Instruction manual DT-AERO1000

Gas ATD, Automatic Tensioning Device, self-regulated, without counterweights and monitored.

Stroke 1000 mm
Measure of the dimension X
Measure of the tension in the line

GALLAND S.A.S 255, ZI de l'illot FR-33240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20 Fax. +335.57.94.07.11
www.galland-sas.com info@galland-sas.com

Summary

I. Introduction

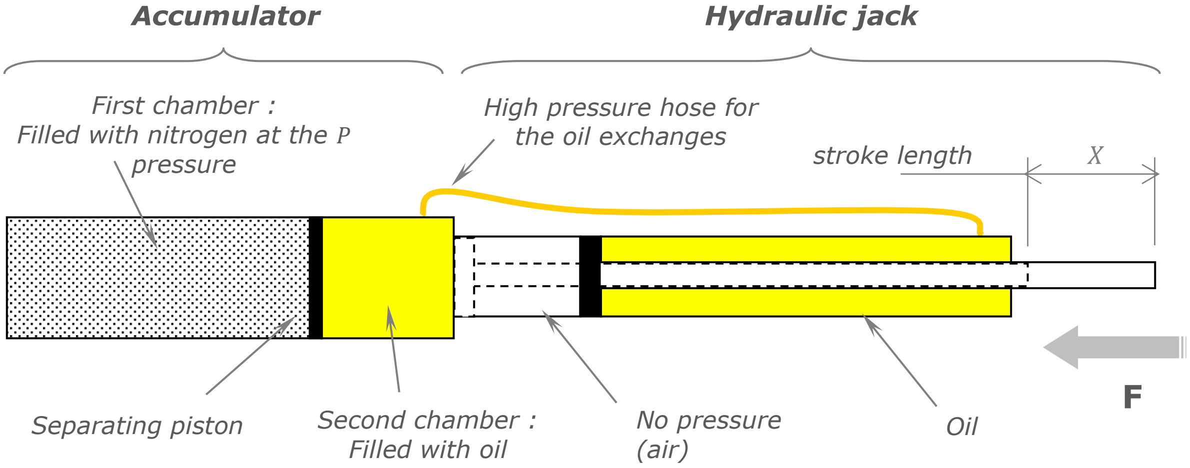
1. How does an AERO work : automatic tensioning device « self-regulated » without counterweights ?

AERO1000 is a gas automatic tensioning device, self-regulated without counterweights. It allows applying a constant mechanical tension in the catenary wires, up to a tension of 4000 daN while it compensates the expansion of the copper wires (contact wire and/or catenary wire on Messenger) according to the variation of the external air temperature.

AERO is composed of two connected parts:

- One accumulator of nitrogen gas (N2),
- One hydraulic cylinder. The accumulator is composed of two reserves divided by a piston. The first chamber is filled with nitrogen and the second is pre-filled with oil, and exchange with the hydraulic cylinder through a « high pressure » hose (*Picture 1*) :

1. The mechanical load applied in the catenary wire (F) is proportional to the nitrogen pressure (P) in the accumulator.
2. The nitrogen reserve under pressure (P) will expand or compress, according to the external temperature.
3. An exchange of oil is done between the accumulator and the hydraulic cylinder through the hose which will move the piston.
4. The stroke of the hydraulic cylinder (X) is directly linked to the external air temperature (T) through the compression or expansion of the gas, and thus compensates the expansion of the wire(s).
5. The mechanical loads (F) in the catenary wires remain the same whatever the external air temperature (T).



Picture 1 : AERO working principle

2. Concerned products

"DT- AERO1000 rev G" is dedicated to the following tensioning device :

- AERO1000 ind A : Tensioning device without counterweights.
- AERO1000 ind B : Tensioning device without counterweights.

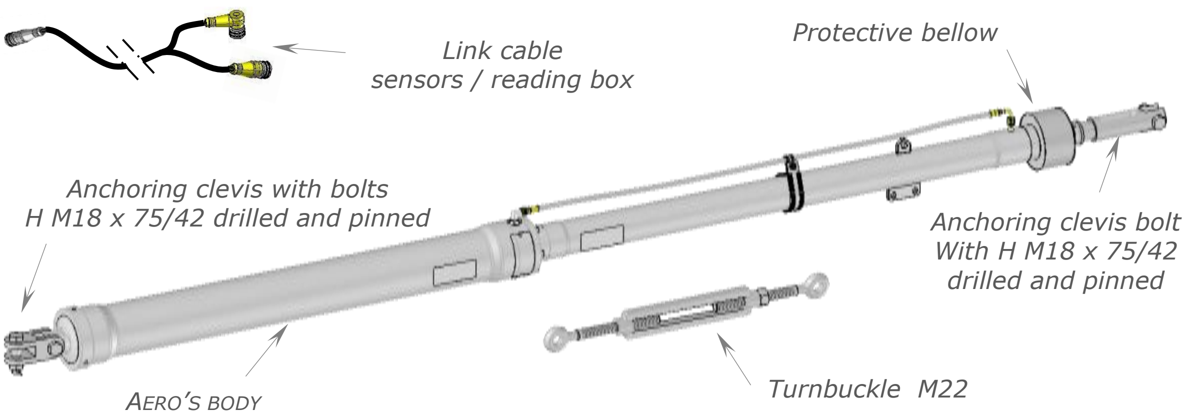
N.B. : Other versions are available according to the different tensioning specification for the wire for tramways or catenary applications. Do not hesitate to ask us more information.

3. Reception

AERO **must remain** in its packaging until it will be installed on field.

The AERO is composed of several parts visible on the *Picture 2* :

- 1 AERO's body,
- 1 anchoring clevis,
- 1 double anchoring clevis,
- 3 bolts H M18 x 75/42 drilled and pinned,
- 1 turnbuckle,
- 1 link cable for sensors / reading box.



Picture 2 : Elements of the AERO1000

At delivery AERO is already filled with nitrogen at a low pressure. You must keep this low pressure until installation; otherwise you may damage the sealing parts.

4. Dimension and weight

AERO1000 :

- Can be included in a Ø180 mm cylinder of 2600 mm length,
- It weighs around 52 kg.

5. Main technical characteristics

- The working temperature range of the AERO is -30°C to +80°C.

N.B. : Other versions are available according to the different temperature specification. Do not hesitate to ask us more information.

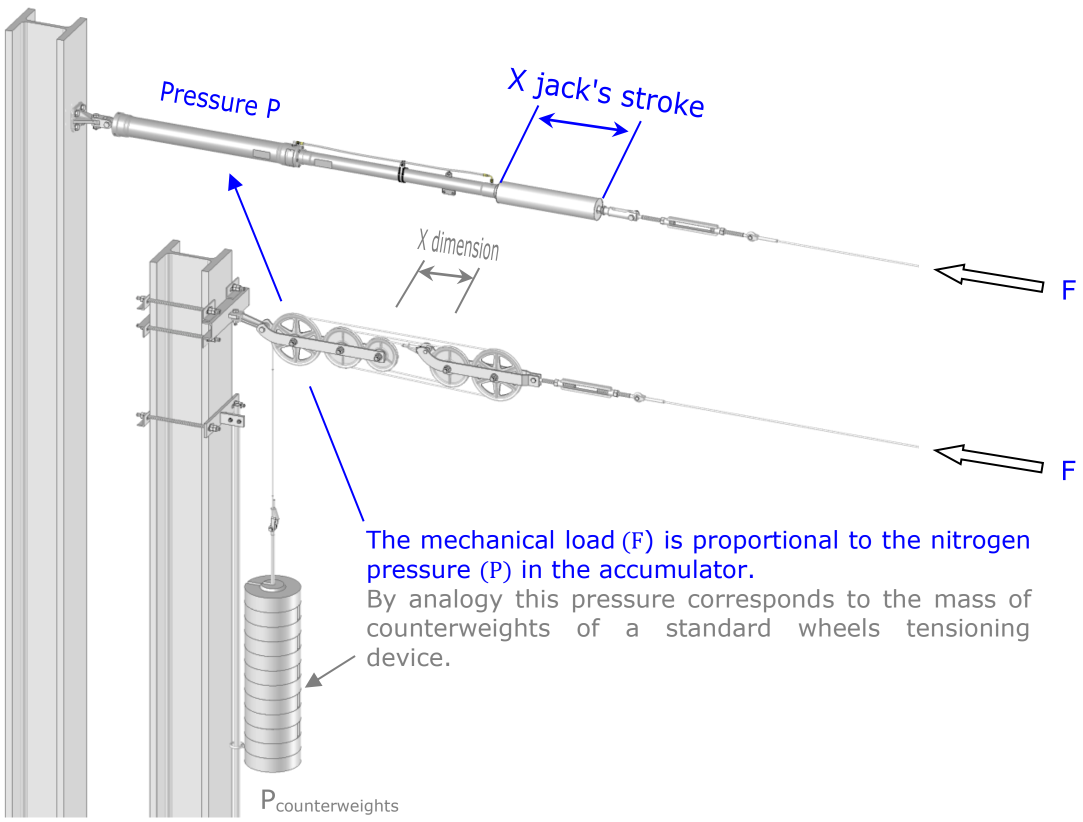
- The maximum catenary mechanical load with AERO is 4000 daN. The reserves can allow an overload of the tension in the limit of 4000 daN in increasing the nitrogen pressure in the reserve (max 200 bar).

- Possibility to manage temporary overloading of the catenary mechanical load by 50% for the 72 hours expansion operation just after unrolling of the wires.

- The maximal stroke length of the tension cylinder is 1000 mm.

- A pressure sensor is integrated in the accumulator, and a displacement sensor is integrated in the tension cylinder.

