is waiting for probe activation: move up the probe or bring one axis towards it mechanical stop.
- Sound requesting measurement of a straight section
- Single beeps (2 different tones): beeps sounded when each beam is cut
- Validated point sound
- Activated probe sound
- Validated straight sound (after the 2nd point)
- Sound requesting measurement of an end
- Sound indicating that the staight section has been badly measured, and requesting to measure the straight again
- Sound requesting the measurement of a point in the middle of small bend
- Sound requesting the measurement of a point in the middle of large bend
- Sound indicating tube movement
- End of measurement sound

D.1.c. Single/double precision

Straight section points can be taken in two ways: single or double precision.

- Single precision

In single precision, the probe moves towards the tube, and as soon as the two beams are cut, the point is noted and the probe can be raised: only the upper parts of the tube are measured.
This method is the quickest, but depends entirely on the tube diameter from where the straight is calculated. The straight sections must therefore be cylindrical.



- Double precision

In double precision, the probe moves towards the tube in the same way. The two beams are cut, but the probe continues to move downwards until the beams are reactivated. The system beeps and the probe can then be raised, cutting the 2 beams a 2nd time.
Using this method, the beams are cut 4 times instead of 2. The tube is therefore "surrounded" by 4 lines, and calculation of the straight section point no longer depends on the tube diameter entered in the general parameters.
In this way, it can also be used when the tube diameter is not constant ("variable diameter"), when the tube is not round (flattened or oval tube), or when the tube is poor quality.

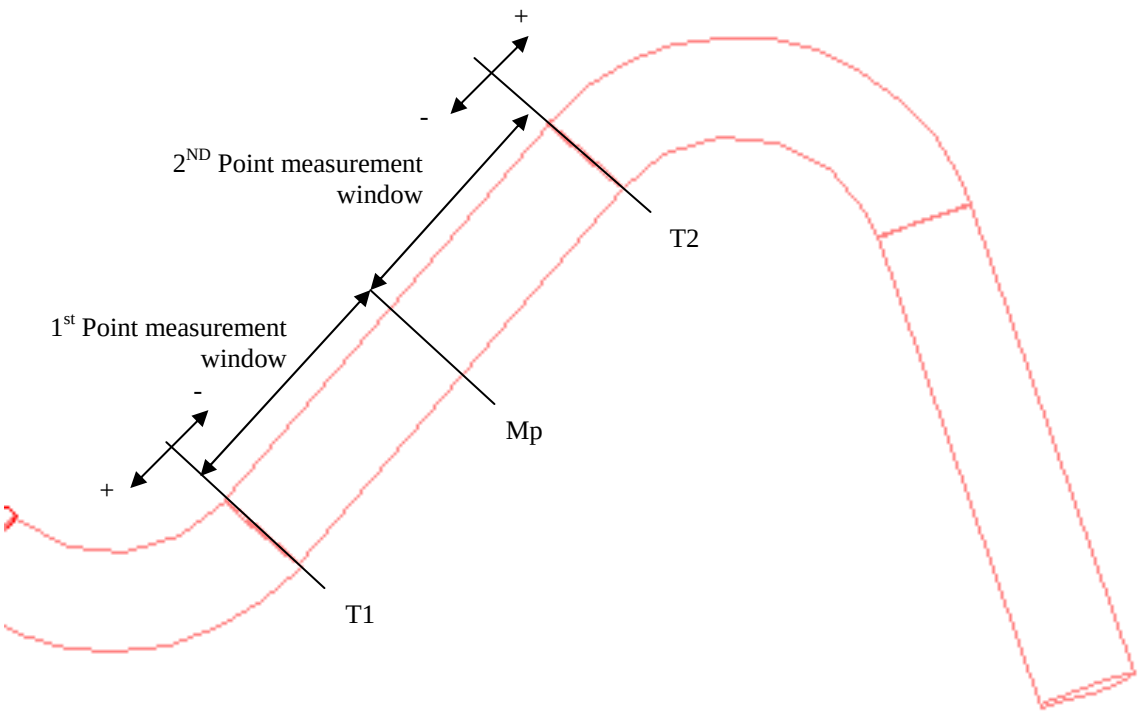
Double precision is less quick but more precise than single precision on bad roundness tubes or on variable diameter tubes. However, in most cases, single precision, which is very quick, will be the method used.

D.1.d. Measurement windows

To secure measurement quality, G-Tube imposes to take points on each straight section in their respective half straights.
For this, measurement restrictions exist : the “measurement windows”.
On each straight, the operator is obliged to take the 1st point between the previous bend and the middle of the straight, i.e. between the T1 and the Mp, and the 2nd point between the middle and the 2nd bend, i.e. between the Mp and the T2.
When the measurement is taken, a test is carried out for each point, and if one of them is taken outside the authorised window, G-Tube asks to measure again. (cf §D.3.e)

Only the 2 ends are not affected by this measurement window.
If the end has an overhang which is not taken into account(cf §D.1.e), if the tube length does not correspond to theoretical length, or if the end cannot be measured, it is impossible to actually know the middle of the straight sections.

In this way, the windows stop any points being taken in the elbow, which would produce a false result, and force the operator to redistribute points on the straight to obtain a better measurement.



These measurement windows can be modified:

- The bend side window limit (corresponding to T1 or to T2) can be moved outside the bend to improve the measurement, where deformation occurs close to the bend.
- The window length (by default half of the straight) can also be set
  - Decreased, to limit point taking to a smaller zone
  - Increased, to facilitate measurement, in particular if the straight section is small.

To change these parameters, the T1MpT2 (1752) must be edited; select the relevant pitch point (T1 for the 1st half/T2 for the 2nd half) and access the parameters (F3, or Additional Functions – Parameters)

Ind	Paramètres	Valeur
1	Restrictions mesures dans le coude	0
2	Fenêtre de mesure	100.00
3	Type de Point	Normal

You can change:

- Restrictions on elbow measurements (0 by default): if a value > 0 is entered, this window moves from the bend (restriction removed).
- Measurement window: window length (½ the length of the straight by default): reduce this length to restrict further, increase to allow more measurement freedom

For some complex tubes, it can be useful to turn off the “Measurement window”. To do so, contact your ROMER agent.

D.1.e. Offsets and Shapes

Some tubes have ends which differ from the theoretical (Offsets, shapes). These physical ends must be taken into account during measurement:

- For offsets, the end point of the overhang value must be shifted.
- For shapes (where the end diameter differs from the tube diameter): when the end is measured, G-Tube must interpret the correct diameter.

To do so, the relevant end or ends must be specified, as well as the end values (1 7 4):

- Offset: give the value for which the point must be changed (+ for surplus material, - for less material)
- Diameter: end diameter! This value must be entered, even if this refers to a nominal diameter.
- Shape length: length over which the diameter differs from nominal.

Warning: G-Tube only takes these changes and diameter into account during measurement. Therefore, these ends will not appear in the 3D view, or during a memory-based inspection (except if this comes from a measurement taking these ends into account).

D.1.f. The different probes/selection

The probe to be used should be chosen depending on tube diameter, complexity, accessibility and quality.
Except for old ones, all non contact V probes are attached using a 3 120° point index system and a clamping ring.
These probes can therefore be changed rapidly and without recalibration. It is therefore easy to change probe to always use the most suitable.
To change probe, refer to the measurement system user guide.

As a general rule, “what can do more can do less”, and a large probe will allow you to measure a larger range of diameters than a smaller one. On the other hand, measuring an end will be more difficult with a large V probe than with a small one. On a small diameter tube with a complex geometry (lots of bends, small straight sections, difficult accessibility), a Microprobe will be must more effective than a large probe.

The main probes are the following:

Probe	Single precision		Double precision		Notes
	Min. Ø	Max. Ø	Min. Ø	Max. Ø	
Microprobe	2 mm	10 mm	2 mm	8 mm	easy to use, accessibility, suitable for cables and small diameters. Section laser not available
Extended 1’’	6 mm	35 mm	6 mm	20 mm	
Non extended 3” (single precision)	6 mm	70 mm	No		Flexible, suitable for all diameters
Extended 3’’	20 mm	70 mm	20 mm	50 mm	Measurement of ends less than 10mm difficult
7’’	50 mm	170 mm	No		Laser beams – for large diameters

When the probe is changed, it must be selected in the list:

- 2171 (Measurement, Probe, change)

The probe selection window appears: choose the installed V probe, and confirm.
The active probe is displayed in the status bar on G-Tube’s main screen.

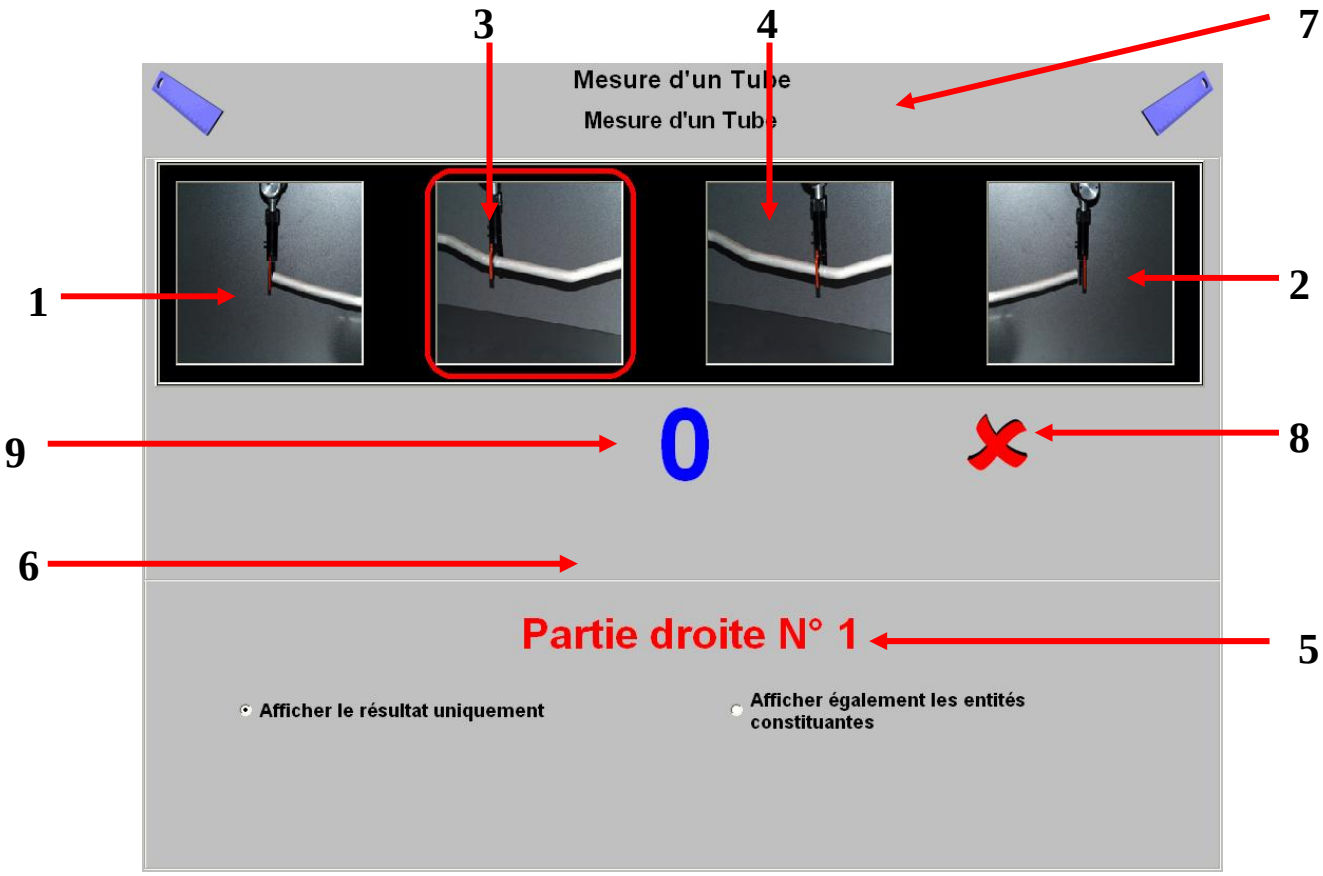
When taking the first measurement after starting G-Tube, the probe must be selected the 1st time, even if it has not be changed. The selection window is displayed automatically.

D.2. Basic measurements

D.2.a. Measuring the current tube (211)

After a tube has been selected as a master tube, it is possible to measure “the current tube”: this means measuring the tube corresponding to the selected master tube.

After selecting the function (211), G-Tube displays a graphical view of the tube to be measured, with the 1st straight section highlighted.
When this is confirmed, the screen changes to measurement:



1: End A
2: End B
3: 1st point on the straight.
4: 2nd point on the straight.
5: Straight section number
6: Message
7: Cancel measurement
8: Delete the last point/beam/straight
9: Number of cut beams on the straight

Explanations:

1 / 2: Measurement of an end: When the image is encircled, the corresponding end must be measured.
3 / 4: Measurement of a point: When the image is encircled, the corresponding point must be measured.
5: shows the number of the straight section to be measured.
6: Message : Messages may display during measurement; they can refer to:

- A bad measurement (cf §D.3.e)
- A particular measurement to be taken (point in the bend, displacement, displacement T, …)
-

7: clicking on the upper right zone (of the whole screen) completely cancels the measurement and returns to G-Tube's main screen.
8: Delete: depending on the measurement being taken, this allows you to:

- delete the last beam if point measurement is in progress
- delete the last point if straight measurement is in progress
- delete the last straight or end in other cases.

At the end of measurement, G-Tube returns to the main screen, and the diameter/number of straight sections are displayed in the "Measurement" field.

D.2.b. Measuring a new tube (213)

In the case of prototypes, sample tubes, or for other reasons, it is possible to measure a tube which does not correspond to any master tube. This is a new tube.

Use the following steps to take this measurement: After selecting the function (213),

- the general parameters table is displayed (see para. C.4.a), the measured tube diameter must be entered.
- After confirming, G-Tube tube suggests a default 2D bending radius (2 x diameter): Modify or confirm this directly.
- The number of straight sections is then requested

Display	Action	Note:
	Function selection (213)	
General parameters table	Enter the diameter and the other parameters (cf §C.4.a) OK	
Bending radius	Enter the bending radius OK	By default, G-Tube proposes 2D (radius = 2 x diameter
Number of straights	Enter the number of straight sections OK	
End A	Enter the overhang and/or shape of the first end, if applicable OK	If the diameter entered at the end is nil, the end will not be recorded
End B	Enter the overhang and/or shape of the second end, if applicable OK	If the diameter entered at the end is nil, the end will not be recorded
	Measure as usual	

D.2.c. Measured tube management

i. Save (214)

Whether it be the current tube or a new tube, it can be saved once it has been measured, It is saved the same way as a master tube and can subsequently be used as a master tube.

