FRANGIBLE TUBULAR APPROACH MASTS
INSTALLATION MANUAL

13.04.2023
Revision 4.0

exel
COMPOSITES

CONTENTS

1. GENERAL

1.1 SYMBOLS USED IN THIS MANUAL

Specific symbols are used in this manual to attract readers' attention to information of special importance. These symbols, their reference and explanations are presented in the table below.

Symbol	Referent	Explanation
	INFO	A useful hint to facilitate installation.
	NOTE	In case of incorrect action, the structures are in danger of being broken. When performing this action, please exercise extreme caution. Note related to the matter.
	DANGER	In case of incorrect action, fitters or persons in the proximity are in danger of accident. Please exercise extreme caution when performing this action.
	REFERENCE	Further information about the subject elsewhere in the manual.

1.2 REQUIREMENTS OF ICAO

According to the requirements of ICAO (International Civil Aviation Organization) frangible safety approach light masts shall be used in all installations. Below is an extract from Aerodrome Design Manual Part 6, Frangibility, First Edition – 2006.

"Chapter 1 INTRODUCTION
1.3 OBSTACLES TO BE MADE FRANGIBLE

1.3.2 Annex 14 — Aerodormes, Volume I — Aerodorme Design and Operations, Chapter 5, specifies that elevated approach lights and their supporting structures should be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

a) where the height of the supporting structure exceeds 12 m, the frangibility requirements should apply to the top of 12 m only; and

b) where a supporting structure is surrounded by non-frangible objects, only that part of the structure that extends above the surrounding objects shall be frangible.

Chapter 5 TESTING FOR FRANGIBILITY
5.1 GENERAL

5.1.2 The frangibility of any aid should always be proven before the aid is considered for installation. High-speed, full-scale testing is a proven method for verification of frangibility. Results of the numerical simulation show this approach to be capable of demonstrating frangibility. However, as for any numerical simulation methods, the model and simulation approach used must be validated for this purpose by comparison with representative test data. Numerica simulation methods are discussed in Chapter 6.

5.1.4 Static tests, as opposed to dynamic tests, are considered adequate for verification of frangibility of visual aids of low mass having an overall height equal to or less than 1.2 m, such as elevated runway and taxiway lights, taxiing guidance signs and visual approach indicator systems.

5.1.5 Dynamic test are recommended for verification of frangibility of navigational aids having an overall height in excess of 1.2 m and located in positions where they are likely to be impacted by an aircraft in flight. Such aids are approach lighting towers, wind direction indicators, transmissometers, ILS localizer and glide path antennas and MLS approach azimuth and elevation equipment. ILS glide path antenna and the MLS aaproach azimuth and elevation equipment provide a unique situation due to their size and mass of the instrument and support structure. While frangibility requirements should be applied to this equipment in general, these requirements may be too restrictive for such large structures."

(Aerodrome Design Manual Part 6, Frangibility; First Edition — 2006: International Civil Aviation Organisation, Doc 9157 AN/901.) According to the requirements of ICAO (International Civil Aviation Organisation) frangible safety approach light masts shall be used in all new installations. Below is an extract from International Standards and Recommended practices, Annex 14 Vol.1, seventh edition July 2016, § 5.3.1.4"

1.3 MAST FAMILY OF EXEL COMPOSITES OYJ

Exel Composites Plc has accepted the challenge of ICAO requirements by designing a light, frangible, approach light mast family based on composite materials. The Exel mast has passed a full-scale impact test as a proof of meeting the requirements of ICAO. In Exel masts, frangibility is a unique built-in feature and no breakaway points at regular intervals used by other manufacturers are needed. If case of a collision, the mast will break down at the point of impact, and there is no danger of the broken pieces of the mast wrapping around the wing of the aircraft.

Due to its design and materials, an Exel mast is light but at the same time very stiff and strong and can thus well withstand wind loads and jet blast loads caused by aircraft jet engines. In case of a side impact, however, the mast will break down safely to small pieces.

Exel masts are in practice maintenance-free, and the composite materials used in them resist fatigue and corrosion. The masts will maintain their physical properties regardless of the weather and temperature. They can be safely used in maritime or other climate conditions causing corrosion. Exel-masts have been painted with visible aviation yellow colour, and therefore they do not need to be marked separately for visibility. The chosen materials make the masts transparent to electromagnetic signals. Exel masts do not distort ILS signals and as a result, the need for calibration of ILS antenna system is decreased.