6. Analogy with a standard tensioning device (wheels and counterweights)

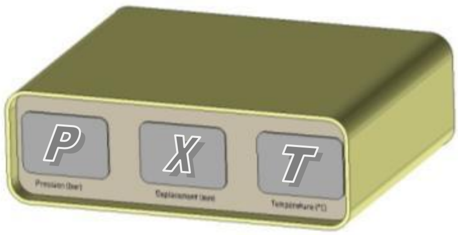


Picture 3 : AERO / Standard wheels tensioning device

II. Required tools

1. A reading box (N11001/202)

This reading box (*Picture 4*) permits to read the pressure in the accumulator (*P [bar]*) and so the tension in the line, as well as the position of the piston (*X [mm])* and an indicative value of the temperature (*T [°C]*).



Picture 4 : Reading box

N.B :
- **N11001/201** : Reading box in french version

Important :

We highly recommend using the tools that we will introduce below in order to guarantee the best installation following our instructions.

2. A bottle of nitrogen N2 (compressed nitrogen)

- Gas identification :

Gas	Pressure	Concentration	N° CAS	N° CE	CLP
Compressed nitrogen (N2)	200 bar	100 %	7727-37-9	231-783-6	Press. Gas (Comp.) H280

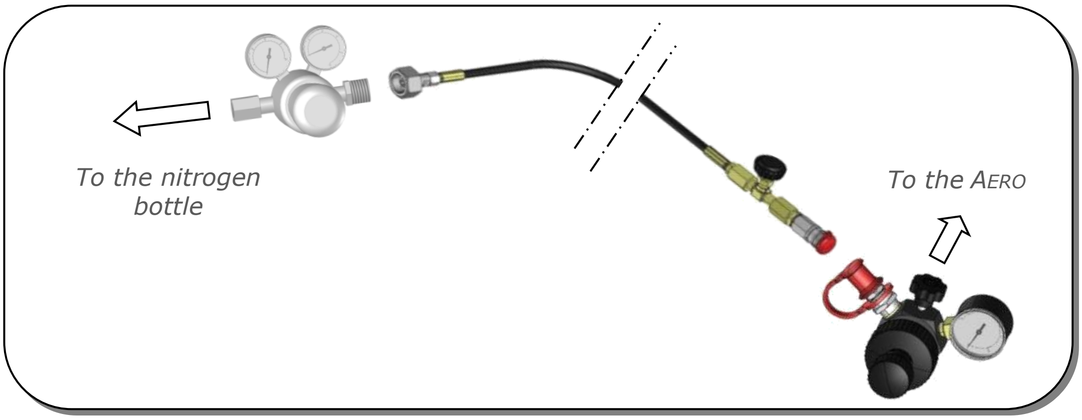
- A gas safety data sheet can be supply by GALLAND if need.
- Bottle ***not supplied*** by GALLAND.
- Warning, according the country, the applicable standards, the standard connections on the bottle can be different !
  So, it is necessary to adapt the connector of the filling kit (N11020/REP) according this standard.
  Thank's to communicate to GALLAND the dimensions of the connections on the bottle in order to supply the adapted filling kit.

3. A filling kit with its suitcase (N11020/REP)

REP	Bottle connection dimension	Standard
/101	W21.8 x 1/14	AFNOR
/102	W24.32 x 1/14	DIN

For all other dimension, contact GALLAND company.

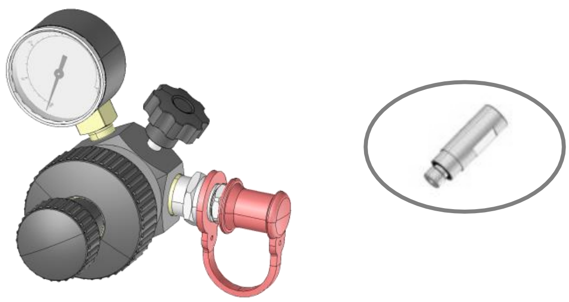
This filling kit is composed of 3 main parts, as on the *Picture 5* :



Picture 5 : Filling kit

- **A control kit with its adaptor (N11021)**

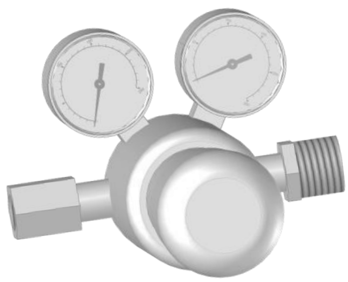
Permit, with its adaptor, to manage the filling pressure in the AERO (*Picture 6*).



Picture 6 : Control kit with its adaptor

- **A pressure regulator for bottle**

It is recommended to use a pressure regulator for bottle to release the nitrogen at the exit of the bottle under pressure (*Picture 7*). It is also better to control the available pressure in the bottle and the useful pressure in the hose.



Picture 7 : Pressure regulator

- **A filling hose (L = 10 m)**

This hose (*Picture 8*) permits to link the control kit (*Picture 6*) to the pressure regulator (*Picture 7*).

Picture 8 : Filling hose

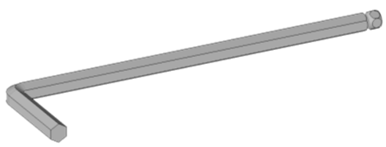
- **A discharge tool (N11025)**

This tool (*Picture 9*) permits to discharge nitrogen of the AERO.

Picture 9 : Discharge tool

- **A hexagonal key of 5 (N77150-5)**

This key (*Picture 10*) permits to unscrew the protection cap of the AERO.



Picture 10 : Hexagonal key of 5

4. « Standard » catenary tools (not supplied)

- ✓ Lever hoist,
- ✓ Pulling hand,
- ✓ Slings,
- ✓ End wrench 13 (for the control kit),
- ✓ On field tools,
- ✓ …

III. Preliminary operations

Before starting to install it is important to determine :

1. Filling Pressure P,
2. Position of the stroke, X dimension.

Once those parameters determined, the installation will proceed as usual with a standard wheels tensioning device.

Then no more adjustment is required.

1. Mechanical tension of the line according to the filling pressure

The mechanical tension in the wire is proportional to the nitrogen pressure P in the accumulator. To obtain the traction strength $F\ [daN]$, the accumulator has to be filled at a pressure $P\ [bar]$.

This pressure is calculated thanks to the formula bellow:

$$\boldsymbol{P_{Theoretic} = \frac{F}{21.1} + 4}$$

Examples :

F [daN]	P [bar]
1000	51.4
1500	75.1
2000	98.8
2500	122.5
3000	146.2
3500	169.9
4000	193.6

Warning !

The filling must be done at the external installation temperature. It must be slow and progressive.

2. *X dimension* according to the span length and the external temperature

The position of the piston, X dimension, is determined according to the conception and projects parameters following :

- $\alpha\ [K^{-1}]$: Coefficient of thermal expansion of the wire considerated,
- $L\ [m]$: Length to regularize,
- $T_{max}\ [°C]$: Maximum temperature of the temperature range considerated,
- $T\ [°C]$: External temperature.

The following formula links the expansion of the wire (report on the dimension X of the jack) with these parameters :

$$X_{Theoretic} = \alpha \times L \times (T_{max} - T)$$

Refer to abacus for setting.

3. Example for a span of 650 m and the mechanical tension to apply of 1300 daN

See Annex 1.

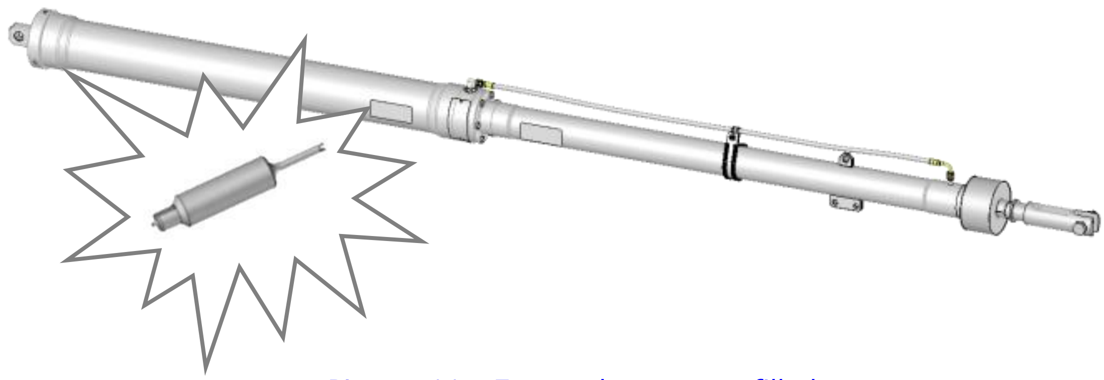
IV. On field installation

1. First step for the AERO

We remind that at delivery the AERO is filled at a low pressure. You absolutely must keep this low pressure otherwise you may damage the sealing parts.