After selecting the function (214), enter the tube name (if the name already exists, G-Tube asks if you want to overwrite the old one, or a new name is requested).

To enter a new name while overwriting the previous name, press the Ctrl key at the same time as using the “Save” function.

ii. Export to G-Pad (212 / 2191)

A measured tube can be exported to G-Pad in 2 ways:

- “Switch to G-Pad” (212): this allows you to return to G-Pad, and to open the measured tube as thought it had been measured using G-Pad (blue entry).- If an inspection has been done, the reference is also sent to G-Pad
- “Export to G-Pad” (2191): in this case, you do not switch to G-Pad automatically, and the measured tube is sent to G-Pad as a theoretical tube (red entry)

Warning: it is only possible to export to G-Pad if G-Tube has been accessed via G-Pad.

iii. Export in SupraVision format (2192)

In the same way as a theoretical tube, a measured tube can be exported in SupraVision format.
To do so, select Export > SupraVision (2192); a window opens to enable you to chose the destination folder. Select the folder where you want to export the tube, and then confirm.

NB: see appendix for SV format

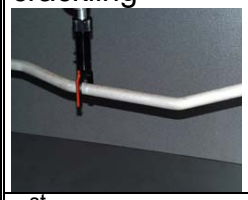
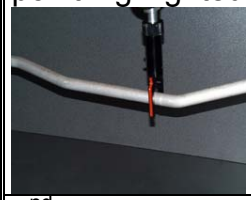
D.3. Tube measurement Operation

When selecting measurement (current part, new part, or specific measurement), the measurement screen appears.
The various elements must be measured according to instructions in the window.

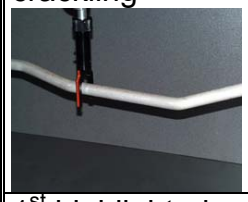
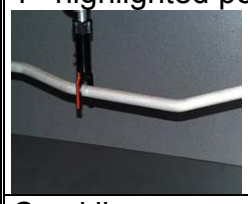
D.3.a. Taking points on a straight section

A straight section is measured with 2 points, which should cover the longest possible length.
Firstly, the screen shows the 1st point (highlighted picture).
It is important to distinguish single and double precision:

i. Single precision:

Display/Sound	Action	Note
1st highlighted point / crackling 	Move the V probe to activate the beams	Once the V has been activated, the crackling stops
1st highlighted point 	Move down the V probe onto the 1st half of the straight	A small beep is sounded when each beam is cut
A sound is made after the 2 beeps	Raise the V probe	
Number of beams = 2 / 2nd point highlighted / crackling 	Move the V probe to activate the beams	Once the V has been activated, the crackling stops
2nd highlighted point 	Move down the V probe onto the 2nd half of the straight	A small beep is sounded when each beam is cut
Number of beams = 4 (short) / A sound is made after the 2 beeps	Raise the V probe	The straight section has been completed

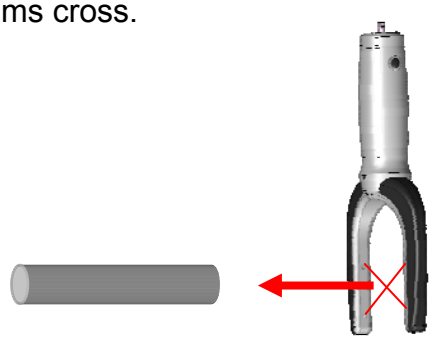
Double precision:

Display/Sound	Action	Note
1st highlighted point / crackling 	Move the V to activate the beams	Once the V has been activated, the crackling stops
1st highlighted point 	Move down the V onto the 1st half of the straight	A small beep is sounded when each beam is cut
Crackling	Continue to lower the V until the beams are reactivated	If the V is raised, the crackling continues
The crackling stops, a beep is sounded	Raise the V	A small beep is sounded when each beam is cut
Sound after the 2 beeps / Number of beams = 4 / 2nd point highlighted / crackling 	Move the V to activate the beams	Once the V has been activated, the crackling stops
2nd highlighted point 	Move down the V onto the 2nd half of the straight	A small beep is sounded when each beam is cut
Crackling	Continue to lower the V until the beams are reactivated	If the V is raised, the crackling continues
The crackling stops, a beep is sounded	Raise the V	A small beep is sounded when each beam is cut
Number of beams = 8 (short) / A sound is made after the 2 beeps		The straight section has been completed

D.3.b. Measurement of an end

No matter which measurement type is used (single or double precision), ends are measured in the same way:

The probe must be perpendicular to the end and the beams must cut the tube together, where the 2 beams cross.



- **Skipping a measurement:**

Where it is impossible to measure an end (assembled tube, non suitable end, preshaping, …) the operator can skip this measurement.
To do so, just hold the probe switch-button pressed until you here the signal (‘long click’).
The measurement is skipped and the point on the straight section closest to the end is considered as the end.

D.3.c. Taking a point in a bend

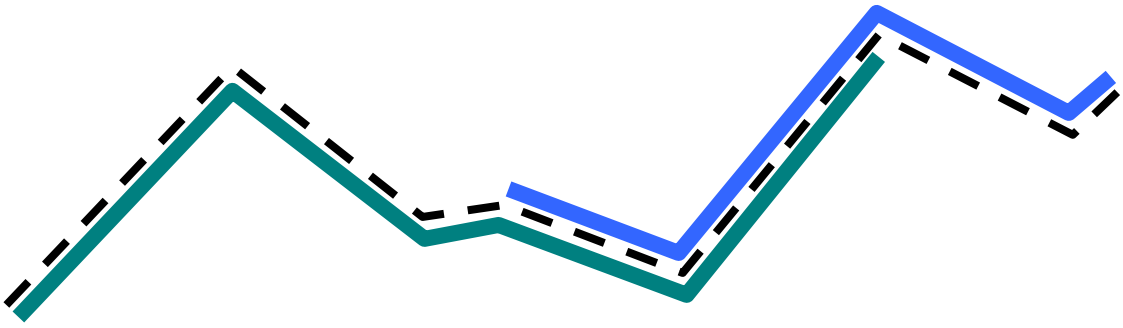
For some very tight or open bends (cf §C.4.a), it is requested to take a point in the bend:
The V probe must be moved down onto the middle of the bend, with the V perpendicular to the tube, cutting the 2 beams, to indicate its position.
The measurement is the same regardless of measurement mode (single or double).

D.3.d. Long Tubes: Tube movement

In case of too long tube to be measured in one step, the tube can be moved during measurement.

i. classic movement

The simplest movement involves remeasuring two straight sections back after movement. By superimposing these 2 straight sections before and after movement, the 2 tube parts can be attached automatically.



Some conditions must be met for this to be possible:

- The 2 straight sections used for the movement must form a bend which is neither too open or too closed (20° < angle < 160 °)
- At least 3 straight sections must already have been measured

Method:
After measuring the 2 straight sections, keep pressed the probe push-button (long click) until you hear the signal, then move the tube in order to be able to measure the rest.
The screen then asks for the 2 previous straight sections to be remeasured.
Complete the measurement as usual.

NB: A tube can be moved as many times as necessary as long as there are 3 straight sections between each movement.

NB: It is impossible to cancel a straight section once it has been moved.

ii. Moving using a T

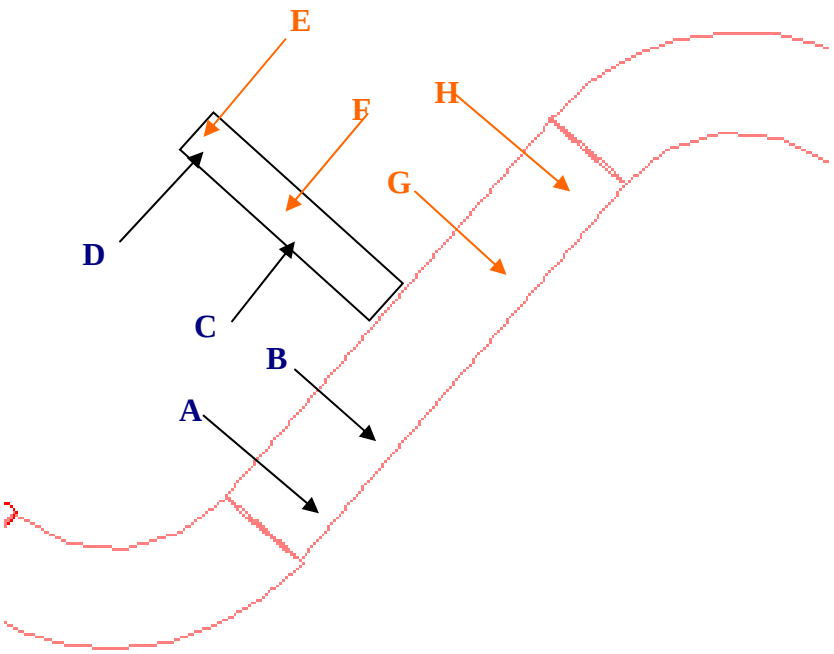
When you cannot move the tube in the classic way (the section is too long, the angle is too small) you can use a displacement T square (see C.4.c)

This involves adding a tube(« T ») perpendicular to the straight section. This T will then be measured as a straight, and will be used for movement. This intermediate “straight section” does not feature in data or inspection.

This T can be the same diameter as, or a different diameter to the tube and can be added anywhere on the tube straight section.
To do so, it must be specified in the theoretical: enter the LRA (173), select the straight section onto which to insert the T, and activate additional parameters (F2).

When measuring, everything functions in the same way as during normal movement except that the long click is not required, G-Tube directly requests measurement, movement and remeasurement of the T as well as the straight.

Display	Action	Note
	173 : Edit the theoretical LRAs	
LRA table	Select the relevant straight (select the L)	
L highlighted	F2:	Displays parameters
Parameter table	Enter the T diameter and select “Yes” for “Use a measuring T”, then validate	
	211 : Start measuring	
	Measure the 1st part of the tube as normal	
The relevant straight section	Measure the 1st half of the straight section (2 points) (A; B)	
	Measure the T (2 points) (C; D)	
	Move the tube	
	Remeasure the T (E; F)	
	Measure the 2nd half of the straight section (2 points) (G; H)	
	Complete the measurement as usual	



NB: You cannot go back once you have moved.

D.3.e. Remeasuring a straight section {causes}

When measuring, because of a badly taken point, tube deformation, or for another reason, an error message can be displayed.
There follows a list of possible messages:

Display	Action	Note
Straight Section badly measured	Measure the straight again	Bad measurement of the straight
Straight Section badly measured	If it continues, remeasure the previous straight	
Straight Section badly measured	Change the intersection error permitted during measurement: (cf § C.4.a)	The tube is deformed
Measurement in the bend (T1)!	Remeasure the current straight	The 1st point on the current straight was measured in the bend
Measurement in the bend (T2)!	Remeasure the previous straight	The 2nd point on the previous straight was measured in the bend
Bend Measurement (angle > 180)	Take a point in the middle of the bend	The bend forms an angle higher than 178°
Bend Measurement (large angle)	Take a point in the middle of the bend	The bend forms a large angle
Bend Measurement (small angle)	Take a point in the middle of the bend	The bend forms a small angle
Measure out of the Authorised Window (T1)!	Remeasure the current straight	The 1st point on the current straight was measured outside the window
Measure out of the Authorised Window (T2)!	Remeasure the previous straight	The 2nd point on the previous straight was measured outside the window
Go Back!	Remeasure the previous straight, measuring the 2 points within a distance lower than twice the bending radius	One 180° bend follow another one.
Bending Radius	Enter the real radius	The real radius is from far different from the theoretical one, due to springback

D.4. Specific measurements (215)

In addition to tube measurement, some specific measurements are possible

D.4.a. Quick measurement (2151)

In many cases, the most important tube elements are the ends since these are connection points.

It is possible to carry out a rapid test only taking the ends into account:

- Select function 2151: The 3D view appears, showing the 1st straight section
- Confirm
- Measure the 1st straight section and the 1st end
- Measure the last straight section and the 2nd end
- Once measuring is completed a table shows the control results:
    - Nominal A-B distance
    - Nominal angle between the end straights
    - Measured A-B distance
    - Measured angle between the end straights
- Based on these results, the operator can decide either
    - To confirm the results if correct, in which case the quick test is finished
    - To cancel if the results are not correct, in which case G-Tube runs normal tube measurement in order to carry out a complete test.

D.4.b. Springback measurement (2152)

Because of tube manufacturing requirements, it is possible to take tube elasticity (Springback) and stretching (elongation) coefficients into account. (cf § E.1)

To know these coefficients, they can be measured.