1.4 EXEL TUBULAR MASTS

Exel tubular masts are available in three different diameters. The main features of tubular masts are presented in the enclosed illustration and in the table below. The tubular masts are the shortest masts in the approach light system. They consist of glass fibre modules of different lengths, which will be connected by aluminium joint elements either by bonding or by threaded joints.

Lights in tubular masts shorter than 2 m are serviced with the mast in the upright position. The tubular masts taller than 2 m are equipped with a hinged baseplate which can be tilted for approach light maintenance.

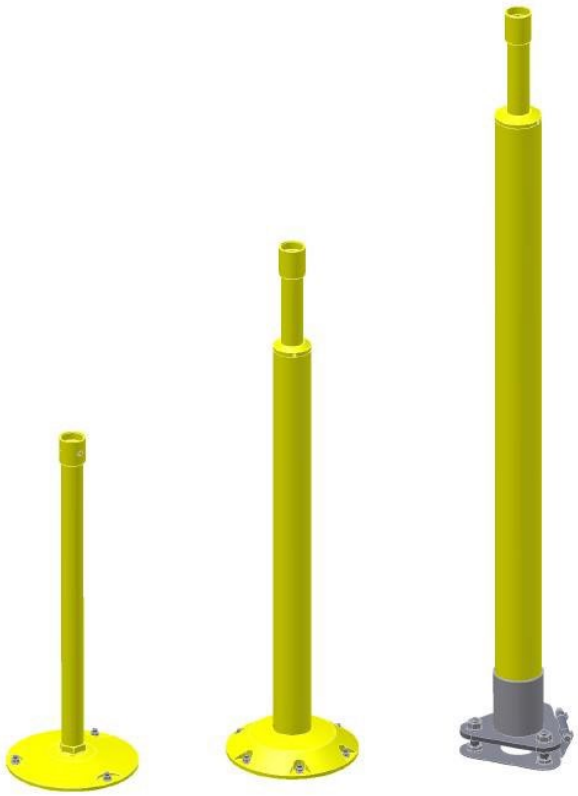


FIGURE 1. EXEL TUBULAR MAST TYPES

Mast size	Mast features
D51	One-part mast, fixed base, maximum height 1,6 m.
D86L	Two-part mast, fixed base, maximum height 2,0 m.
D106L	Two-part mast, hinged base, maximum height 5,5 m.

TABLE 1. TYPES AND MAIN FEATURES OF TUBULAR MASTS

- Maximum height is subjected to wind conditions and extra equipment.
- Detailed structures of tubular masts are shown in assembly illustrations and the mast list.

2. FOUNDATION

2.1 FOUNDATION DESIGN

The factors affecting the foundation design are:

- Height of the mast
- Quantity of lights / mast (in tubular masts there's one light per mast with possibility for extra light.)
- Wind lad (including jet blast loads caused by the aircraft engines in the proximity of the threshold)
- Soil quality

The following tables describe some typical examples of mast foundations. The calculations have been made for tubular masts carrying single luminaires and lattice masts carrying barrettes of four luminaires. The maximum wind speed used in the calculations is 40 m/s. Dimensioning of the foundations has been done according to DIN 4017 : 2006.

Two types of foundations have been calculated, slab foundation and drum foundation.