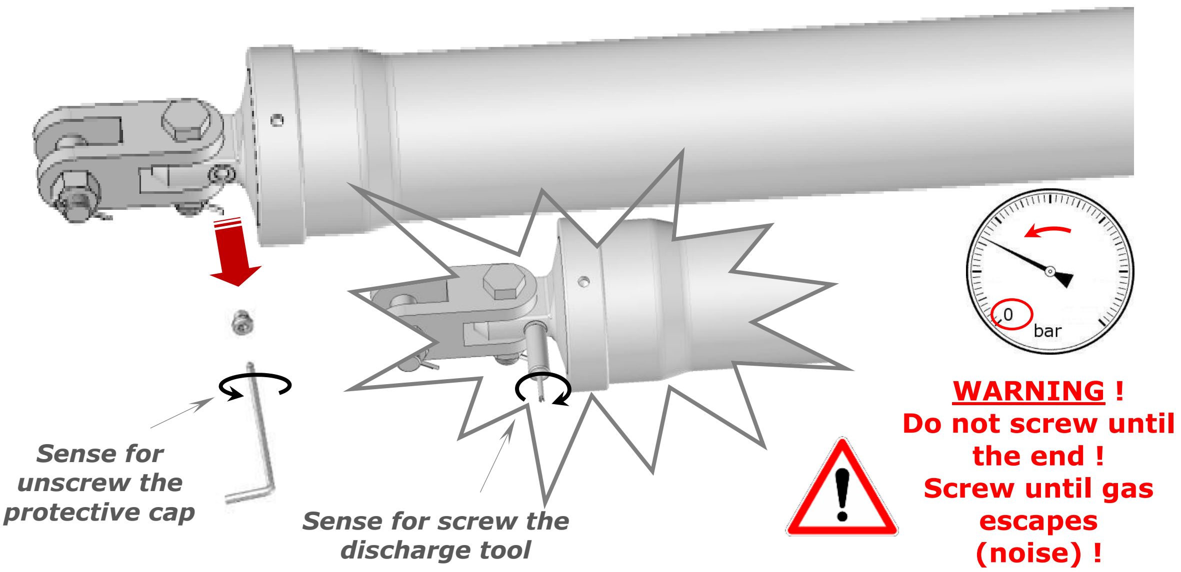
Before the installation, start by empty completely the accumulator with the discharge tool included in the filling kit (*Picture 9*).

Operations to do on the ground.



Picture 11 : Empty the gas pre-filled

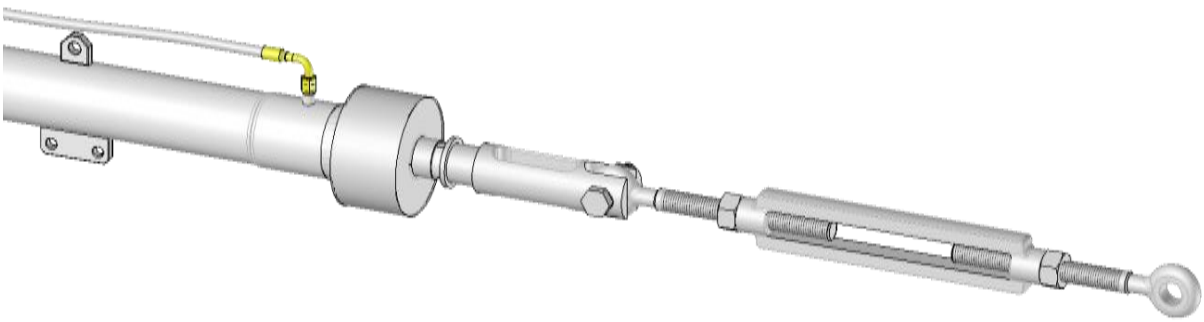
Unscrew the protective cap G1/8 (gas thread, N11015), located under the AERO on the double clevis side, with a hex key n° 5 (*Picture 10*).
Keep this protective cap because it will be to put back in place at the end of the installation. Then screw slowly the discharge tool to empty completely the gas in the chamber (*Picture 12*).



Picture 12 : Screw the discharge tool and empty the AERO

2. Installation of the turnbuckle

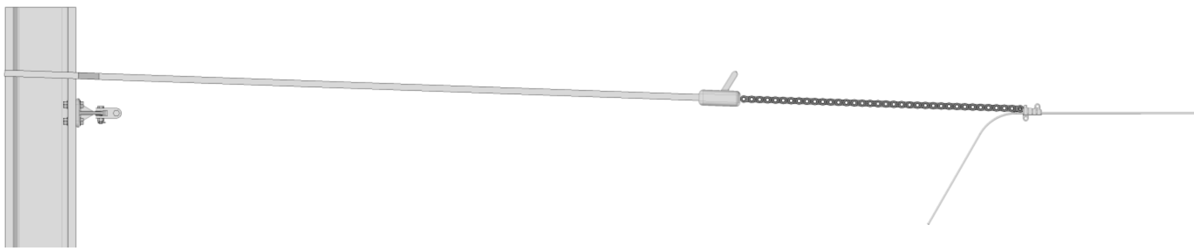
Install, on the anchoring clevis, and adjust the turnbuckle provided with the AERO in **median position** (*Picture 13*), in order to adjust after the length of the line which will be anchor on it.



Picture 13 : Install the turnbuckle in median position

3. Take back the mechanical tension in the line

Take back the mechanical tension following the same process that for a standard installation (with the lever hoist, pulling hand, slings…).



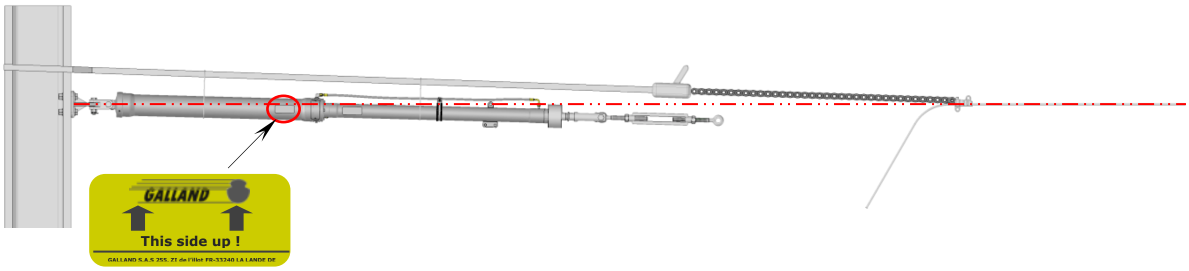
Picture 14 : Take back the mechanical tension in the line

4. Anchor the AÉRO

Anchor the AERO to the pole in the right position, the hydraulic hose must be in upper position.

A yellow sticker pasted (like on the example) on the body of the AERO shows the right position.

Note :
It is advised to maintain temporary the AERO to have the next steps easier. This mounting have to be done with a little angle with the line in order to avoid that the sling which takes back the tension take back it at the end of the installation and so does not distort the setting of the AERO.



Picture 15 : Anchor the AERO to the pole

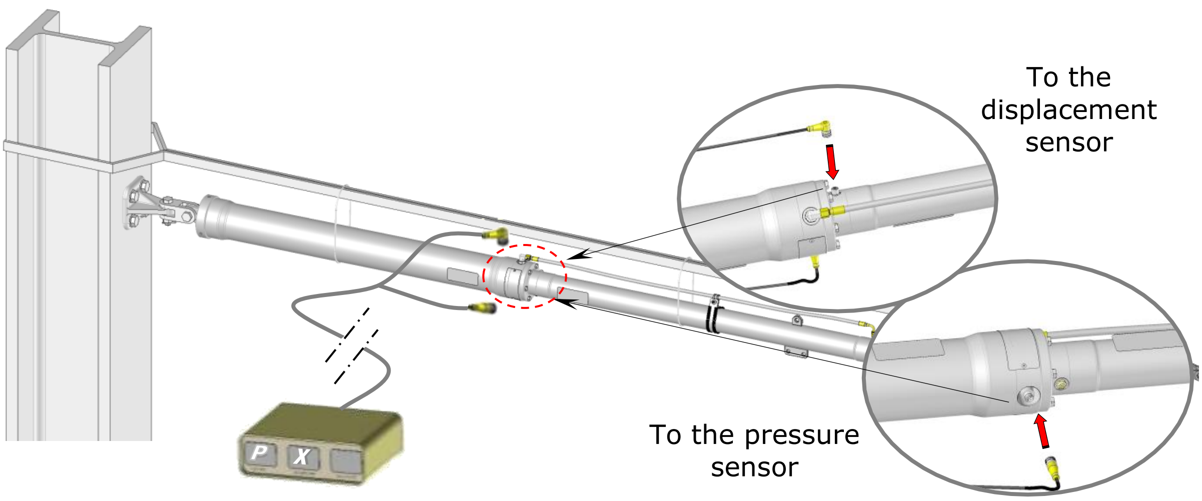
5. Connect the reading box to the AERO

Connect the *extremity bent* of the cable to the displacement sensor. This one is located at the junction accumulator/jack, on top, jack side.

Connect the *right extremity* of the cable to the pressure sensor. This one is located under the AERO's body at the junction accumulator/jack, accumulator side.

Lower the link cable at the bottom of the pole.

Screw the link cable to the backside of the reading box (*Picture 16*).



Picture 16 : Connect the reading box

6. Adjusting the output of the jack's piston

Output the piston of the AERO at the *X* dimension, determined at the § III.2 page 10.

In order to anticipate the clearances in the mounting and the setting up of the system, anticipate outputting of the $X_{Theoretic}$ dimension determined with approximately Δ mm more.

This Δ varies with the final tension. Indeed, more the tension is high, more the induced clearances by the installation are important.