To do so, a 2 bend master tube must be programmed:

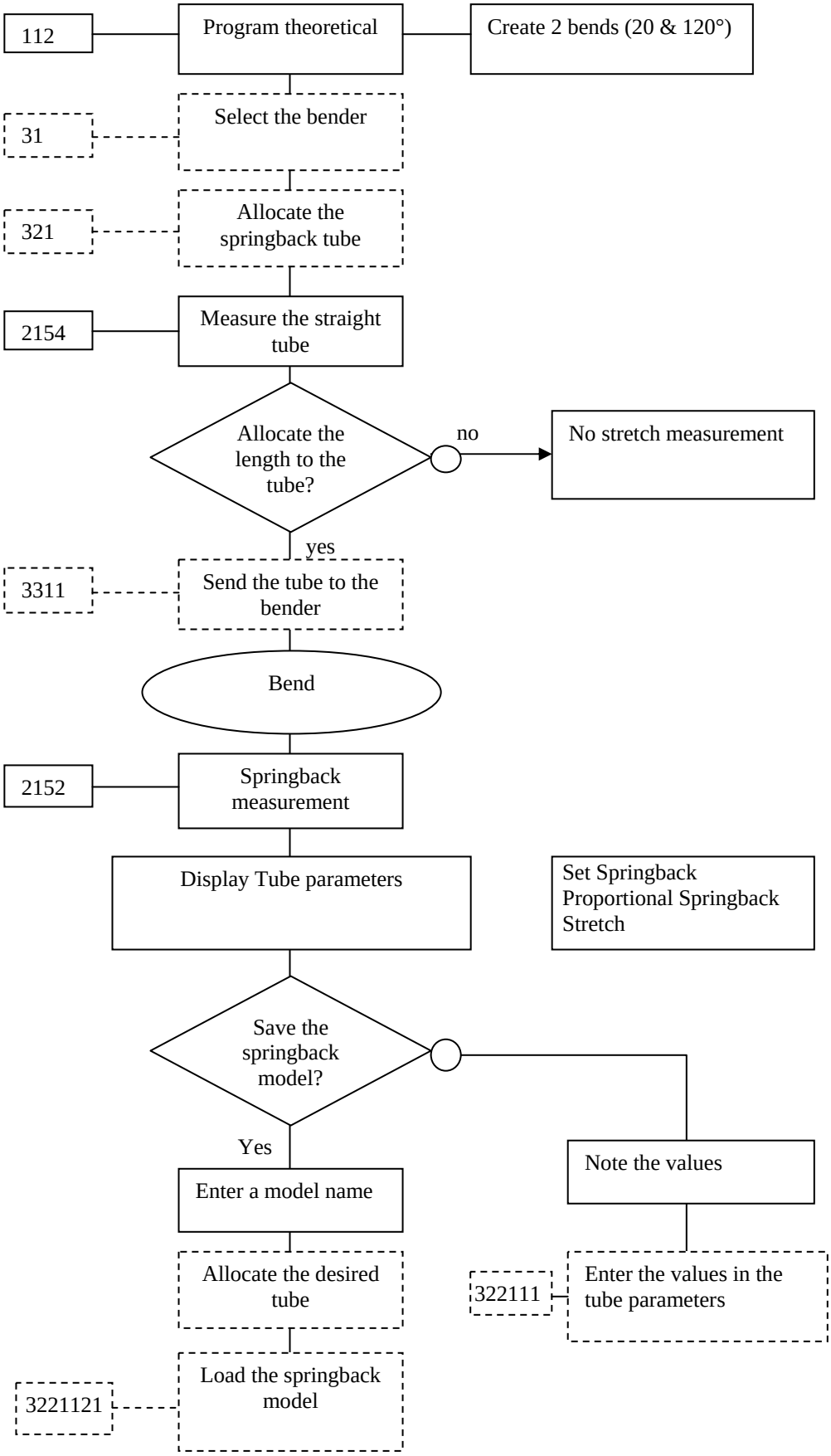
- 1 open angle bend (20°)
- 1 closed angle bend (120°)

It is also important to know the unbent straight section tube length accurately in order to calculate the stretching coefficient. (For this, use the Straight length measurement function). § D.4.d).
Program the tube and open it as a master tube.
Measure the straight length (when asked “do you want to apply this length to the master”, reply yes).
Then bend the tube and select the Springback measurement function, then measure the bent tube.
Once measurement is completed, G-Tube calculates and displays the following coefficients:

- Tube elongation
- Fix springback
- Proportional springback

These values can be applied directly to the bender (depending on model) or in G-Tube: if the bender is configured in G-Tube, do not open the tube using function 12, but select the bender (31) and allocate the tube to it (321); measure the springback: G-Tube finally asks whether you want to save the coefficients as a model. (cf E.5.b)

Springback measurement flow chart



------- : Optional

D.4.c. Measurement statistics (2153)

i. Neutral file

Not supported yet

ii. Rapid analysis

This function enables measurement tests to be carried out (repeatability, repetition) by measuring a tube N times by X operators.
Recording will be started, the measurements carried out by X operators, then when recording is finished, a statistical table displays.

iii. DAM

Renault Test functions: refer to Renault documentation.

D.4.d. Measuring a straight tube (2154)

To measure a elongation coefficient, the length of the unbent straight tube must be accurately measured.

To do so, select the Straight Tube Measurement function:
The theoretical general parameters window appears.
Confirm this window to proceed to measurement:
Measure the straight section and then the 2 ends
When measurement is completed, the general parameters redisplay, but now showing the new length.

This value can be applied to the theoretical and to the bending tube parameters.

D.5. Edit the measured tube (218)

After measuring a tube, the data can be displayed directly in the measurement menu. This enables measurement to be verified prior to inspection or to save the measured tube.
Publishing a measured tube gives the same options as a theoretical tube.

D.5.a. XYZ (2181)

Cf § C.4.b

D.5.b. LRA (2182)

Cf § C.4.c

D.5.c. 3D view (2183)

Cf § C.6.

D.6. Manual mode inspection

Tube inspection consists of comparing the measured tube to the master tube. In manual mode (without bender), inspection simply involves aligning the measured tube on the master tube, depending on the reference method being used (cf § C.4.e).. Then view the results manually.

D.6.a. Inspection of measured tube compared to current tube (22)

After measuring the current tube (cf §D.2.a),, select the Inspection function: G-Tube aligns the 2 tubes (measured and theoretical).
The desired results can then be viewed. (cf §D.7)

D.6.b. Memory inspection (216)

Inspection does not only entail the last measurement: : any tube can be opened as a measured tube, and can be considered as such for inspection, in which case a tube already in memory is inspected.

This can be useful to compare two tubes in memory - one opened as master (12) and the other as measured.

This function can also be used to carry out a new inspection of a tube already measured and saved.

Select the Memory Inspection function (216) and select the tube to be inspected in the list of tubes, then confirm.
The selected tube is displayed in the measured field. It can be used as tube which has just been measured and all tasks applicable to measured tubes can be carried out.

D.7. Results (23)

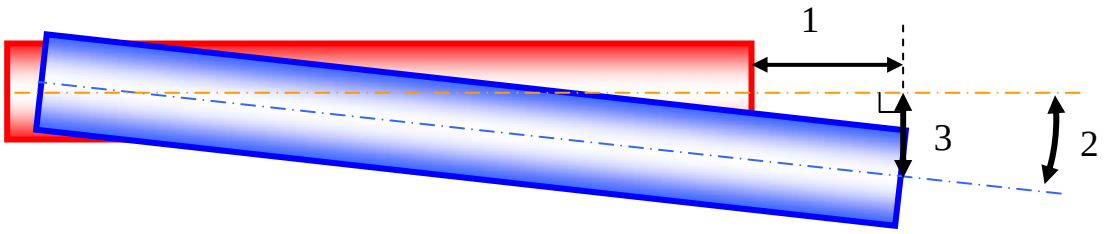
Two levels of results are available: Standard and extended, depending on which details you wish to see.

D.7.a. Standard result (231)

i. T1MpT2 (2311)

These results are specifically the data which enable a tube to be validated or not. There are 2 parts: ends and pitch points.

The first part represents errors on ends A and B:

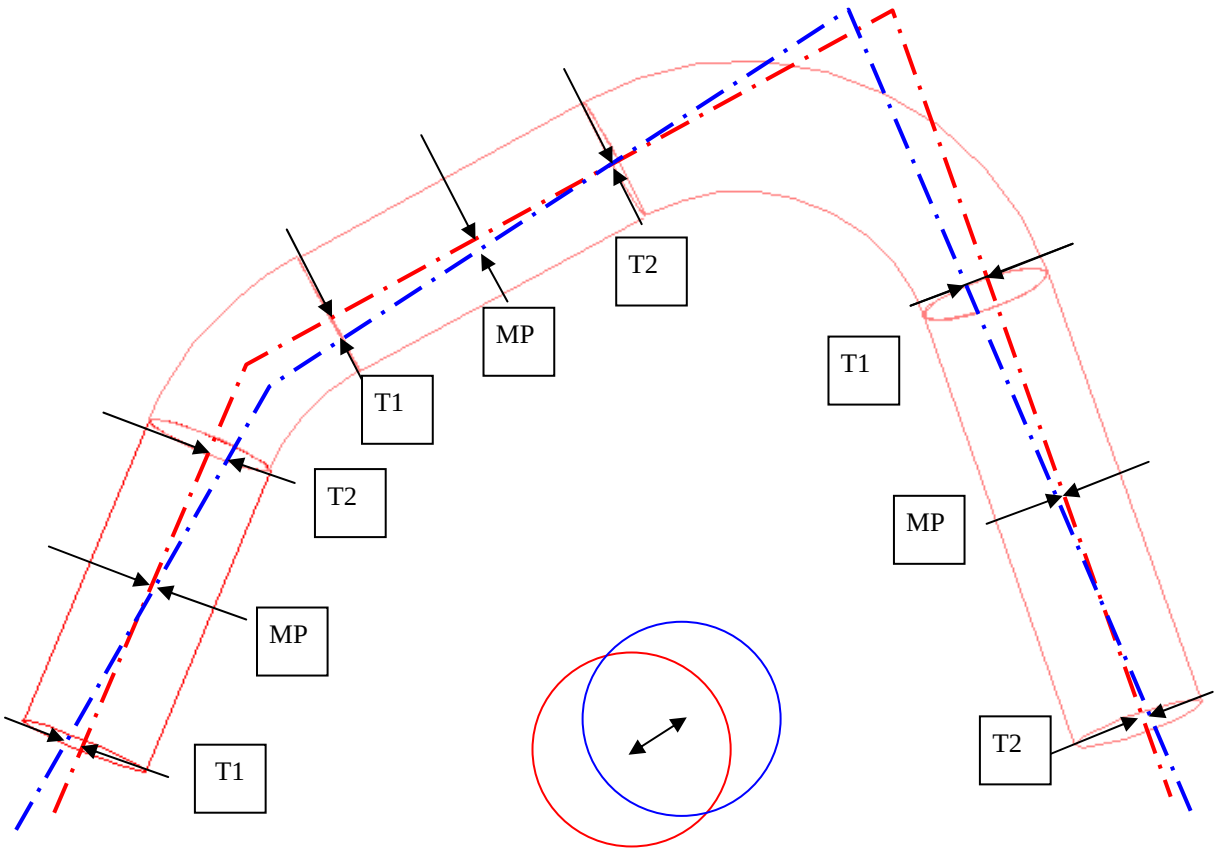


1: **Length**: This is the difference between the theoretical end and the measured end projected onto the theoretical straight.

2: **Angle**: This is the angle difference between theoretical and measured straights. Warning, this does not refer to the bend angle error at the end!

3: **Deviation**: This is the envelope difference at the end (= relevant pitch point), i.e. the difference between the measured end and its projection onto the theoretical straight.

The 2nd part represents tube envelope errors at the pitch points and the middle point, which is representative of the tube test gigs.



For each point, the difference displayed is the difference between the measured point and its projection onto the theoretical straight.

In standard results, the value displayed is a single distance shown full size (projected absolute value).
In addition, these results can be displayed in 3D view. (cf § D.7.c)

ii. LRA (2312)

These results, called Delta LRA, are the basis of corrections applied to the CLRAs when used with bender. (cf §E.1).
Warning: measured LRA accuracy depends in part on the lengths and angles encompassing each bend. This is why these results cannot be used to validate a tube (cf §B.4)

The deviation in length is the difference between measured and theoretical length : if the value is < 0, the real length is too small.

The rotation difference is the difference in angle between measured and theoretical rotation.
Warning, this value comes from the measurement. Its sign does not therefore depend on bending way (clockwise or trigo).

The angle difference is the difference between measured and theoretical angle: indication > 0 indicates a bend which is too tight.

iii. XYZ (2313)

This result displays the difference in 3D between measured and theoretical intersection points.

Warning, measured intersection points are virtual points obtained from measured lines. Their accuracy depends on the bend angle and the result cannot be used to validate a tube under any circumstances. (cf §B.4)

The values displayed are the differences in 3D between measured and theoretical points, they are not projected points. Only the FS is displayed in standard mode

iv. Printing (2314)

The results can be printed separately by displaying the desired result (T1MPT2, LRA or XYZ) and then using F8 additional function.
It is also possible to print all these results directly together using the print function.

Before effective printing, the 3D view is displayed. This enables you to select the desired view in order to print it. In this case, validate the view. If the 3D view should not be shown, Cancel to close the view.

D.7.b. Extended result (232)

These results give the same entities, but with more detail.

i. T1MpT2 (2321)

The same values are given as in Standard results (§ D.7.a.i),, but the X, Y and Z deviation is also given, based on the master tube axis.

Nb : GTube can be configured to display non projected deviations (measured point-nominal point instead of measured point-nominal line) : cf §G.5

ii. XYZ (2322)

The same values are given as in Standard results (§ D.7.a.iii, but the X, Y and Z deviation is also given, based on the master tube axis.

iii. Printing (2323)

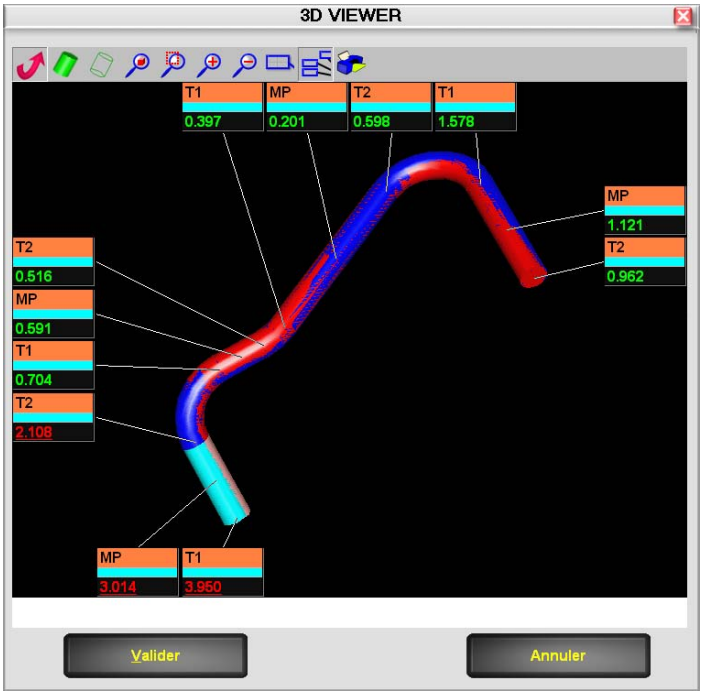
Printing extended results is the same as printing in Standard mode, but T1MpT2 and XYZ values are given with their individual X, Y and Z components according to the master tube axis.

D.7.c. 3D view inspection (233)

On 3D view, measured and master tubes are aligned. As with the other results, it is first necessary to calculate inspection (22).
The two tubes are displayed together (according to the selected reference mode), the master in red, and the measured in blue.

This enables tube deviations to be seen in an objective manner.

A button enables labels showing the T1MpT2 differences to be added (for configurationCf § C.6)



D.7.d. Excel report (234)

In the same manner as direct printing of results, the Excel report function enables an Excel report to be generated.
G-Tube firstly displays the 3D view to select the view you wish to show on the report (cancel if you do not want to show it).

For Excel configuration, cf § G.2

E- THE “BENDERS” FUNCTION (3)

E.1. Principle of tube manufacture and correction

E.1.a. Principle

Industrial tube benders all follow the same principles, using LRA bending data (Length, Rotation, Angle) (save exceptions).

Tube bending is carried out in the following manner: the tube advances through a length L, then rotates R, and the bending arm applies angle A to the tube, then moves on to the next bend.