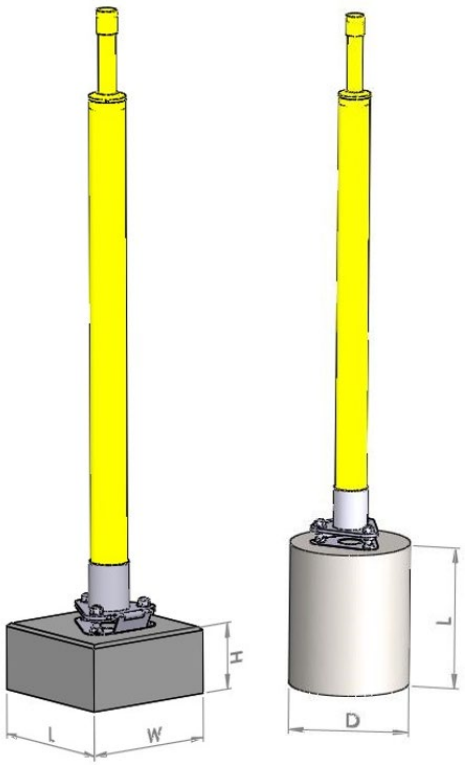


FIGURE 2. SLAB AND DRUM FOUNDATION

2.2 DIMENSIONING OF FOUNDATION FOR TUBULAR MASTS

SLAB FOUNDATION		SOIL TYPE 1			SOIL TYPE 2			SOILT TYPE 3		
Mast height	Mast type	L=W	H	Mass	L=W	H	Mass	L	H	Mass
m		mm	mm	kg	mm	mm	kg	mm	mm	kg
H = 2,5	D51/D86L	600	200	170	600	200	170	700	200	250
H = 4	D51/D86L	700	300	350	600	300	260	800	400	620
H = 2,5	D106L	450	400	190	450	400	190	700	400	470
H = 4	D106L	600	400	350	550	400	290	800	400	620
H = 5,5	D106L	700	500	600	650	400	400	1000	400	960

TABLE 2. DIMENSIONS OF CONCRETE SLAB FOUNDATION FOR TUBULAR MASTS

DRUM FOUNDATION		SOIL TYPE 1			SOIL TYPE 2			SOILT TYPE 3		
Mast height	Mast type	D	H	Mass	D	H	Mass	D	H	Mass
m		mm	mm	kg	mm	mm	kg	mm	mm	kg
H = 2,5	D51/D86L	500	800	390	500	600	280	-	-	-
H = 4	D51/D86L	500	1000	480	500	800	390	-	-	-
H = 2.5	D106L	500	800	390	500	600	280	-	-	-
H = 4	D106L	500	1000	480	500	800	390	-	-	-
H = 5.5	D106L	500	1200	570	500	1000	480	-	-	-

TABLE 3. DIMENSIONS OF CONCRETE DRUM FOUNDATION FOR TUBULAR MASTS

Soil type 1: Sand, sandy soil
angle of friction $\delta = 25°$
weight by volume $\gamma = 17$ kN/m≥
cohesion c = 0 kN/m″

Soil type 2: Compacted coarse sand and moraine
angle of friction $\delta = 40°$
weight by volume $\gamma = 21$ kN/m≥
cohesion c = 0 kN/m″

Soil type 3: Hard clay (drum foundation should not be used!)
angle of friction $\delta = 0°$
weight by volume $\gamma = 19$ kN/m≥
cohesion c = 20 kN/m″

Concrete: > K30

- In a groundwater area the foundation shall be deeper.
- In a soil frost area, the foundation shall reach below the soil frost penetration depth.

- All design values mentioned in this instruction are purely indicative. Exel Composites Plc shall not take responsibility for their applicability to the area in question.
- It is highly recommended to always consult a local civil engineer about the dimensioning of the foundation.
- Exel Composites Plc will provide the necessary load calculations (shear force and bending moment), when requested.

- Positioning of masts is in the layout-drawing.

- The heights of the top of foundation are listed separately for each position in the mast list if this information has originally been provided to Exel Composites Plc.

2.3 PREPARATION OF FOUNDATION FOR D51 AND D86L MASTS

For D51 and D86L tubular masts the foundation bolts do not need to be cast to the foundation. The cast surface is left horizontal and sufficiently flat for mounting of the mast on top of the surface.

- Tubular mast base will be fixed later with expanding anchor bolts.
- Drill 60-70 mm deep holes for the bolts during mast erection. Hole diameter is 10-11 mm.