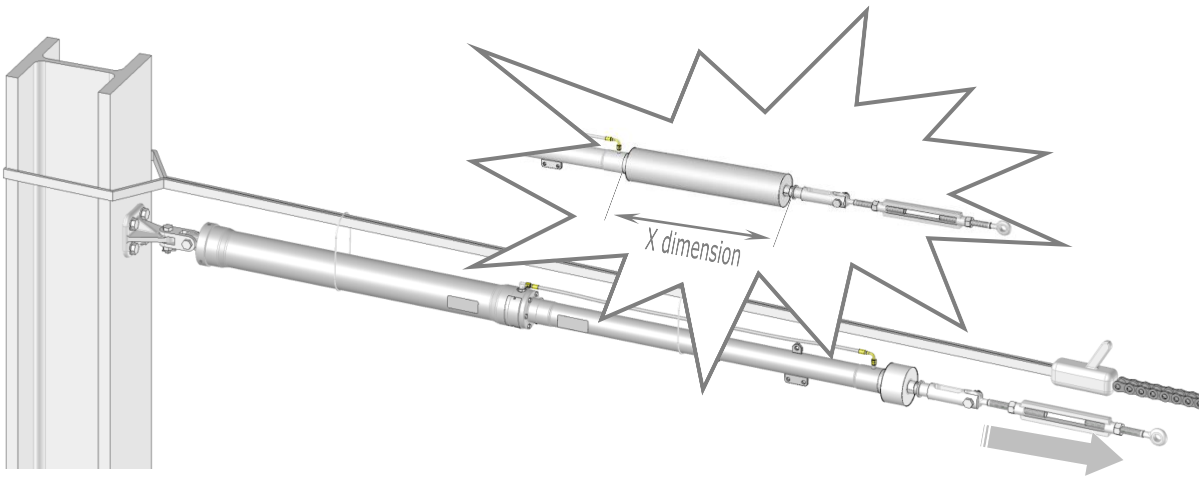
⇨ $X_{Installation} = X_{Theoretic} + \Delta\ mm$

F [daN]	Δ [mm]
< 2000	70
≥ 2000	100

To output the piston, pull continuously and progressively, without shock, on the anchoring clevis (*Picture 17*) with a sling inserts in the oblong hole of the clevis and a 750 kg lever hoist.

The system being composed of a fluid, an inertia before movement is present when we act on the piston. So, it is normal that it is difficult to put in movement the piston at the beginning.

Then, check the $X_{Installation}$ dimension with the reading box and adjust the position of the piston if it is necessary.

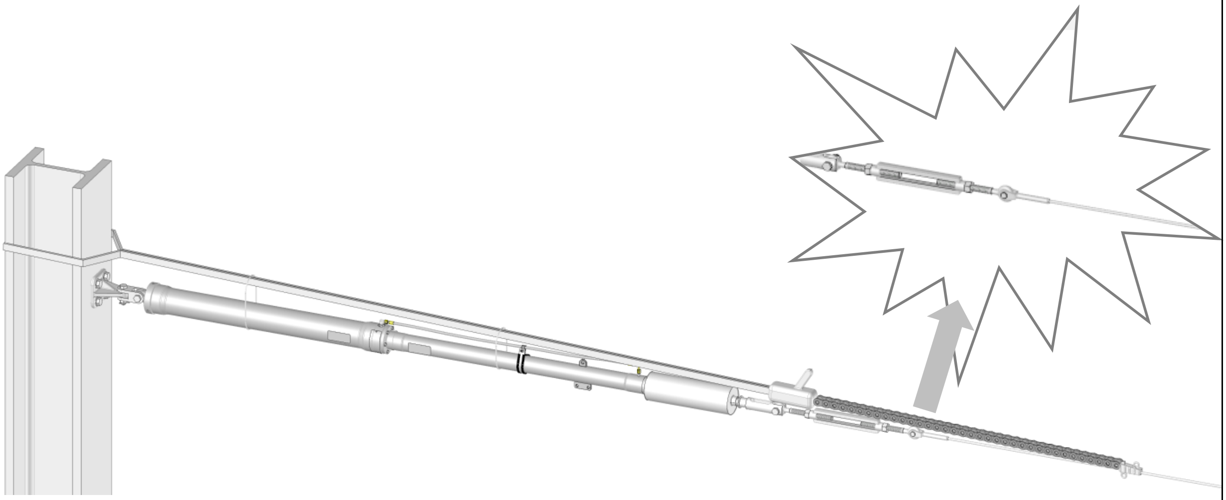


Picture 17 : Output the piston at $X_{Installation}$ dimension

GALLAND S.A.S
255, ZI de l'Illôt
FR - 33 240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20
Fax. +335.57.94.07.11
www.galland-sas.com
info@galland-sas.com

7. Anchor the line on the AERO

Anchor the line at the turnbuckle of the AERO (*Picture 18*).

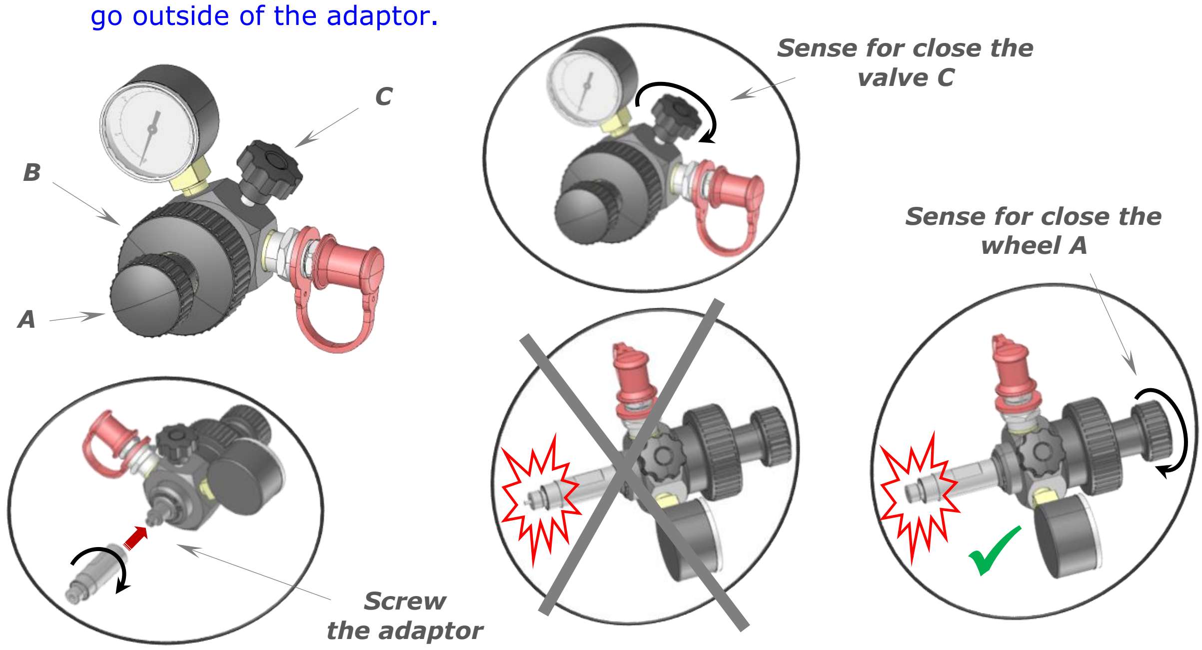


Picture 18 : Anchor the line on the AERO

8. Fill the AÉRO with nitrogen

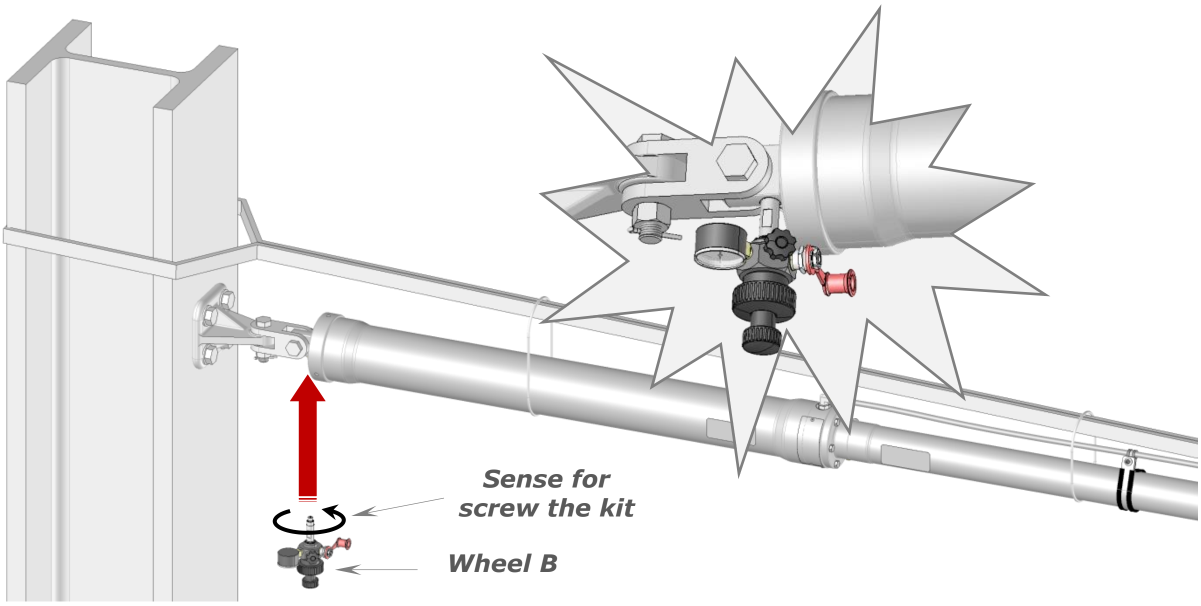
Before to fill the AERO with nitrogen, prepare the control kit with its adaptor like on the *Picture 19*.

- Check that the valve **C** is *well close*.
- Screw the adaptor on the control.
- *Unscrew the wheel* **A** to insert completely the discharge rod. This one must not be go outside of the adaptor.