Length L corresponds to translation of the tube through bender axis Y,
Rotation R corresponds to rotation of the tube on itself, i.e. around bender axis Y (B orientation).
Angle A corresponds to tube bending around bender axis Z (C orientation)
That is why some countries use the terms YBC instead of LRA.

A tube always presents different mechanical properties (elasticity, stretching ellongation), depending on material, diameter, thickness, or even manufacturing batch…
In addition, on a bender, the tools are never identical and are assembled with their own specifications.
This means that if a tube is bent using LRA data, it is very possible that the bent tube will not correspond to theoretical data entered into the bender: the angles will be too open, or the tube too long,…

It is therefore necessary to correct this bending data to compensate for shortcomings in bender tool assembly, elasticity, stretching,…
G-Tube does this when a tube is inspected in Auto or semi Auto mode.
G-Tube reads bending data and corrects them in relation to LRA errors on the measured tube. These data can then be sent back directly to the bender.

Following this, bending data are no longer discussed in terms of LRA, but in terms of CLRA (corrected LRA) (or CYBC instead of YBC).

E.1.b. Correction rules

When a tube does not fall within tolerance, this means that the bending data do not allow a tube to be produced with the desired LRA characteristics.
These data must therefore be modified.
To do this, each value is corrected using the measured deviations:

If for a theoretical length of 100mm, the actual length is 95mm, bending has produced a length which is too short, and so a length longer than 100mm must be entered. 5mm is added in order to produce a length closer to the desired length.

This principle is applied to all LRA:

$CL_{n+1} = CL_n$ - Delta L
$CR_{n+1} = CR_n$ - Delta R
$CA_{n+1} = CA_n$ - Delta A

As a general rule, LRA are corrected on all bends. However, in some cases, not all should be modified:

- If a shaping tool is mounted on the bender
- If the bit length = straight section length.
- If tube characteristics do not permit repeatable values to be obtained.

To do so, the relevant values must be blocked. (cf § C.4.c)

The third case is very important:

- A length must be blocked if its value is smaller than a critical value
- An angle must be blocked if the length value before or following the bend are smaller than the critical length.
- A rotation must be blocked if one or more straights making up the rotation are smaller than the critical length.
- A rotation must be blocked if one or both angles making up a rotation are lower than a critical angle.
- The critical length can correspond to the bender shoe to avoid the straight being too short for the mounted tool.
- The critical angle corresponds to the minimum needed to obtain a repeatable measurement.

E.1.c. Correction Types

You can specify whether to carry out normal correction for each value according to the rules described above, or not apply the correction (freeze the value). You can also specify that correction should be “optimised”.
In this case, by editing the LRAs, selecting the chosen value and then entering the parameters using F2.

Normal (“yes”) or full correction, corrects the whole value by the difference using the formula above.
No correction (“no”) does not modify the value.
Optimised correction modifies the value in weighted manner.

Optimised correction can be useful if the bending angle is small, for example.

By default, a tube is fully corrected on all its LRAs (except where a value is modified manually).

In the master tube general parameters, G-Tube can be allowed to automatically select the values to fully correct, either optimised or not at all, according to the following rules:

- Total: total correction is applied to all the LRAs
- Partial: total correction is applied to all values, except some which are not corrected.
  - If a length is lower than the “minimum correction value”, the current and next bending angles, the previous, current and next rotations, as well as the length itself will be fixed.
  - If a bend is lower than the “minimum correction value”, the current and next lengths, the previous, current and next rotations, as well as the bending angle itself will be fixed.

- Optimised: all the values are fully corrected except if the bending angle is lower than the “minimum correction value”, in which case the whole bend line (L, R and A) will undergo optimised correction.

The minimum length and angle values for correction can be modified in the master tube general parameters. (by default L=0 / A=15°)

The choice of correction type in the general parameters only selects automatically from the LRAs, the values to fully correct, optimised, or not at all, in the same way as is possible manually.

E.1.d. Absolute CLRAs

Some benders (manual ones in particular) do not use CLRAs for each bend, but CLRAs which increment as you work through the bends:
L no longer corresponds to the length of each straight section, but to the total tube advance from the beginning of bending for each straight section.
R no longer corresponds to each bend's rotation, but to total tube rotation since the beginning of bending for each bent section.
Only the bending angle remains the same.

To select Absolute CLRA mode, please refer to the next section. § E.7.a

E.2. Principle for the use of a bender in G-Tube

G-Tube can be used with or without a bender.
Configuring a bender in G-Tube allows auto-manual mode to be used to carry out tube inspection/correction. Depending on the type of bender, it also allows direct communication (through serial or parallel cables) with the bender to exchange CLRAs, and to run bending parameter management from within G-Tube.

Many bender types can be configured. For other types, one or more “virtual” benders can be used which will operate in the same manner, but without communicating directly. In this case, it is still possible to print the CLRA to transfer them using the bender panel.

In G-Tube, each configured bender has its own folder, in which the current tube (allocated to this bender) will be copied. This means that each bender is fully independent of the others, and that the same tube can be allocated to several benders with different parameters depending on the bender. The only thing in common relates to the theoretical elements (nominal data, inspection parameters,…).

Once a tube is allocated to a bender, it preserves all its bending parameters (CLRA, parameters) for as long as they are not modified or the tube deleted from this bender (which does not in any case delete the theoretical). The current tube can therefore be changed without losing tube information.

On the other hand, if a structure change is made to the theoretical tube (add/delete a tube, inversion, …) it will be deleted from the other bender folders automatically.

Bender programming (management, configuration) can only be done by technicians trained and authorised by Romer (a password is required).
Contact your agent for any configuration.

E.3. Bender selection (31)

To work in Bender mode, first use the “Bender (3) > Change (1)” function and select the bender in the list.

It is also possible to use Auto-Manual mode, select the bender and then return to the main menu using Esc.

The bender name and image are displayed in the Bender field, and the allocated tube is redisplayed with.

E.4. Managing a tube for a bender

E.4.a. Allocating a tube to a bender (321)

Once the bender has been selected, the current tube must be allocated it to it (the tube you want to inspect and produce).
Select the “Bender (3) > Current Tube (2) Change (1)” function and select the tube in the list.
The theoretical tube is displayed in the theoretical zone.
If corrections have already been applied to this tube, it is reloaded with these corrections and parameters.

Warning: to select the tube, do not use “Tube (1) > Open (2)”, since this would deselect the bender.

E.4.b. De-allocating a tube / deleting a tube for a bender (324 and 325)

In some cases, you need to have no tube allocated to the bender (receiving a theoretical tube from the NC). In this case, changing the current tube is not enough.
Select the “Bender (3) > Current Tube (2) None (4)” function. The theoretical zone displays “EMPTY”.

This operation does not delete files from the bender folder.

However, selecting “Bender (3) > Current Tube (2) > Delete (5)” deletes the tube file in the bender folder. The theoretical tube is not deleted.

NB: This type of deletion is carried out automatically if the operator modifies the tube’s theoretical structure (Add / Delete a bend).

! Warning, deletion will result in the loss of parameters and CLRA

E.5. Editing tube bender parameters (3221)

NB: the list of parameters depends on the type of bender and site configuration.
The main and common ones are shown here. Please refer to the appendix for other parameters. § H.5

E.5.a. Editing (3221)

Bender parameters are set out in 3 groups.

- Tube Parameters: to do with the tube itself
- Machine Parameters: to do with the bender
- Tool Parameters: to do with tool settings (mandrin, clip, …)

These can be set out differently depending on the bender.

i. Tube (32211)

All benders have the following 4 parameters:

- Cut tube length: by default, the length of the developed theoretical tube, but this can be modified to enter the true length of the straight tube. This value is often sent to the NC. If the length has been measured using special measurement functions, it is applied automatically. (cf §D.4.d).

- Fix springback
- Proportional springback

} These elasticity and stretching parameters can be loaded from a springback file. (cf § E.5.b.i)

- Stretching

ii. Machine (32212)

The only common parameter is the loading position

iii. Tools (32213)

By default, no tool parameters are common to all benders.

E.5.b. Using parameter models

When tubes share common parameters, parameter models can be saved.
With a first tube, enter the relevant parameter values, then save these parameters as a model: Tubes in the same category can then load the relevant parameter model, and then modify only the parameters which are different.

Warning: A parameter model is associated with the bender model under which it was saved. It cannot be loaded with a different type of bender.

i. Springback model (322112)

This model only concerns springbacks and stretching. It can be loaded with any bender.
To save a model, enter the values (322111) and select “Springback > Save” (3221122).
To load on another tube, change the current tube (321), then select “Springback > load” (3221121).
To delete a model, select “Springback > Delete” (3221123).

ii. Full model (32214)

The full model operates in the same way as the Springback model, but must follow the same bender type. This concerns all bender parameters (Tube, Machine and Tools)

To save a model, enter the values (32221) and select “Parameters > Model > Save” (322142).
To load on another tube, change the current tube (321), then select “Parameters > Model > Load” (322141).
To delete a model, select “Parameters > Model > Delete” (322143).

E.6. CLRA – Bend Parameters

E.6.a. CLRA and their parameters (3222)

The CLRA can be viewed to see how they correspond to the NC, or to assign values to the NC manually.

However, they cannot be modified.
Access the CLR using 3222. The CLRA table is displayed. The values displayed are the most recent corrections made to the current tube for the selected bender.

Bend parameters can be programmed, specific to each bender, for each action (L, R or A): These can be speed, pressure, tool stage, … This can also be known as "Tools Data".
These parameters can concern a single value (L, R, or A), or be associated with two values (LR, LA, or RA). They are accessed through additional functions:

Select the value (L, R, or A) on the relevant bend, then press F2: the parameters associated with this bend can then be modified.

NB: the number of parameters and type depend on the bender type: contact your G-Tube agent.

E.6.b. Reset CLRA (3223-3224)

The 1st time that the tube is allocated to the bender, the theoretical LRA are applied to the CLRA. Subsequently, the CLRA are changed each time a correction is made.

It is possible to start again using theoretical LRA or specific data. This is known as reset CLRA.
Select the Reset CLRA function to reset CLRA to theoretical values. This operation can be required depending on bender when an update is applied.

It is also possible, in specific cases, to zero CLRA, not using theoretical data, but using CLRA values saved as Reset data, known as TLRA.

To save CLRA as TLRA, activate Zeroing CLRA mode with TLRA. You are asked "Do you want to use current CLRA to zero CLRA?". Reply yes.

It is possible to view these TLRA at any time using function 3225.

E.7. Communication between G-Tube and a bender

E.7.a. Communication Parameters (34)

These parameters mainly concern communication type. The number of parameters depends on bender type (NC).
The main parameters are the following:

- **Serial Port**: Computer serial port to which the file is sent if using serial communication.
- **Speed / Parity / Stop bits / Number of bits:** serial transmission parameters
- **Handshake**: type of serial transmission (None/ RTSCTS/ Xon-Xoff/ XonXoffRTSCTS)
- **Multichannel module**: module channel (refer to module use): XXNN:
    - XX: Rx Tx inversion
    - NN: Channel number
- **Use network**: place the file on the network or not
- **Extension / Path / File name**: network file parameters
- **User the same name each time**: choice between the specified name or the tube name for the network file
- **Shell**: path and name of the program to be run after placing the network file
- **Bend opposite to trigonometric direction**: clockwise or trigonometric (anti-clockwise) bending direction
- **Available**: communication activation/deactivation.
- **Bidirectional**: Bidirectional/Unidirectional communication mode (G-Tube > NC)
- **Absolute CLRAs** : Use absolute or non-absolute CLRA values

Other parameters may also appear (**header, end of file**, …). Refer to the appendix for the specific bender or your G-Tube agent.

E.7.b. Maintenance Communication (333)

This function is reserved for technicians who have been trained and authorised by ROMER. Depending on bender, it enables the file format, Clearway Node ® number (Addison Mark I, II and III) to be configured, or no function. (password required)

Contact your agent to configure your communications.

E.7.c. Sending/Receiving a theoretical tube (3311 / 3321)

These functions usually enable tube theoretical data to be exchanged.
Note that not all benders allow bidirectional exchange (see Appendixes).

- Send: G-Tube sends the bender tube theoretical data. Depending on communication protocol, data sent may or may not contain bender data.

- Receive: If a current tube is assigned to the bender, G-Tube receives theoretical data about this tube from the NC as well as bender parameters (depending on the protocol).

- Receiving a new tube: To recall a tube not present in G-Tube memory, remove any current tubes (function 324) from the bender (the Theoretical field displays “EMPTY”), and select the “Receive theoretical” function (3321). The Name/Diameter/Number of straights for the imported tube must be entered. Only the theoretical tube is received at this time: it must then be allocated to the bender, then the theoretical data must be send to the bender again so that the bender data can then be recovered.

E.7.d. Send/Receive CLRA (3312 / 3322)

Depending on protocol, these functions enable CLRA and bender parameters to be sent//received.

- Send: G-Tube sends corrected data (CLRA) to the NC as well as bender parameters (depending on protocol). Depending on NC, these data are sent to memory, or directly to the Run Page.

- Receive: G-Tube recalls the NC of current data (CLRA) as well as bender parameters (depending on protocol).

NB: The tube must firstly be allocated to the bender.