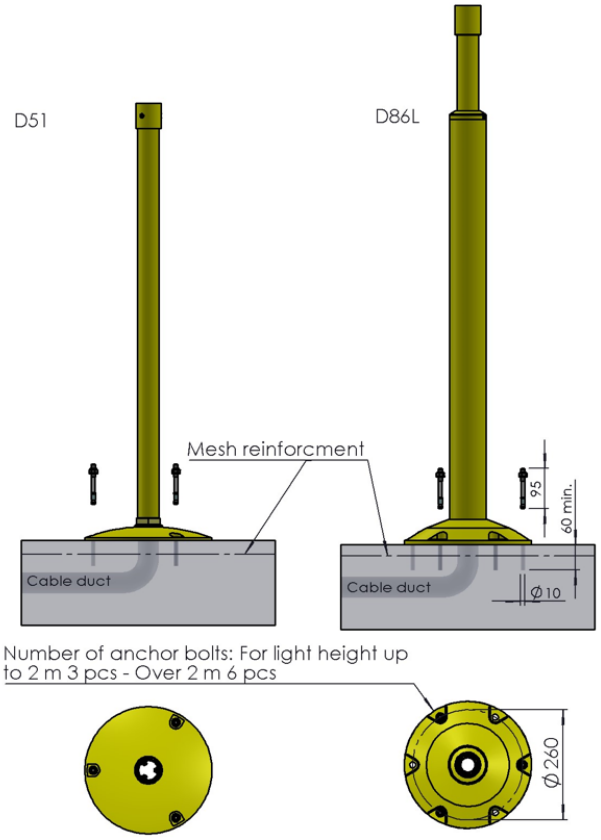


FIGURE 3. ATTACHING D51 AND D86L MASTS TO FOUNDATION

2.4 PREPARATION OF FOUNDATION FOR D106L MASTS

For the foundation of the tubular mast D106L, the foundation bolts must be cast in accordance with figure 4. The base plate of the hinged base and hex nuts are used in casting.

- Tubular mast base will be fixed later.