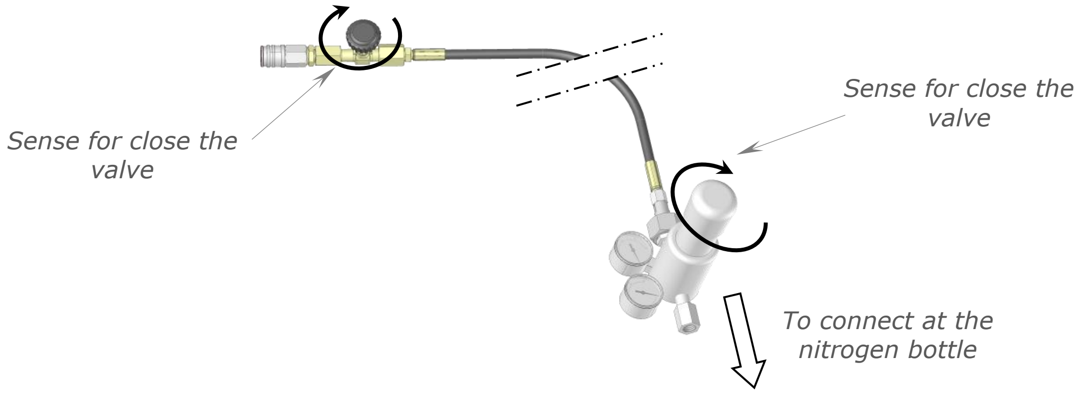
Picture 19 : Prepare the control kit with its adaptor

With the wheel B (*Picture 19*) screw the control kit under the AERO (*Picture 20*).



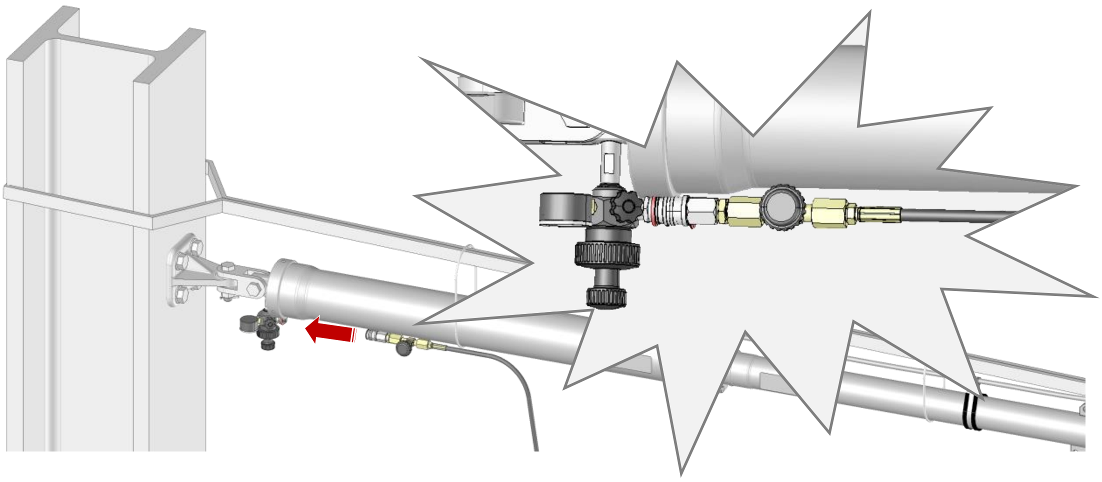
Picture 20 : Screw the control kit under the AERO

Connect the filling hose to the pressure regulator of the nitrogen bottle, close the valves (*Picture 21*).
The hose being enough long, this link with the bottle occurs on the ground.



Picture 21 : Connect the hose and the pressure regulator on the nitrogen bottle

Connect the filling hose to the control kit already installed on AERO with the fast coupler (*Picture 22*).



Picture 22 : Connect the filling tool to the control kit trough the fast coupler

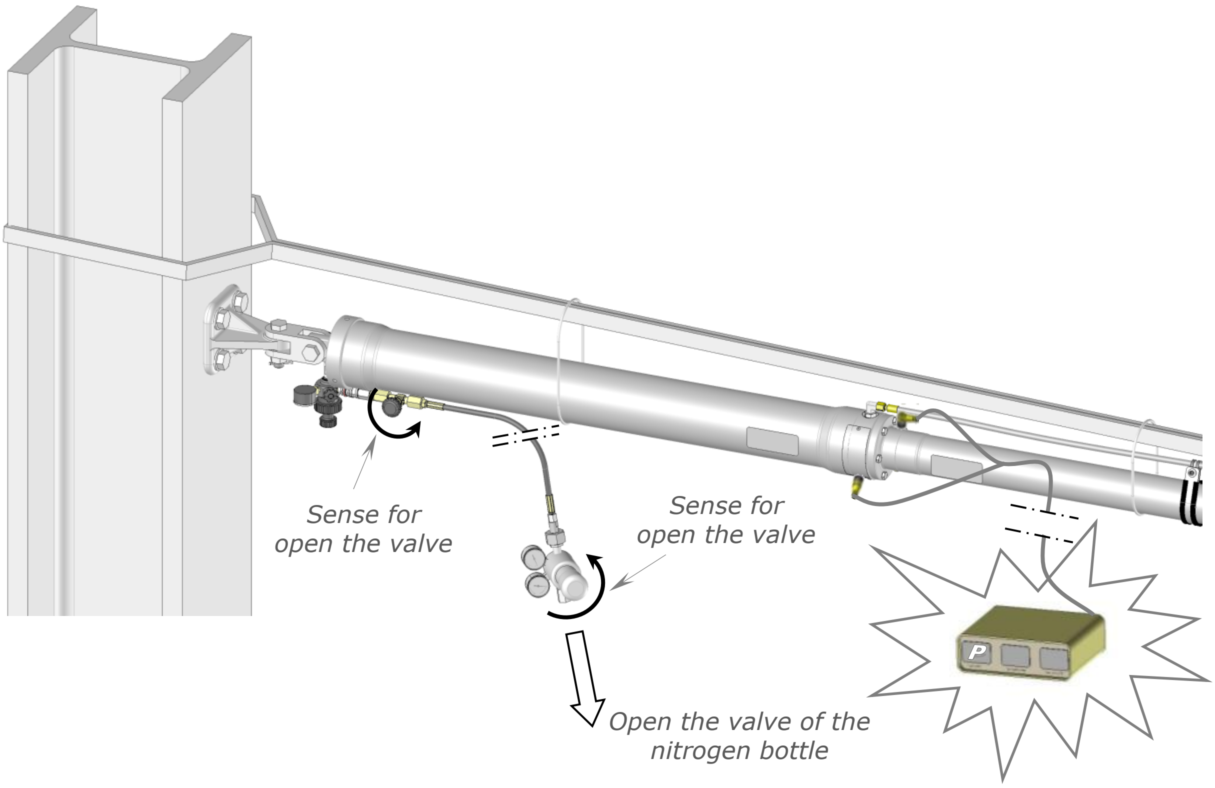
It needs few minutes to fill the gas, this duration can change a bit according to the filling pressure.

Open the valves : nitrogen bottle, pressure regulator and hose, in this order and let AERO's filling (*Picture 23*).

Check the filling pressure with the reading box. During filling, more the pressure in the chamber increase more the pressure in the line increase as well. The piston will input a slightly according to the clearances in the line and the AERO will take back gradually all the tension of the line. The sling which takes back the tension will become "soft".

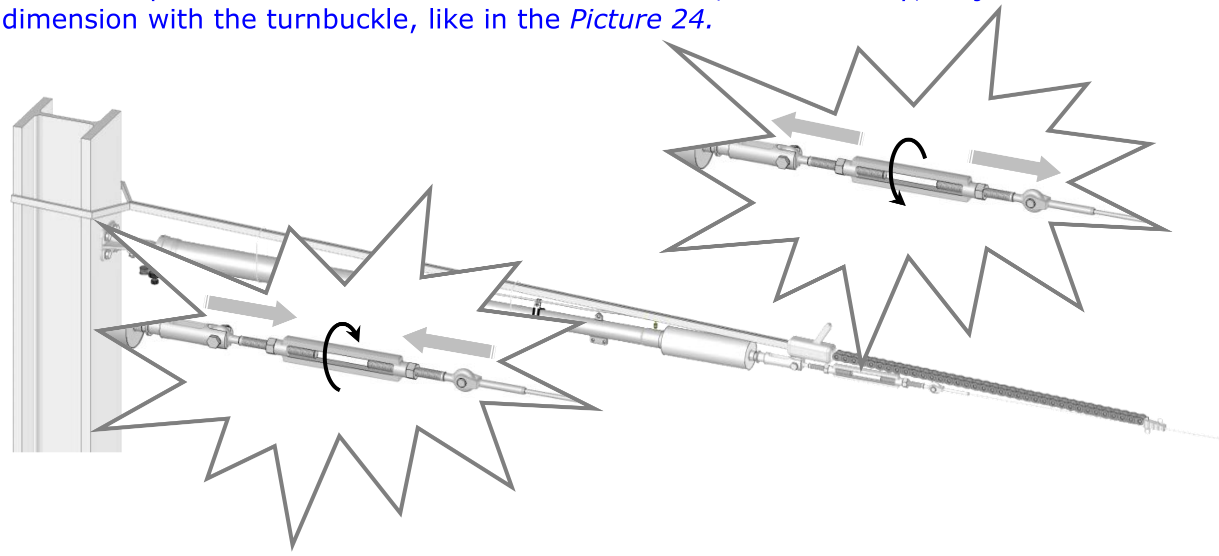
Warning !

The filling has to be done on site.
It must be slow and progressive.