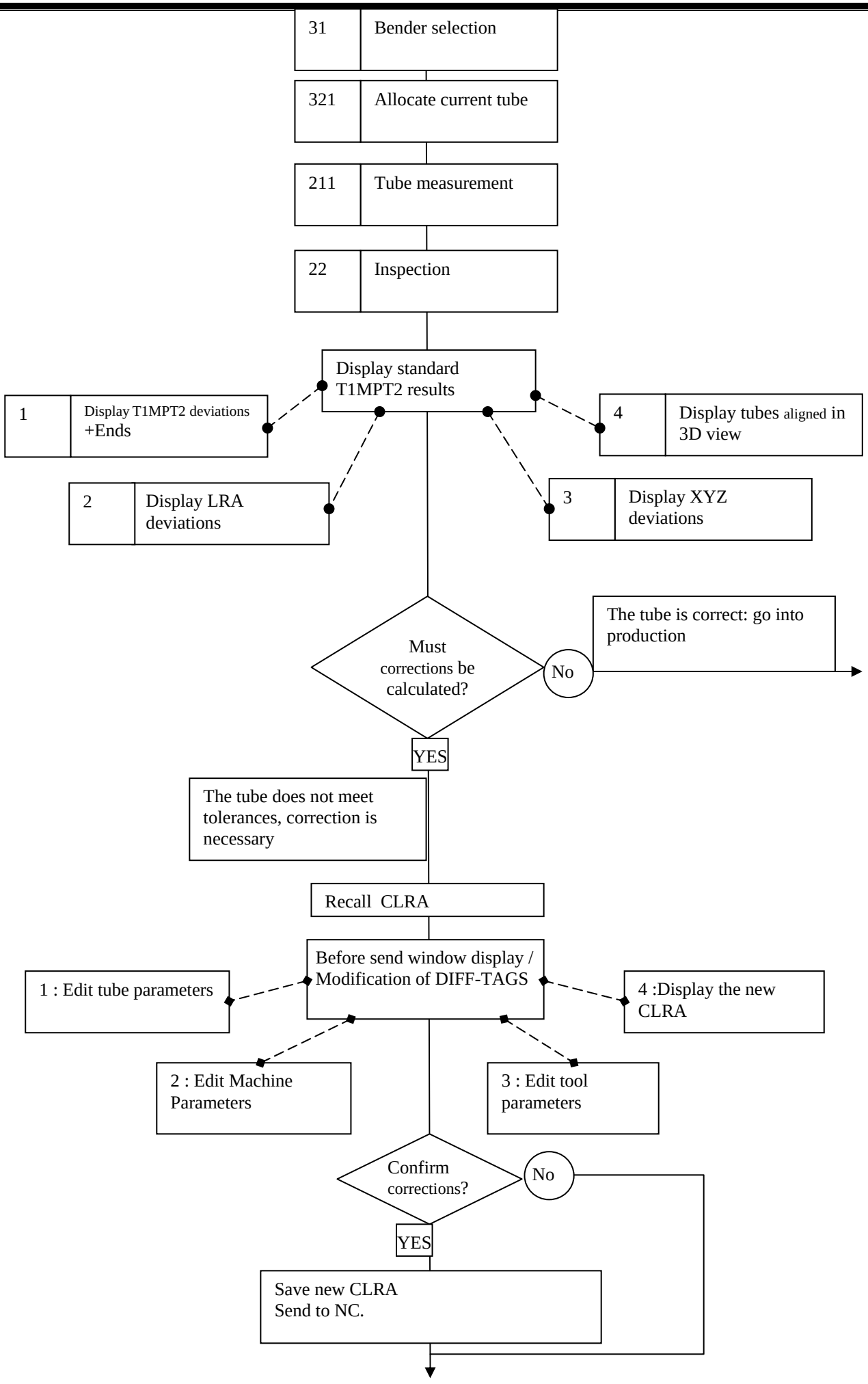
E.8. Inspecting a tube in semi-automatic mode

E.8.a. Process

Inspecting a tube in use with a bender is not just a matter of superimposing the measured tube and the theoretical tube, as is the case in manual mode. This mode (semi-automatic) runs a complete process:

- Superimposition of measured and theoretical tubes
- Results display
- Recall the NC CLRA (depending on protocol)
- Correction calculation
- Send new CLRA to the NC

All these operations run automatically. It is possible, however, to subsequently display the results.
Using this inspection mode is the same as manual mode up to the point of inspection.


31
Bender selection
321
Allocate current tube
211
Tube measurement
22
Inspection
Display standard T1MPT2 results
1
Display T1MPT2 deviations +Ends
2
Display LRA deviations
3
Display XYZ deviations
4
Display tubes aligned in 3D view
Must corrections be calculated?
No
The tube is correct: go into production
YES
The tube does not meet tolerances, correction is necessary
Recall CLRA
Before send window display / Modification of DIFF-TAGS
1 : Edit tube parameters
2 : Edit Machine Parameters
3 : Edit tool parameters
4 :Display the new CLRA
Confirm corrections?
No
YES
Save new CLRA
Send to NC.

E.8.b. Results display

After reference data calculation, the results display automatically in the following manner:

This table shows the deviations in:

- The **T1MpT2** (by default) (1), which allows you to see if the tube produced is correct.
- The **LRA** (delta LRA) (2), which allows you to see corrections that might be applied to the CLRA.
- **Intersection point** (XYZ, 3) deviations
- Aligned **3D view** of the 2 tubes (4)

All these results can subsequently be viewed, usually using functions 2311/ 2312/ 2313/ 233).

There are two possibilities with these results:

- Either the tube meets tolerance: the operator can ***CANCEL*** the correction process.
- Or the tube does not meet tolerance: the correction process must be run by selecting ***OK***

E.8.c. Diff-Tags

When the correction process is run (OK), the G-Tube results window recalls the bender CLRAs (depending on protocol), then a screen appears, which shows

- bending parameters (1, 2, or 3) so that they can be modified before sending to the bender
- the new CLRAs (not changeable) (4)
- The Diff-Tags

The Diff-Tags correspond to a material surplus specified for bending:
If the actual tube is too long compared to the theoretical tube (because of stretching, or on purpose to leave sufficient play for the mandrin), by default, the overhang will automatically be added to end B.
In some case, it may be necessary to apply an overhang to end A. Enter it manually (the length is then subtracted from B).

Diff Tags are applied to the 1st CLRA length in all cases.

E.8.d. Editing bender parameters

At the same time as Diff-Tags and CLRAs, bender parameters can be consulted and changed before sending to the bender.
Select the parameters you wish to change. (refer to the relevant appendix for the bender)

Once the Diff-Tags and bending parameters have been entered,

- OK: save the new CLRA and parameters and send them to the bender (depends whether communication is installed or not)
  NB: The Diff-Tags are not saved.

- Cancel: no changes are taken into account.

F- THE “AUTO/MANUAL” FUNCTION (4)

F.1. Principle

Operating in semi-automatic mode enables you to launch an automatic inspection/correction process, but bender selection and measurement is done manually.

Automatic mode (“AUTO/MANUAL” function) enables everything to be done automatically.
The screen displays a grid (“workshop”) with all the configured benders (with or without connection).
The operator only needs to select his bender, then G-Tube automatically begins measurement. When measurement is finished (i.e. when end B has been measured), inspection is run and the correction loop follows.

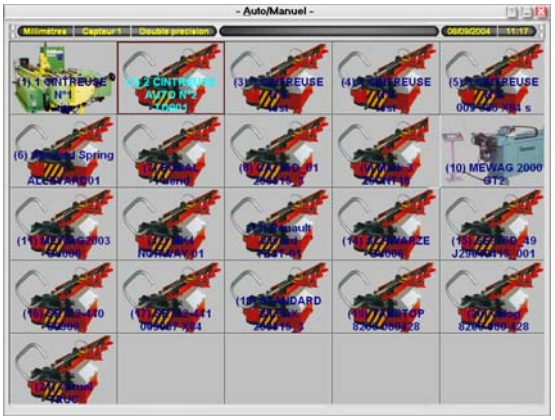
Once the correction loop has completed (or been cancelled), the screen returns to Auto mode.
Then, when current tubes have been correctly allocated to each bender, each operator can select his bender in the Workshop Grid, check/correct, and return to his bender. The screen defaults to the workshop.

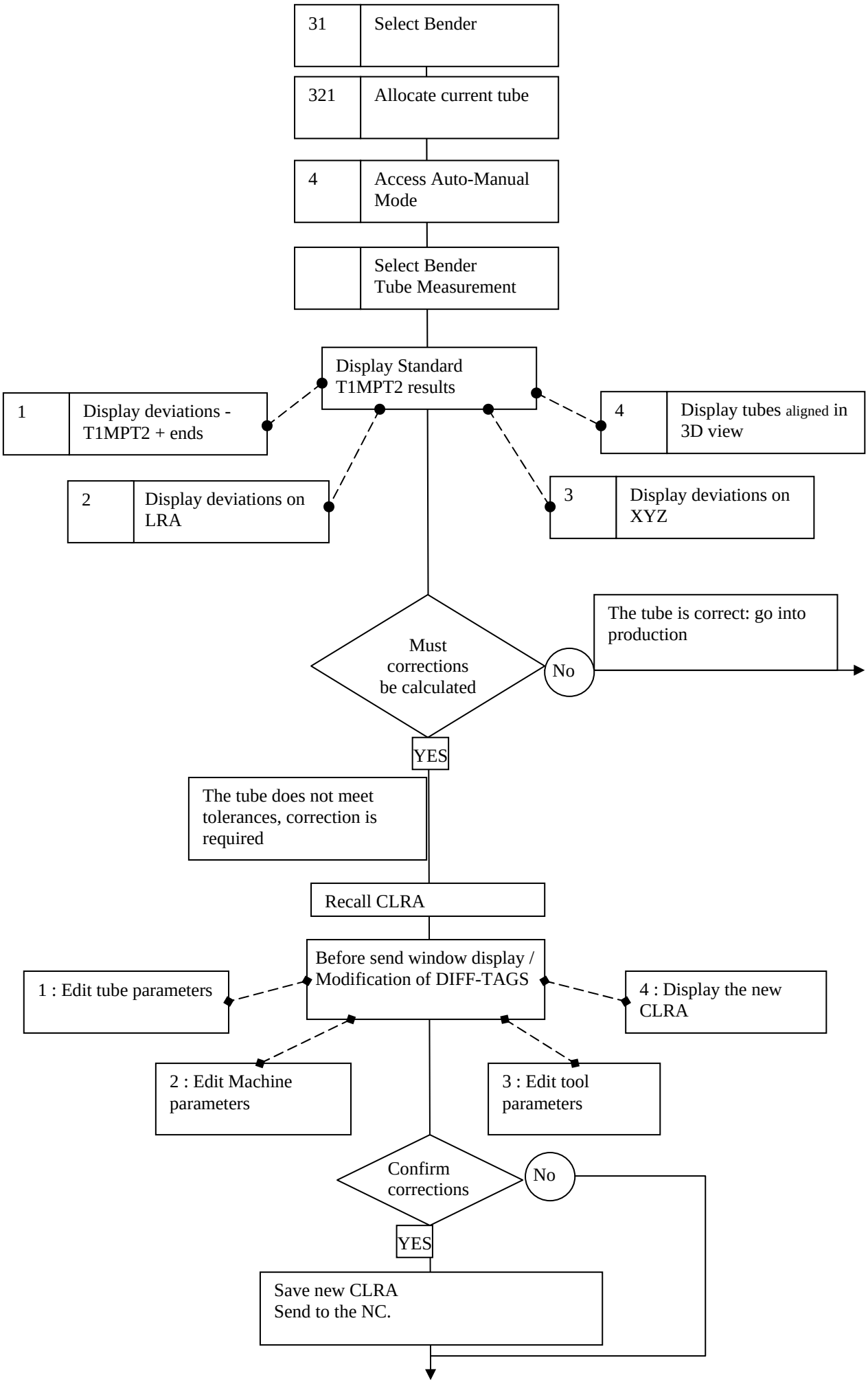
NB: for navigation in Auto-Manual mode, see § A.5

F.2. Use

As in Semi-Auto mode, firstly you must

- Select the desired bender (3 1)
- Assign the current tube (3 2 1)
- Send the old CLRA to the bender to be sure that the same CLRA are on both sides (not required if using Bidirectional communication)
- Then access Auto-Manual Mode (4)
- Select the bender and confirm
- Measure
- When measuring is completed, inspection takes place automatically and the same correction process as Semi-Auto mode begins.
- At the end of the process, the screen returns to Auto-Manual mode.




31
Select Bender
321
Allocate current tube
4
Access Auto-Manual Mode
Select Bender
Tube Measurement
Display Standard T1MPT2 results
1
Display deviations - T1MPT2 + ends
2
Display deviations on LRA
3
Display deviations on XYZ
4
Display tubes aligned in 3D view
Must corrections be calculated
No
The tube is correct: go into production
YES
The tube does not meet tolerances, correction is required
Recall CLRA
Before send window display / Modification of DIFF-TAGS
1 : Edit tube parameters
2 : Edit Machine parameters
3 : Edit tool parameters
4 : Display the new CLRA
Confirm corrections
No
YES
Save new CLRA
Send to the NC.

G- SYSTEM MENU (5)

The system menu is a configuration menu, and is therefore only used occasionally, which is why it does not appear in the main menu.
It is reached by pressing **Ctrl + 0** (zero) or **5**.

G.1. Select language (511)

G-Tube offers 11 languages.
Since the menu only has 9 buttons, they are displayed 8 at a time (the 9th button allows you to move to the following languages):

- French
- English
- German
- Spanish
- Italian
- Portuguese
- Czech
- Russian
- Japanese
- Swedish
- Chinese

NB : some languages can be correctly displayed only if the operating system (Windows) manage the specific characters for the language (Cyrillic, Chinese , Japanese characters).

G.2. Excel report (512-513)

Function 234 is used to generate an inspection report under Excel.

This report displays a header, followed by the results, under a presentation that can be chosen between different predefined or customized templates.

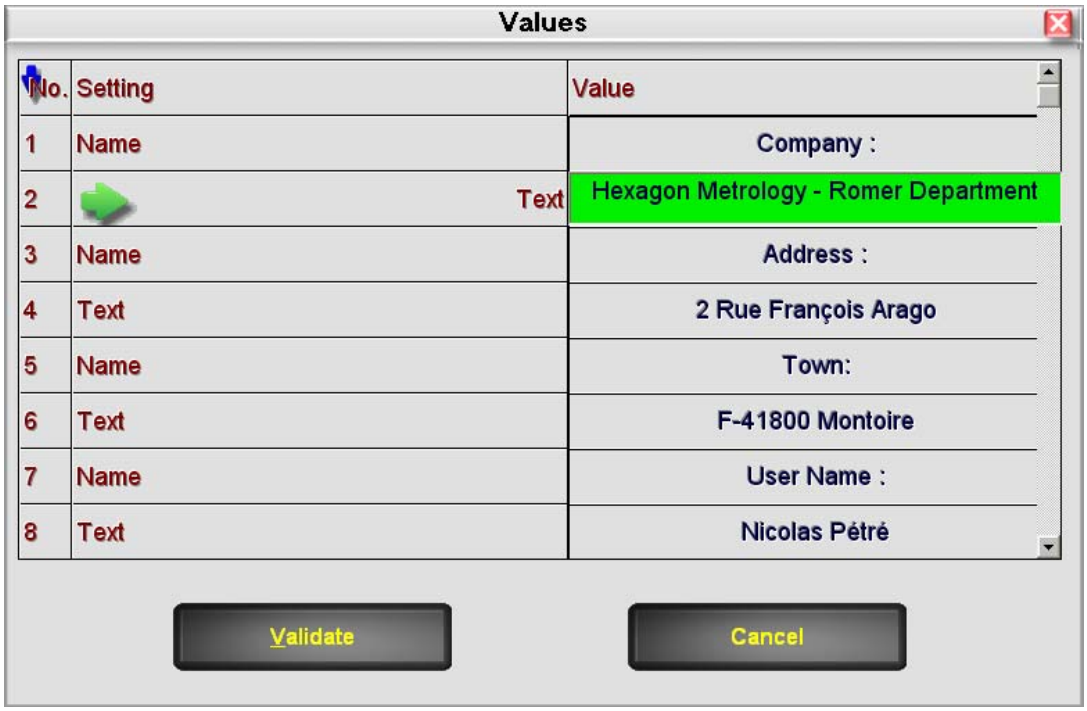
The configuration of this report in G-Tube allows you to modify the text of the header and to choose the template.

G.2.a. Report Header (512)

The report header contains some fields, filled in by G-Tube (common with G-Pad). There are 2 types : Name and text and have each an index (used for the customization of the report).

Generally, the name represents the title of the following text.

Note : modification of a field is retroactive in G-Pad (and reverse).



G.2.b. Excel Template (513)

Different templates fo report are predefined, and those models can be customized..

The function « Excel Template » si used to select the desired model.

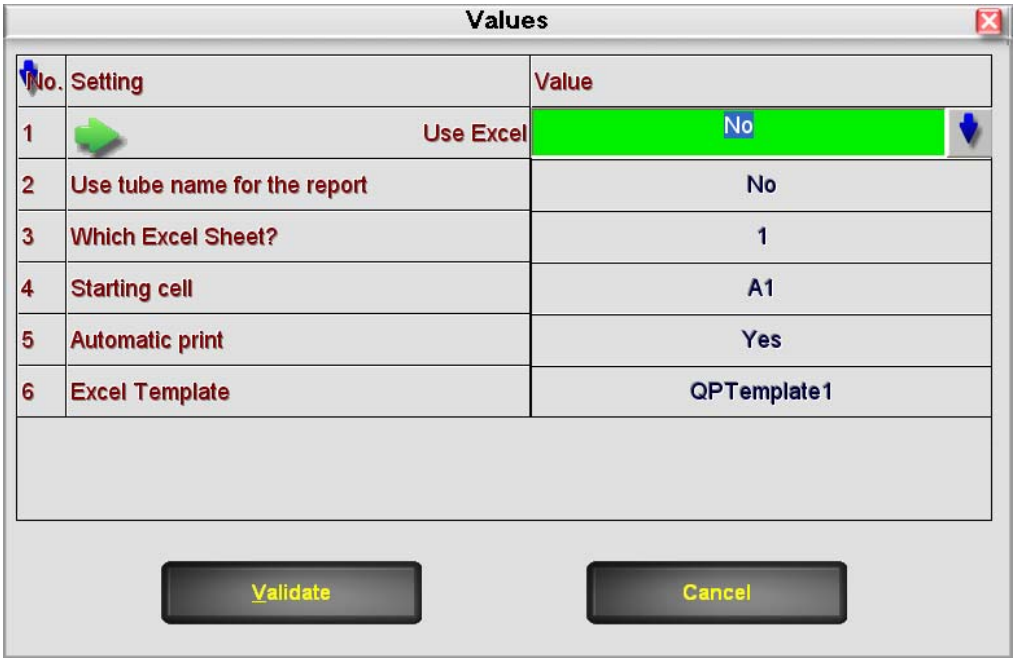
NB : all the Excel Files present on C:\GTech\GTube\Config\Templates\Reports folder are displayed. Then only the real Excel Templates for G-Tube should be presents on this folder.

G.3. Quick Print (514)

« Quick Print » ,accessible from all sheets with F8, can be set up to print through Excel .

The chart is then sent to an Excel file.

- Set Up (5141)



- Use Excel (Yes/No) : activate / disactivate the use of quick print through Excel (in case of No (default), the following parameters are not used)
- Use Tube name for the Report : allows to save automatically the Excel file with the tube name.
- Which Excel sheet : allows to choose on which Excel sheet will be sent the quick print.
- Starting Cell :Excel cell from which the quick print will be displayed (Top/Left)
- Automatic Print : to print automatically the Execl sheet.
- Excel Template : choice of the Excel Quick Print model;

- Template (5142)

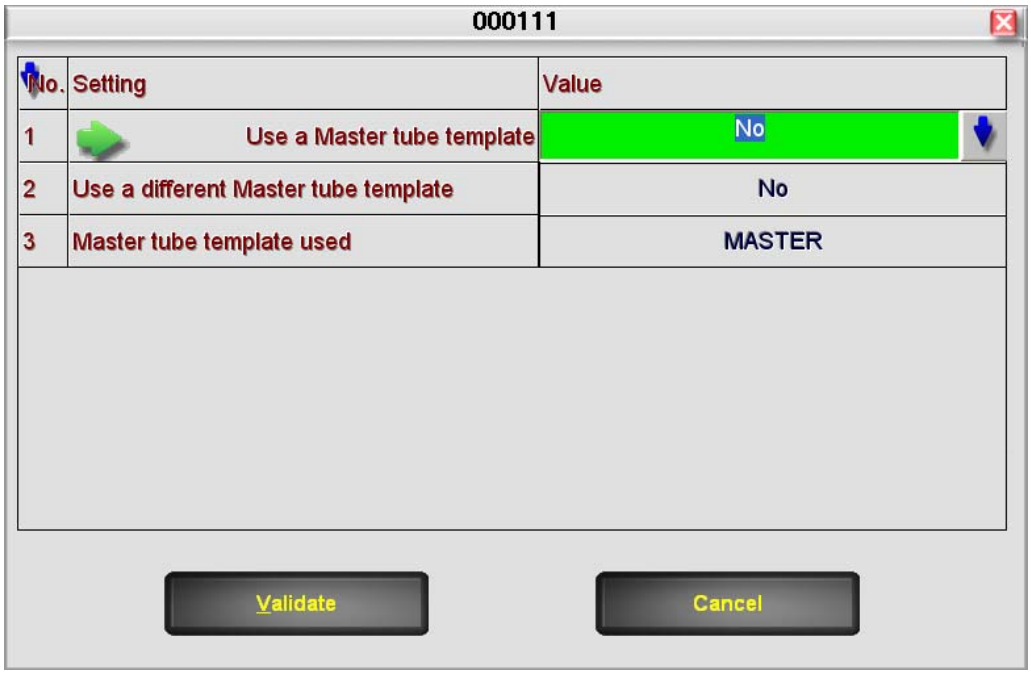
G.4. Master Tube Template (515)

When a new tube is created (Master with 111 or 112 function, or Measured with 213 function), each parameter is set up with a default value.

It is possible to modify the default values, by adding one or several tube template that will then define the parameters values to apply by default to a new tube.

A model of tube has to be first defined and established, that contains the desired default values (contact your Romer agent).

Then it is possible to setup GTube, either to propose the choice for the template, either to impose one template, to all new tubes.



- 1 : Use a master template : activates the use of tube templates
- 2 : use a different Master tube template : allow to use several templates (then display a selection window for each new tube creation).
- 3 : Master tube template used : name of the template used (only if "1" is activated and "2" desactivated).

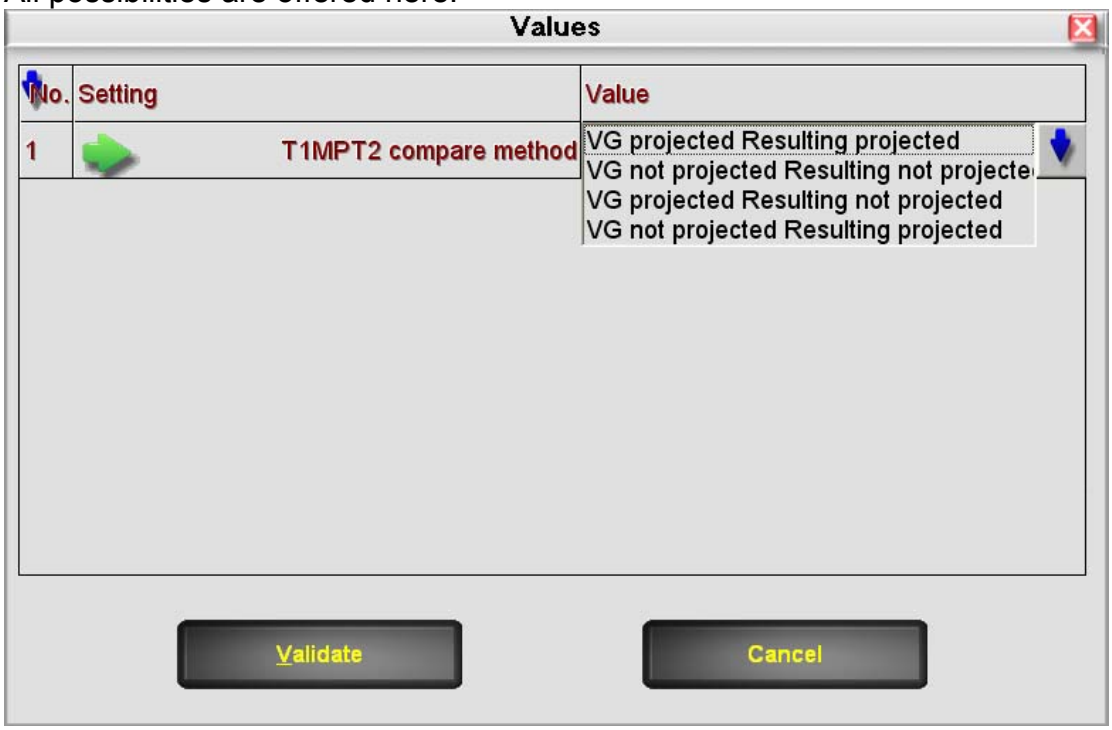
G.5. Others …(516)

Using the function 2321, G-Tube displays the deviations Measured-Nominal with extended results : the absolute value (VG) is displayed with the deviations in X, Y, and Z axis (Componants).

By default, these are the deviation between the tangency point and its projection to the nominal line.

Therefore, it is possible to choose to display the VG and the componants from the measured point to the nominal point instead of the nominal line.

All possibilities are offered here.

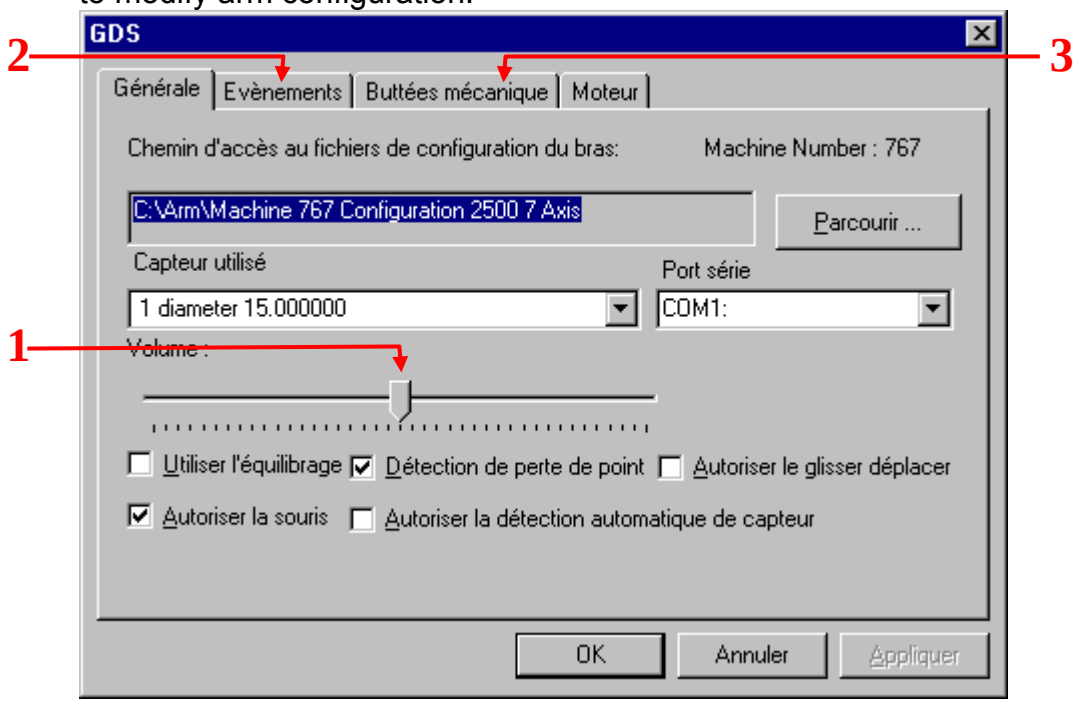


NB: this choice concerns only the Extended results on Tangency points (T1MpT2).

G.6. Arm Configuration (52)

This menu allows the measuring arm to be checked:

- **Connect / Disconnect** (521 / 524): activates/deactivates the connection between the arm and G-Tube.
- **Reset** (522): enables the arm axis to be reset.
- **Configuration** (523): This function gives access to the GDSAPI dialogue box, to modify arm configuration:



1: Sets volume
2: Sets mechanical stop sounds
3: Sets sounds for press buttons 1 (BP1), V Beam 1 (B1), V Beam 2 (B2)

For a detailed description of the GDSAPI dialogue box, consult the GDS software manual.

G.7. About (53)

The “about” function displays the G-Tube software version.
NB: This is the G-Tube release number, not the Romosoft release number.

G.8. Exit (54)

H- QUICK REFERENCE

- How to launch the G-Tube application 

From G-Pad: Click on the G-Pad icon in the ROMOTIC window:

Reset the axes if necessary Click on –  (you do not need to select a notebook).

Select the probe in G-Pad.

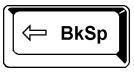
Launch the G-Tube application by clicking on the icon. 

- Directly: Click on the G-Tube icon in the ROMOTIC window: 

- How to navigate in a table

The cell being filled in is displayed in colour.

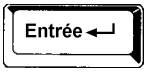
Use  to navigate in the table.

Use 

to delete the last character typed.

Use 

to delete the entire cell.

How to validate a function: press the 

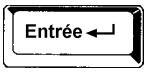
key

How to cancel a function: Press the 

key

- How to choose a probe

(Inspection/Measurement – Measurement – Probe – Selection)

Enter the probe number, 

- How to activate single/double precision

(Inspection/Measurement – Measurement – Probe – Single precision)

(Inspection/Measurement – Measurement – Probe – Double precision)

- How to change measurement unit

Echap 1 7 7 1 (Tubes – Edit – Units – Millimetres) → ***MILLIMETERS***

or 1 7 7 2 (Tubes – Edit – Units – Inches) → ***INCHES***

- How to create a new Tube

Echap 1 1 1 (Tubes – New – XYZ) or Echap 1 1 2 (Tubes – New – LRA)

Enter the tube diameter

↓ ↓ ↓ Enter the general tolerance

↓ ↓ Suppr Enter a note (optional)

Entrée

Enter the number of straight sections

Enter all the XYZ/LRA, including the bending radius.