Picture 23 : Fill the AERO with nitrogen at pressure P

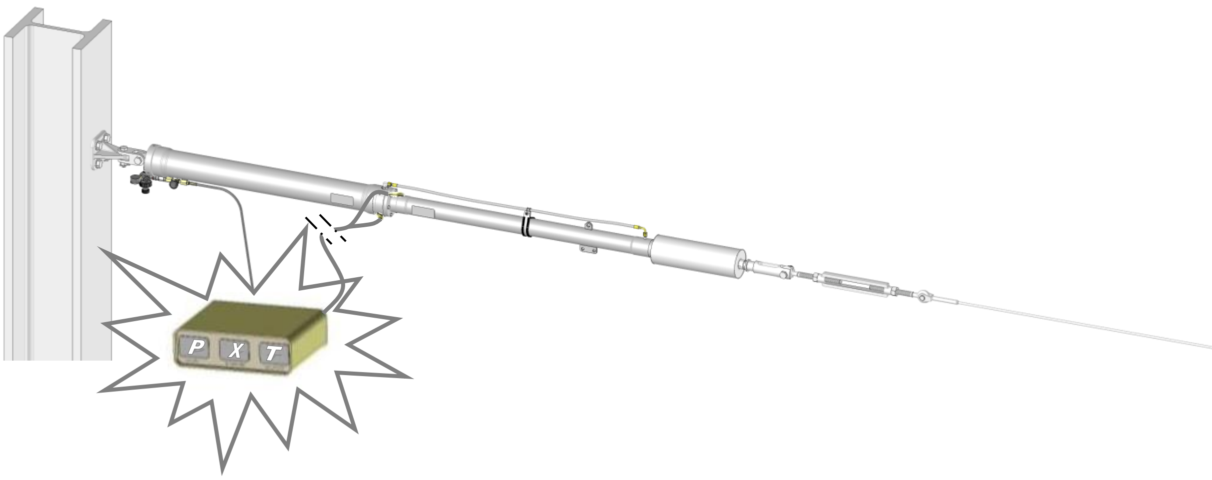
Once the pressure P reached in the accumulator; if necessary, adjust a bit the X dimension with the turnbuckle, like in the *Picture 24.*



Picture 24 : Adjust the X dimension with turnbuckle

Then, take off the tools for take back the tension of the line, in order the AERO takes back well all the tension.

Check the pressure P in the AERO according to the tension in the line desired and X dimension according to the external T (*Picture 25*).



Picture 25 : Check the adjustments parameters with the reading box

If the pressure P in the AERO isn't good :

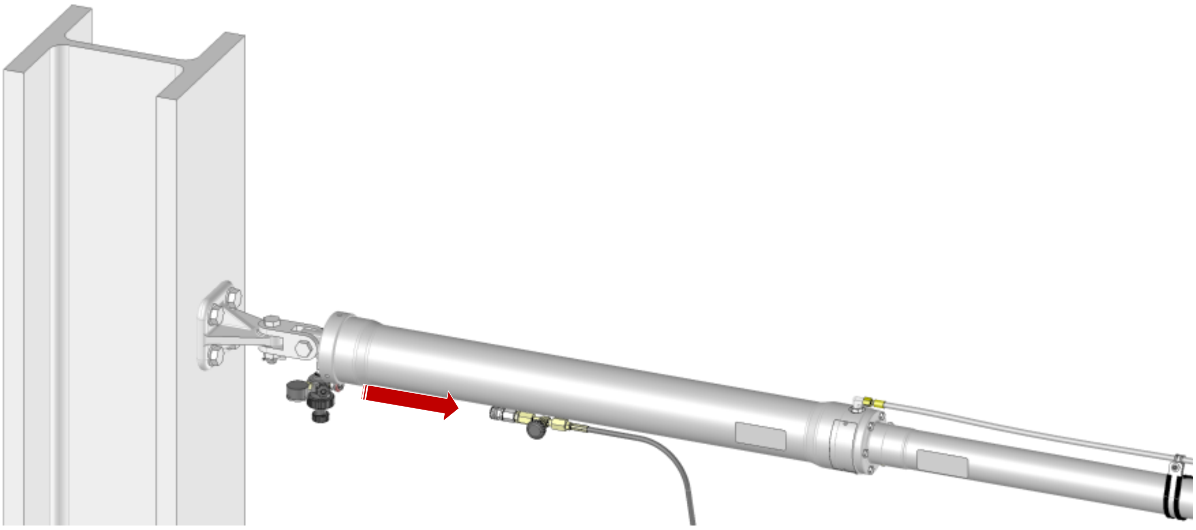
- Adjust this pressure P with discharging or adding gas.

If the X dimension in the AERO isn't good :

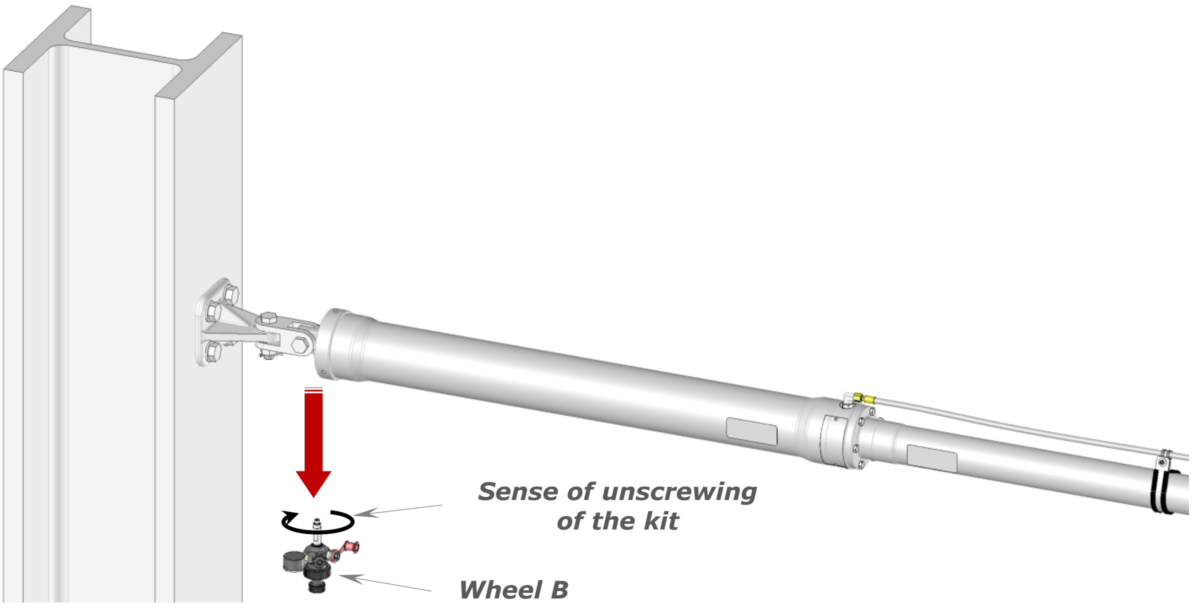
- Adjust the X dimension with the turnbuckle.

9. Remove the filling kit

So, remove the filling kit, by takeoff the hose of the control kit (*Picture 26*) and unscrewing this one, with the wheel B (*Picture 27*), and if necessary the adaptor with an end wrench 13.

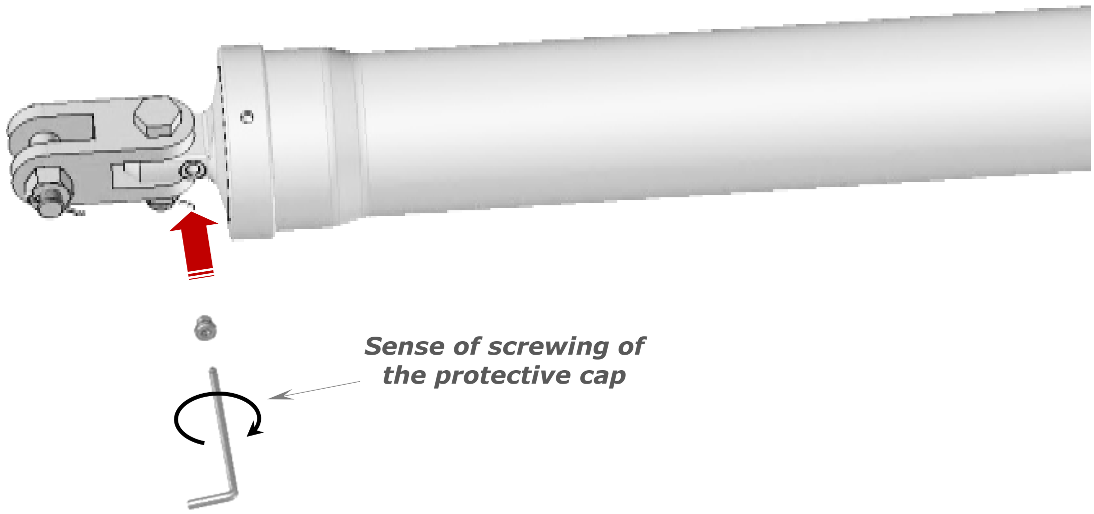


Picture 26 : Take off the hose of the control kit



Picture 27 : Unscrew the control kit of the AERO

Don't forget to screw the protective cap G1/8 removed at the beginning of the installation (*Picture 28*).



Picture 28 : Screw the protective cap

To finalize the installation, disconnect the reading box of the link cable and fix this cable along the pole. Then, put on the protective cap (N11012/101) on the end of this cable.

AERO should look like at the *Picture 29* below.