Entrée

Echap 1 4 Tubes – Save)

Enter the tube name Entrée

- How to enter a general tolerance

Echap 1 7 1 (Tubes – Edit – Parameters)

↓ ↓ ↓

Suppr Enter the tolerance Entrée

- How to edit a tube

Editing XYZ data

Echap 1 7 2 (Tubes – Edit – XYZ)

Editing LRA data

Echap 1 7 3 (Tubes – Edit – LRA)

- How to enter tolerances on intersection points

Echap 1 7 2 (Tubes – Edit – XYZ)

Select the point to have tolerance defined

F2 Enter the point tolerances Entrée

Entrée

- How to view T1/ MP / T2

Echap 1 7 5 2 Tubes – Edit – Inspection – T1MPT2)

- How to enter tolerances on T1 / MP / T2

Echap 1 7 5 2 Tubes – Edit – Inspection – T1MPT2)

Select the point to have tolerance defined

F2 Enter the point tolerances Entrée

Entrée

- How to print a table from the screen

F8 from the table on the screen

.

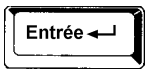
- How to print tube coordinates

(Tubes – Print)

- How to save a tube after creation or modification

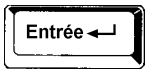
Save a new tube

Tubes – Save)

Enter the tube name 

Save an existing tube

Tubes – Save)



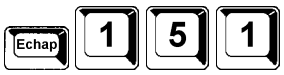
- How to export a tube to G-Pad

(Tubes – Export – G-Pad)

The tube is present on the G-Pad page, it is not saved as an entity

- How to import a tube from G-Pad

Select the tube on the G-Pad page

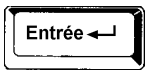


(Tubes – Import – G-Pad)

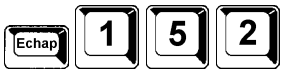
The tube is saved in G-Tube (Tube name in G-Pad)

- How to export a tube to SupraVision

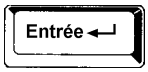
(Tubes – Export – SupraVision)

Select the target 

- How to import a tube from SupraVision

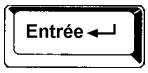


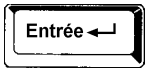
(Tubes – Import – SupraVision)

Select the folder or file 

- How to delete a tube

(Tubes – Delete)

Select the tube, 

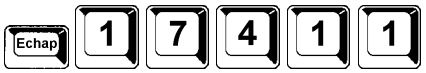


- How to view tube parameters

(Tubes – Edit – Parameters)

- How to add/delete/edit an end

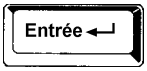
Add an end



(Tubes – Edit – Ends – A – Add) → for end ***A***.

or 

(Tubes – Edit – Ends – B – Add) → for end ***B***.

Enter the values for the different parameters. 

Delete an end

(Tubes – Edit – Ends – A – Delete) → for end ***A***.

or 

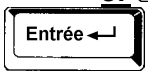
(Tubes – Edit – Ends – B – Delete) → for end ***B***.

Edit an end

(Tubes – Edit – Ends – A – Edit) → for end ***A***.

or 

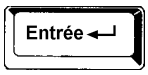
(Tubes – Edit – Ends – B – Edit) → for end ***B***.

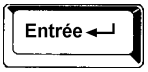


- How to insert/delete/move an intersection point

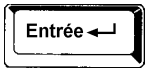
Insert a point

(Tubes – Edit – Modify – XYZ – Insert)

Enter the number for the future point 

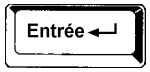
Enter the new point. 

Tubes – Save)

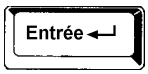


Delete a point

(Tubes – Edit – Modify – XYZ – Delete)

Indicate the number for the point to delete 

(Tubes – Save)



- How to insert / delete a bend

Insert a bend

Echap 1 7 6 2 1 (Tubes – Edit – Modify – LRA – Insert)

Suppr

Enter the number for the future bend Entrée

Enter the new bend Entrée

Entrée

Echap 1 4 (Tubes – Save)

Entrée

Delete a bend

Echap 1 7 6 2 2 (Tubes – Edit – Modify – LRA – Delete)

Suppr

Indicate the number for the bend to delete Entrée

Entrée

Echap 1 4 (Tubes – Save)

Entrée

- How to create a mirror image of a tube

Echap 1 7 6 3 (Tubes – Edit – Modify – Mirror image)

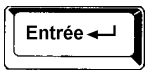
Echap 1 4 (Tubes – Save)

Entrée

- How to invert a tube

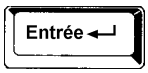
(Tubes – Edit – Modify – Invert)

(Tubes – Save)



- How to view a tube in 3D

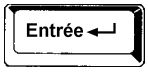
(Tubes – 3D)



- How to open a theoretical tube

(Tubes – Open)

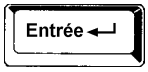
Select the tube



- How to open a measured tube

(Inspection/Measurement – Measurement – Memory inspection)

Select the tube



- How to measure a new Tube

Echap 2 1 3 Inspection/Measurement – Measurement – New Item)

Enter the tube diameter

↓ ↓ ↓

Enter the general tolerance

↓ ↓

Enter a comment Entrée

Enter the bending radius Entrée

Enter the number of straight sections Entrée

Carry out the measurement

Echap 2 1 4 (Inspection/Measurement – Measurement – Save)

Enter the tube name Entrée

- How to save a tube produced by measurement

Echap 2 1 4 (Inspection/Measurement – Measurement – Save)

Enter the tube name Entrée

- How to measure a Tube quickly

Echap 2 1 5 1 (Inspection/Measurement – Measurement – Special – Rapid)

Entrée

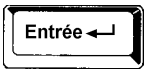
Measure the 1st and last straight sections as well as the ends

View the results

Entrée

- How to measure a known Tube

(Tubes – Open)

Select the tube 

Inspection/Measurement – Measurement – Current Item)

View the Tube 

Carry out the measurement

- How to move a Tube during measurement

During the measuring process, before measuring the new straight section, press and hold. Move the tube and remeasure the 2 last measured straights.

- How not to measure a Tube end

During the measuring process, before measuring the end, press and hold.

- How to cancel taking a point

During the measurement process, using the main press button, click on the  icon as many times are required.

- How to carry out an inspection (Manual Mode)

Inspection with viewing of standard results

Echap 1 2 (Tubes – Open)

Select the tube Entrée

Echap 2 1 1 Inspection/Measurement – Measurement – Current Item)

View the Tube Entrée

Carry out the measurement

Echap 2 2 (Inspection/Measurement – Inspection)

Echap 2 3 1 1 (Inspection/Measurement – Results – Standard – T1MPT2)

or 2 3 1 2 (Inspection/Measurement – Results – Standard – LRA)

or 2 3 1 3 (Inspection/Measurement – Results – Standard – XYZ)

Entrée

Inspection and printing a standard report

Echap 1 2 (Tubes – Open)

Select the tube Entrée

Echap 2 1 1 Inspection/Measurement – Measurement – Current Item)

View the Tube Entrée

Carry out the measurement

Echap 2 2 (Inspection/Measurement – Inspection)

Echap 2 3 1 4 (Inspection/Measurement – Results – Standard – Print)

Inspection with viewing of extended results

Echap 1 2 (Tubes – Open)

Select the tube Entrée

Echap 2 1 1 Inspection/Measurement – Measurement – Current Item)

View the Tube Entrée

Carry out the measurement

Echap 2 2 (Inspection/Measurement – Inspection)

Echap 2 3 2 1 (Inspection/Measurement – Results – Extended – T1MPT2)

or 2 3 2 2 (Inspection/Measurement – Results – Extended – XYZ)

Entrée

Inspection and printing a standard report

Echap 1 2 (Tubes – Open)

Select the tube Entrée

Echap 2 1 1 Inspection/Measurement – Measurement – Current Item)

View the Tube Entrée

Carry out the measurement

Echap 2 2 (Inspection/Measurement – Inspection)

Echap 2 3 2 3 (Inspection/Measurement – Results – Extended – Print)

- How to switch to G-Pad

Echap 1 2 (Tubes – Open)

Select the tube Entrée

Echap 2 1 1 Inspection/Measurement – Measurement – Current Item)

View the Tube Entrée

Carry out the measurement

Echap 2 2 (Inspection/Measurement – Inspection)

Echap 2 1 2 (Inspection/Measurement – Measurement – Switch to G-Pad)

The G-Pad page is displayed with the measured tube in the Machine Reference

Activate the most recently created reference

Carry out measurements in G-Pad

- How to view the Tube in 3D following inspection

Echap 2 3 3 (Inspection/Measurement – Results – 3D)

Entrée

- How to select a bender

Echap 3 1 (Benders – Change)

Select a bender Entrée

- How to allocate a Tube to a bender

Echap 3 1 (Benders – Change)

Select a bender Entrée

Echap 3 2 1 (Benders – Current Tube - Change)

Select the tube Entrée

- How to carry out a complete Tube test cycle

Echap 3 1 (Benders – Change)

Select a bender Entrée

Echap 3 2 1 (Benders – Current Tube - Change)

Select the tube Entrée

Echap 4 (Auto/Manual)

Enter the bender number Entrée

View the Tube Entrée

Carry out the measurement

1 (T1MPT2) Entrée

or/and 2 (LRA) Entrée

or/and 3 (XYZ) Entrée

.../...

Receiving CLRA data from the bender

1 (Tube) → View Tube parameters

or/and 2 (Machine) → View Machine parameters

or/and 3 (Tools) → View Tool parameters

or/and 4 (CLRA) → View CLRA before sending to the bender

Enter the Diff-Tag values (optional)

Entrée

Send new CLRA to the bender

- How to edit CLRA

Echap 3 1 (Benders – Change)

Select a bender Entrée

Echap 3 2 1 (Benders – Current Tube - Change)

Select the tube Entrée

Echap 3 2 2 2 (Benders – Current Tube – Edit – CLRA)

Entrée

- How to initialise CLRA

Echap 3 1 (Benders – Change)

Select a bender Entrée

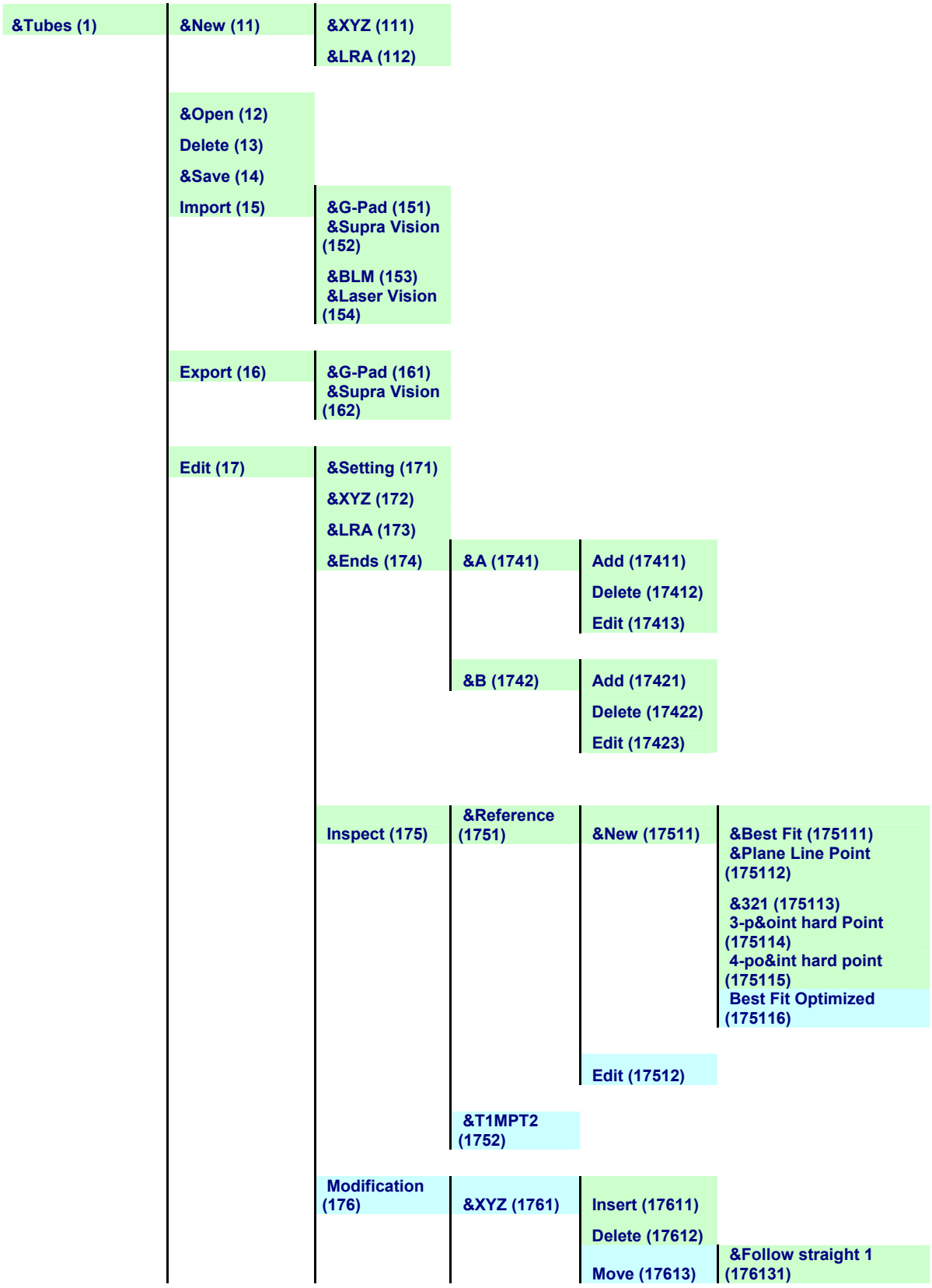
Echap 3 2 1 (Benders – Current Tube - Change)

Select the tube Entrée

Echap 3 2 2 3 (Benders – Current Tube – Edit – Zeroing CLRA)

Entrée

I.1. Tree structure (work in progress)