Picture 29 : AERO installed

V. Options

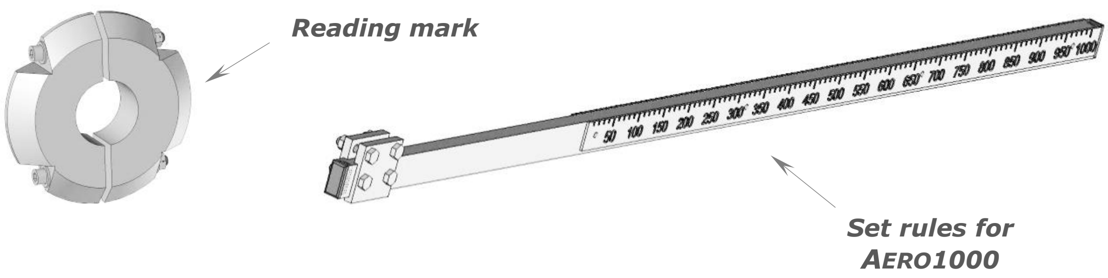
2 options are available for the AERO :

- 1 reading scale to control X dimension,
- 1 stay.

1. Option : Reading scale (JG3688/101)

This option is composed of several elements (*Picture 30*) :

- 1 reading mark, JG3562/101 ;
- 1 set rules for AERO1000, JG3556/1000.



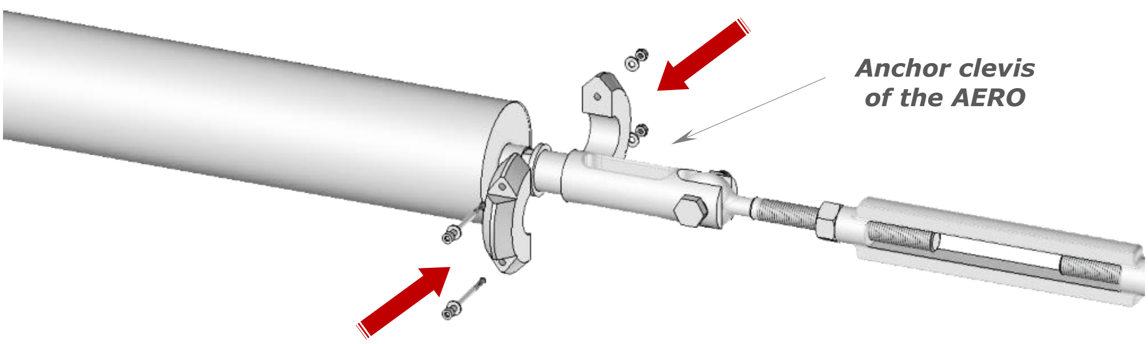
Picture 30 : Elements to install for the reading scale option

Install the reading mark

Unscrew the screws and separate the 2 half-marks.

Insert the reading mark in the groove on the anchor clevis of the AERO (*Picture 31*).

Put the screws and well tight the assembly with a hexagonal key of 5 (*Picture 10*).



Picture 31 : Install the reading mark

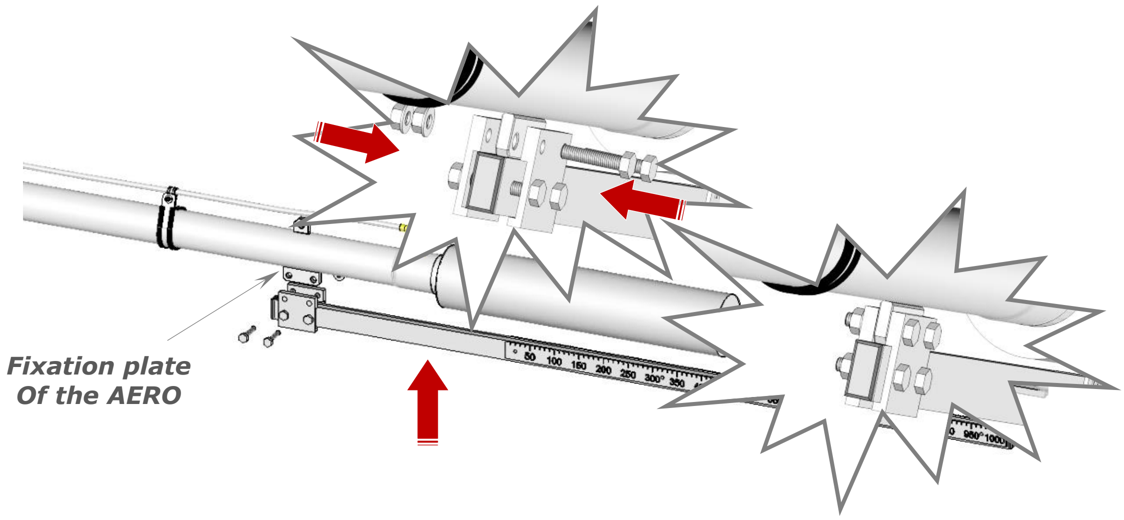
GALLAND S.A.S
255, ZI de l'Illôt
FR - 33 240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20
Fax. +335.57.94.07.11
www.galland-sas.com
info@galland-sas.com

Install the set rule

Unscrew slightly the 2 lower bolts and remove the 2 upper bolts.

Put in contact the rules support on the bottom of the fixation plate of the AERO (*Picture* 32).

Insert the 2 upper bolts and screw the H M10 screws with a torque of 5 daN.m.



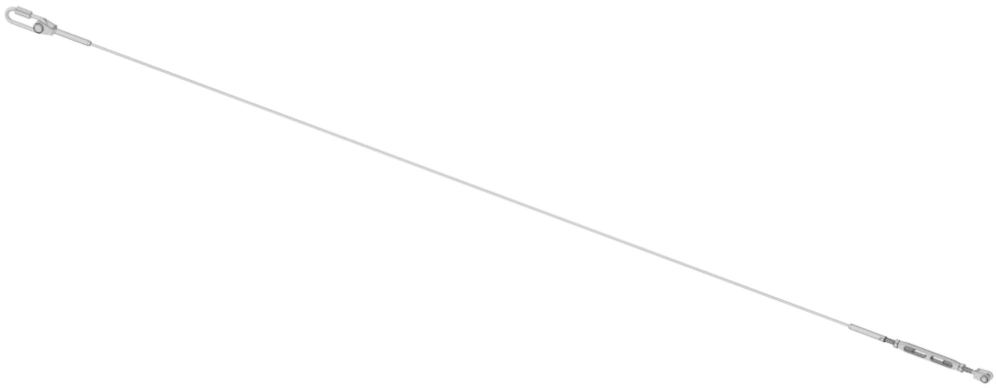
Picture 32 : Install the set rules

Once the reading scale option set up, the final installation must look like to the *Picture 33* below.

Picture 33 : AERO set up with reading scale option

2. <u>Option</u> : Stay (JG2555/L)

This option (crimped stay) is composed with one quick link, one stainless steel cable Ø6 and one turnbuckle.

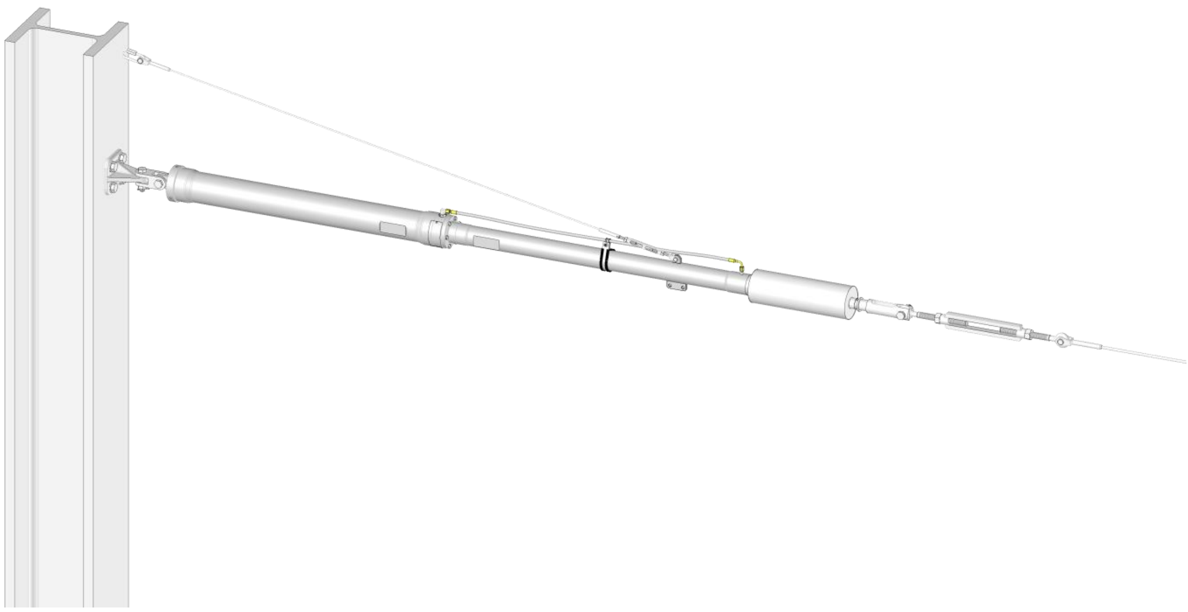


Picture 34 : Stay

The turnbuckle gets fixed on the AERO and the quick link on the pole.

Warning, the fitting part on the pole for the anchoring of the stay is to anticipate and not supplied by GALLAND.

Once the stay option set up, the final installation must look like to the *Picture 35* below.



Picture 35 : AERO set up with stay option

VI. Global checking

1) Check the filling pressure P.

2) Check the X dimension according to the external T.

3) Check if the line adjustments did not change (cantilevers positions, steady arms, etc.)

VII. Maintenance and inspection

Frequency : Once an year, and a checking in extreme period (great cold and / or great heat).

Checking points :

1. Check the pressure P in the accumulator.
2. Check the X dimension according the external temperature T.
3. Check that the bellow is not damaged.
4. Check that link cable and end fittings are not damaged.
5. Check that turnbuckle is well greased.

Nota :
In case you see damages, which affect the good compensation of the line or the reliability of the line you must replace the AERO.

GALLAND S.A.S
255, ZI de l'Illôt
FR - 33 240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20
Fax. +335.57.94.07.11
www.galland-sas.com
info@galland-sas.com

ANNEX 1 : Example of abacus

Example for a span of 650 m and a mechanical tension of 1300 daN

Using the formula on the § III.1 (page 9) for a mechanical tension of 1300 daN, the accumulator must be filled, at the end of the installation, with a pressure $P_{Theoretic}$ of :

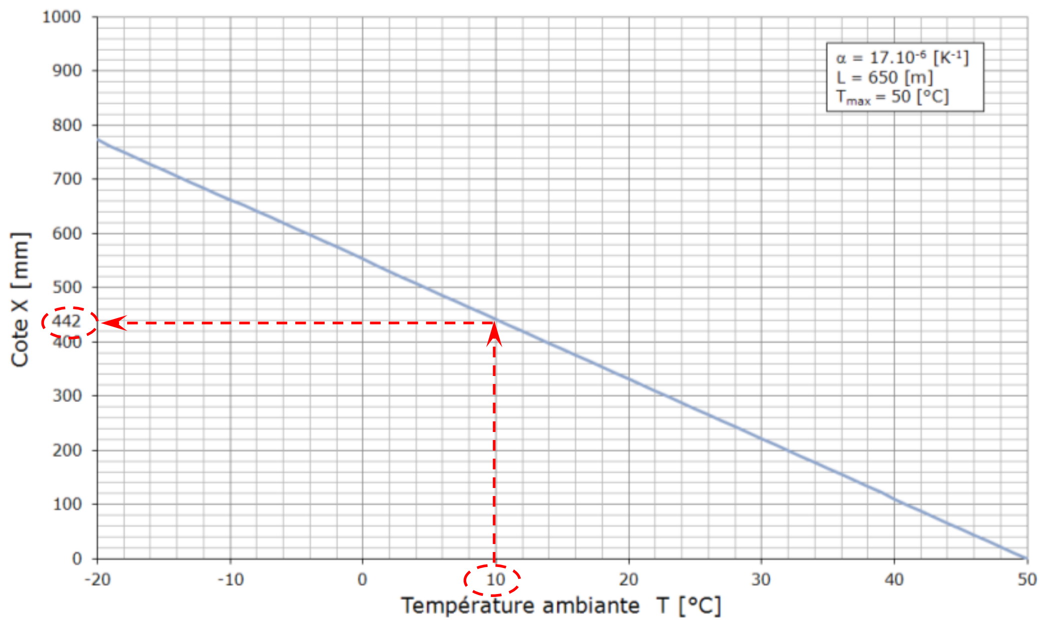
$$P_{Theoretic} = \frac{F}{21.1} + 4 = \frac{1300}{21.1} + 4 = 65{,}6$$

Round to the nearest whole[1] : $P = 66\ [bar]$

The relation on § III.2 (page 10) permits to determine the position of the piston according to the external $T\ [°C]$ and the expansion coefficient of the contact wire $\alpha = 17.10^{-6}\ [°C^{-1}]$.
It is also important to consider the delta of temperature exposure of the AERO, in our example $\Delta T = 70\ [°C]$ ($Tmax = +50\ [°C]$ and $T_{min} = -20\ [°C]$) :

$$X_{Theoretic} = 17.10^{-6} \times 650 \times (50 - T).10^3\ [mm]$$

With this relation, we can draw the curve below *(Picture 36)*, representing the evolution of the X stroke according the external temperature.



Picture 36 : Curve of the evolution of the stroke

If during the installation, the external temperature $T = 10\ [°C]$ the X dimension should be adjusted to $X_{Installation} = 442\ [mm]$.

Setting parameters, according § III.1 (page 9) and § IV.6 (page 14), are :

- $\boldsymbol{P_{Installation}}$ **= 66 bar**
- $X_{Installation}$ = 442 mm + 70 mm => $\boldsymbol{X_{Installation}}$ **= 512 mm**

[1] 0,5 bar gap of pressure which represent a stress of $F = 0{,}5 \times 211 = 10{,}55\ [daN]$

GALLAND S.A.S
255, ZI de l'Illôt
FR - 33 240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20
Fax. +335.57.94.07.11
www.galland-sas.com
info@galland-sas.com

ANNEX 2 : Simplified installation procedure

1. *Filling pressure according to mechanical tension of the :* $P = \frac{F}{21.1} + 4$
   - *Determine the nitrogen pressure in order to fill the accumulator.*

   (See § III.1 - DT-AERO1000)

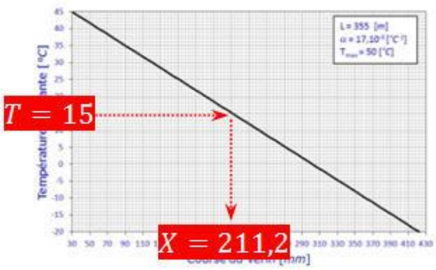
Examples of tensions :

F [daN]	P [bar]
1000	51.4
1500	75.1
2000	98.8
2500	122.5
3000	146.2
3500	169.9
4000	193.6

2. *Determine the jack's stroke X according the external temperature.*
   - *X dimension according to regularized length and external temperature*

   X = α x L x (Tmax – T)

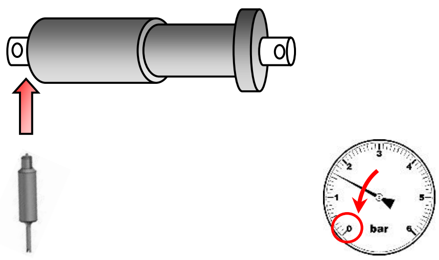
   (See § III.2 - DT-AERO1000)



3. *Discharge the pressure in the accumulator with the discharge tool.*

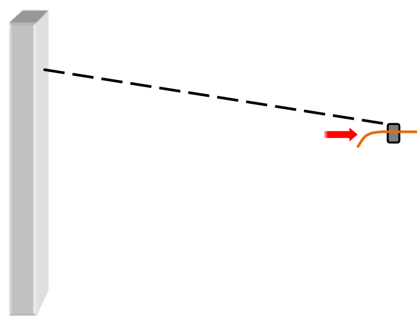
   (See § IV.1 - DT-AERO1000)

   WARNING !
   Do not screw until the end !
   Screw until gas escapes (noise) !



4. *Preparation for positioning the AERO*
   - *Install the turnbuckle in mediane position.*
   - *Take back the tension of the line.*

   (See § IV.2, § IV.3 – DT-AERO1000)

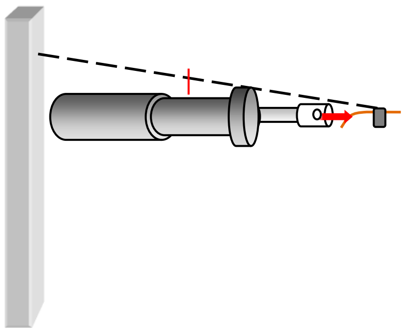


GALLAND S.A.S
255, ZI de l'Illôt
FR - 33 240 LA LANDE DE FRONSAC
Tél. +335.57.94.07.20
Fax. +335.57.94.07.11
www.galland-sas.com
info@galland-sas.com

5. *Positioning the AERO*
   - *Anchor the AERO to the pole.*

⚠ *Maintain the AERO with the sling which take back the tension of the line.*
Warning, the AERO don't be at the horizontal, but with a slight angle to the bottom of the pole.

(See § IV.4 - DT-AERO1000)

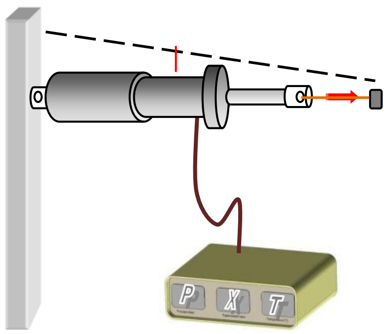


6. *Connect the reading box*
   - *Connect the reading box to the AERO*
   - *Set the output (X dimension) of the jack's piston.*
     - ➢ $X_{Installation} = X_{Theoretic} + \Delta$ ***mm***

F [daN]	***Δ [mm]***
< 2000	*70*
≥ 2000	*100*

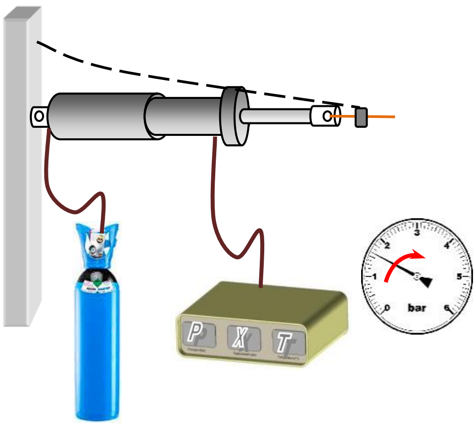
   - *Then, anchor the line on the AERO.*

(See § IV.5, § IV.6, § IV.7 - DT-AERO1000)



7. *Fill the accumulator with good pressure of nitrogen*
   - *Check the pressure with the reading box delivered.*
   - *If necessary, adjust the X dimension with turnbuckle.*

(See § IV.8, § IV.9 - DT-AERO1000)



8. *Take off the insturments*
   - *Take off the sling which takes back the tension of the line.*
   - *Check the setting parameters with the reading box.*
   - *Disconnect the reading box.*
   - *Put back the protective cap.*