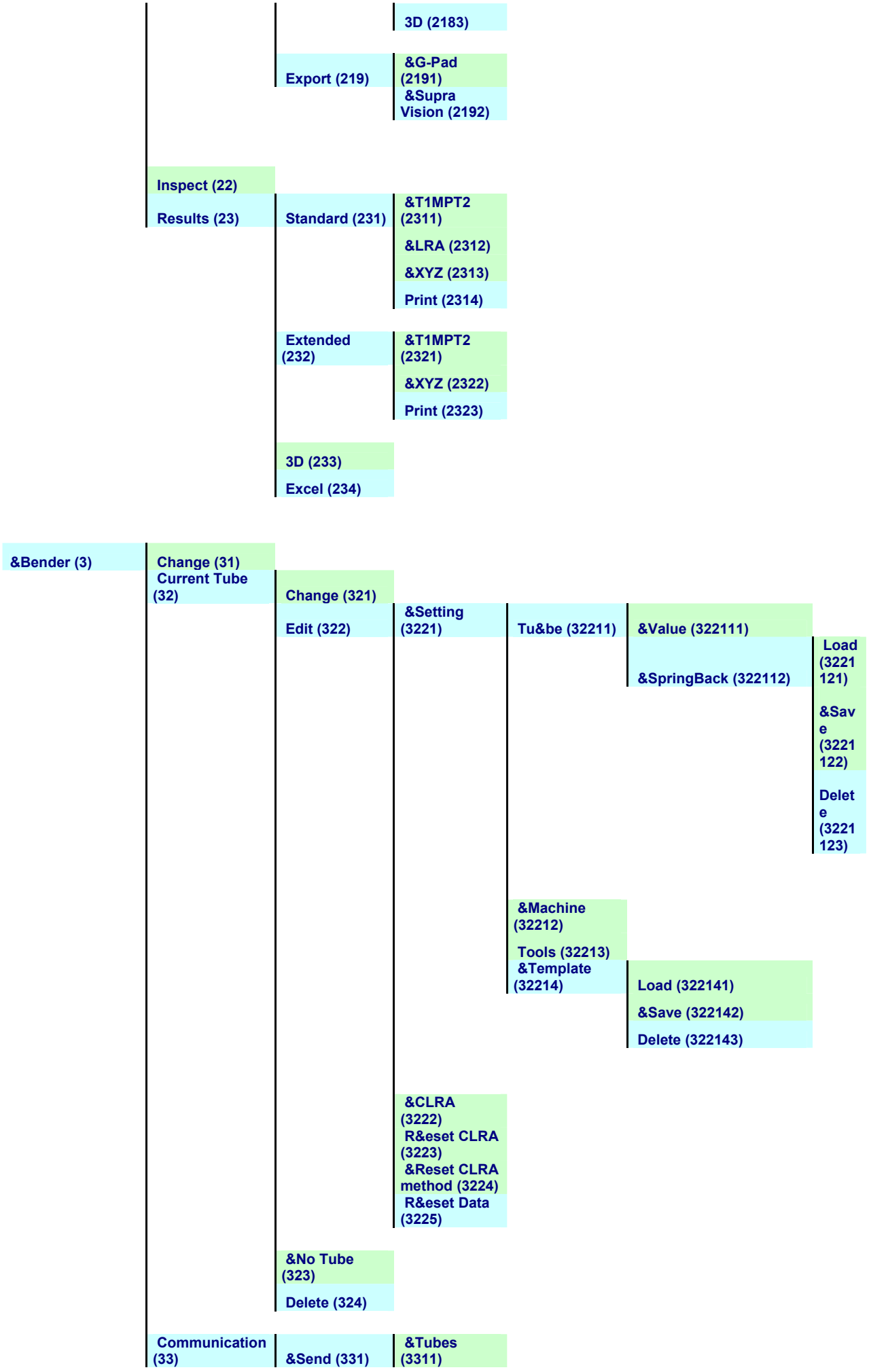
- F&ollow straight 2 (176132)
- Left(+)/Right(-) (176133)
- In(+)/Out(-) (176134)

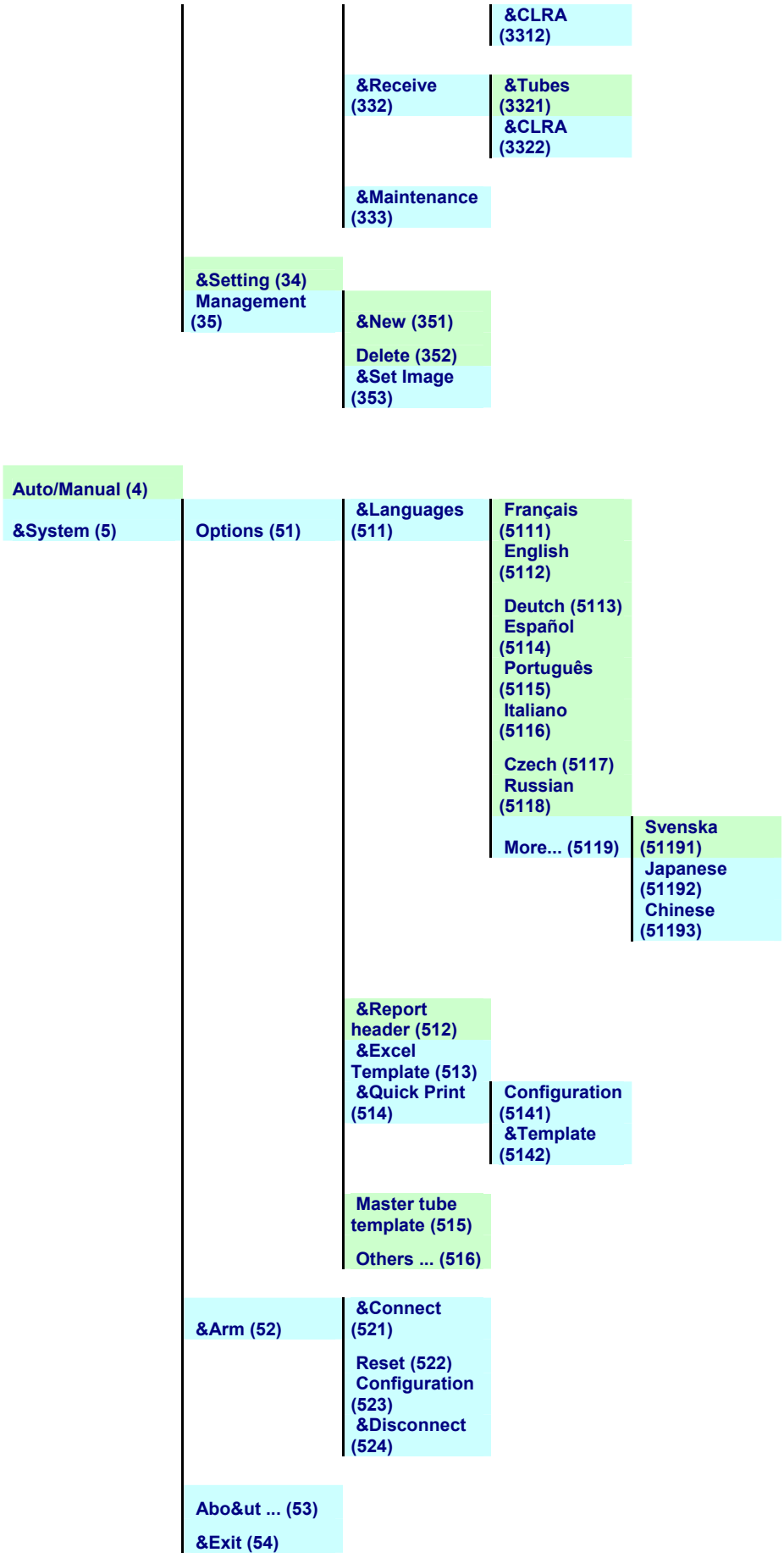
- &LRA (1762)
  - Insert (17621)
  - Delete (17622)
- &Mirror image (1763)
- Reverse (1764)

- &Units (177)
  - &Millimeters (1771)
  - &Inches (1772)

- Print (18)
- 3D (19)

- Inspect/Measure (2)
  - Measure (21)
    - Current Part (211)
    - Switch to G-Pad (212)
    - New part (213)
    - &Save (214)
    - Special (215)
      - &Quick (2151)
      - &SpringBack (2152)
      - Statistics (2153)
        - &Neutral file (21531)
          - &Start (215311)
          - S&top (215312)
          - &Setting (215313)
        - &Quick analysis (21532)
          - &Start (215321)
          - S&top (215322)
          - &Setting (215323)
        - D.A.M. (21533)
          - &Start (215331)
          - S&top (215332)
          - &Setting (215333)
      - S&traight tube (2154)
    - Memory inspection (216)
    - P&robe (217)
      - Select (2171)
      - Single precision (2172)
      - Double precision (2173)
    - Edit (218)
      - &XYZ (2181)
      - &LRA (2182)


3D (2183)
Export (219)
&G-Pad (2191)
&Supra Vision (2192)
Inspect (22)
Results (23)
Standard (231)
&T1MPT2 (2311)
&LRA (2312)
&XYZ (2313)
Print (2314)
Extended (232)
&T1MPT2 (2321)
&XYZ (2322)
Print (2323)
3D (233)
Excel (234)
&Bender (3)
Change (31)
Current Tube (32)
Change (321)
Edit (322)
&Setting (3221)
Tu&be (32211)
&Value (322111)
&SpringBack (322112)
Load (3221121)
&Save (3221122)
Delete (3221123)
&Machine (32212)
Tools (32213)
&Template (32214)
Load (322141)
&Save (322142)
Delete (322143)
&CLRA (3222)
R&eset CLRA (3223)
&Reset CLRA method (3224)
R&eset Data (3225)
&No Tube (323)
Delete (324)
Communication (33)
&Send (331)
&Tubes (3311)


&CLRA (3312)
&Receive (332)
&Tubes (3321)
&CLRA (3322)
&Maintenance (333)
&Setting (34)
Management (35)
&New (351)
Delete (352)
&Set Image (353)
Auto/Manual (4)
&System (5)
Options (51)
&Languages (511)
Français (5111)
English (5112)
Deutch (5113)
Español (5114)
Português (5115)
Italiano (5116)
Czech (5117)
Russian (5118)
More... (5119)
Svenska (51191)
Japanese (51192)
Chinese (51193)
&Report header (512)
&Excel Template (513)
&Quick Print (514)
Configuration (5141)
&Template (5142)
Master tube template (515)
Others ... (516)
&Arm (52)
&Connect (521)
Reset (522)
Configuration (523)
&Disconnect (524)
Abo&ut ... (53)
&Exit (54)

I.2. SupraVision Tube Format

Files use the extension *.$$$.

The file is set out like this:

```
$pnum 0

$spin 0.00

$unit M

$mxyz 4
0.000 0.000 0.000 0.000
185.629 0.000 0.000 38.100
238.432 141.945 0.000 38.100
350.819 142.238 0.957 0.000

$ivar 1
QETL 1.000

$pvar 9
PRBR 38.100
TBDI 19.050
MIME 5.000
AEDI 0.000
AELN 0.000
AEOF 0.000
BEDI 0.000
BELN 0.000
BEOF 0.000
```

$pnum 0 : "SV" tube designation

$spin 0.00

$unit M *:* Units (M = Millimetres / P = Inches)

```
$mxyz 4
        0.000 0.000 0.000 0.000
        185.629 0.000 0.000 38.100
        238.432 141.945 0.000
38.100
        350.819 142.238 0.957 0.000
```

: Tube data in XYZ (intersection points X-Y-Z-Bending Radius) ($mxyz 4 : 4= No. of points)

```
$ivar 1
QETL 1.000
```

Internal variables (1= number of variables):
QETL = General du tube tolerance

```
$pvar 9
        PRBR 38.100
        TBDI 19.050
        MIME 5.000
        AEDI 0.000
        AELN 0.000
        AEOF 0.000
        BEDI 0.000
        BELN 0.000
        BEOF 0.000
```

Tube variables (9 = number of variables):
PRBR: Bending radius
TBDI: Tube Diameter
MIME: Maximum intersection length between to straight sections
AEDI: End A diameter
AELN: End A shaping length
AEOF:
End A overhang
BEDI, BELN, BEOF: Ditto for end B

I.3. Benders Numerical Controls, available types and parameters

Consult the following list of Benders and/or Numerical Controls to check compatibility between your benders and G-Tube. For more information, consult your agent.

I.3.a. Addison

- Mark I / Mark II / Mark III
  Bidirectional communication using ClearWay Node ® network
  All bending parameters are exchanged

- Mark IV / Mark V
  SV-Network type bidirectional communication:
  Network specific protocol
  Exchange files in SupraVision format
  No bending parameters exchanged

I.3.b. Silfax

- SR712 / SR812

  Unidirectional communication
  In most cases, Silfax use Siemens 810 or 840 NCs
  Serial or network communications
  Configurable exchange file format

I.3.c. Crippa

- CA 516 / CA520 / CA532

I.3.d. Robolix

Serial unidirectional communication (contact your Robolix agent)

I.3.e. Evantech

RSS232 bidirectional communication, Evantech protocol

I.3.f. Unison

I.3.g. Eagle

- Adept: Adept Ethernet communication protocol

I.3.h. Eaton Leonard

- Velog / Premier
  Velog protocol Current Loop bidirectional communication
  Fixed file format
  Different parameters exchanged

- Tab Stop
  Tabstop protocol TTL serial unidirectional communication
  Fixed file format

- PICOT: see Other Benders

- HTM6:
- VB12 / VB25 / VB50 :
- U32: see Siemens
- HTI:
- UVM32

I.3.i. Eurobend

I.3.j. Schwarze Robitec

Unidirectional network communication
No parameters exchanged
! CLRA not sent
Fixed file format (defined by Robitec)

I.3.k. Mewag

Unidirectional communication, either network or serial depending on age.
No parameters exchanged
Fixed format (defined by Mewag)

I.3.l. EKA

I.3.m. Lang

Network protocol
File sent contains nominal and measured XYZ, nominal YBC and delta YBC

I.3.n. Miic

In progress

I.3.o. Rosenberger

In Progress

I.3.p. Pedrazzoli

In Progress

I.3.q. Other Benders

Many benders use different NCs (Siemens / Unison / FMNC /…)
In such cases, communication does not depend on the bender type, but on the NC being used.
All use unidirectional communication

I.3.r. CN Siemens

- 810 :
  Serial communication, RTS/CTS, or current loop
  Configurable file and parameters

- 812D:
  RTS/CTS serial communication only
  Configurable files and parameters

- 820D:

- 840D:
  RTS/CTS serial communication or network
  Configurable files and parameters (parameter file managed by NC)

I.3.s. Arena CN

I.3.t. Mingori

I.3.u. FMNC CN

I.3.v. G-Bender Manual Bender

ROMER

Coordinate measuring machines for research, development, production and assembly in their most mobile form –
this is what ROMER stands for in the global Hexagon Metrology network. The portable measuring arms in which ROMER specialises are produced in France and the United States in compliance with stringent quality and environmental standards. ROMER measuring arms permit tactile or optical 3D measurement. Stability, low weight and simple operation are their key advantages.

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