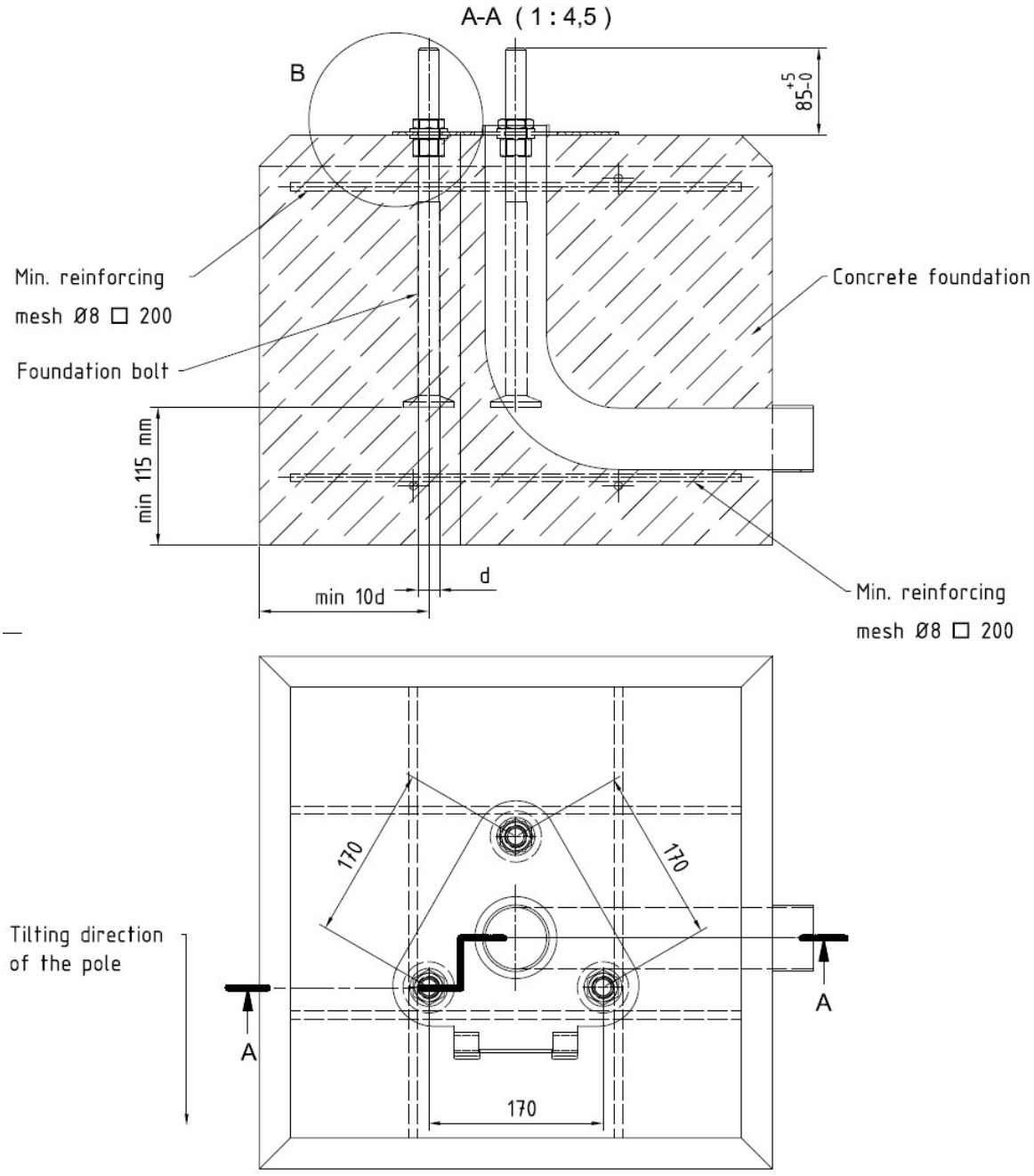


FIGURE 4. D106L MAST FOUNDATION

3. TUBULAR MASTS

3.1 UNPACKING AND HANDLING OF MAST

Unpack the mast carefully on the assembly site. Handle mast modules with care. Be sure not to damage the glass fiber structures, because they are designed to be frangible.

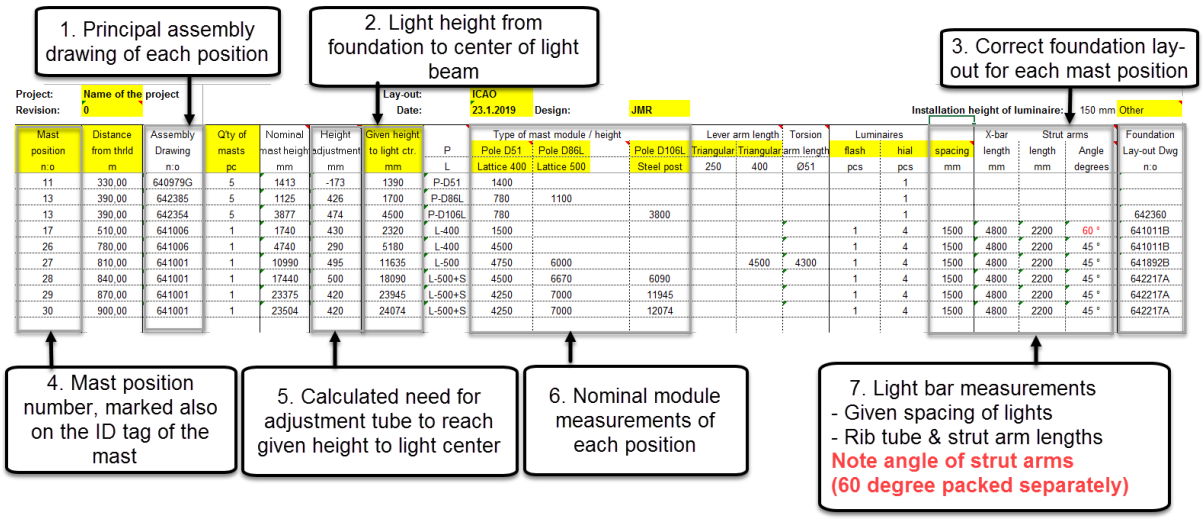
Masts are delivered as assembled modules, which will then be connected on the assembly site. Mast modules have been numbered by positions according to mast list.

All necessary screws, nuts and washers have been fitted.

	• If any damage is found in the masts, contact the representative of Exel Composites Plc. Exel will either repair the damaged parts or provide the repairing instructions.
	• Make sure that the masts have not been damaged during transportation. • Be careful not to damage masts during treatment, because they are designed to be frangible.
	• Always wear gloves when shortening D51 tube and drilling the holes for the top sleeve as well as when fixing the top sleeve. Some glass fibre splinters or dust irritating the skin may get to your hands from machined glass fibre surfaces.
	• Mast modules have been numbered according to their positions and type. POS refers to position according to mast list and ID numbers refer to a separate assembly drawing. See assembly drawings in appendices.

3.2 MAST LIST

Mast list is used as a summary of main components needed for the assembly. Also in case of need for spare parts Exel Composites keeps an archive of all past deliveries which can be ordered based on the mast list or information on ID-tag attached for each mast.



1. Principal assembly drawings can be found in attachments of this manual
2. Light height is given by the customer in ordering phase, mast module sizes are determined based on this also taking into account needed adjustment level
3. Correct foundation lay-out depend on the mast type, detailed information can be found in attachments of this manual
4. Mast position is an individual ID for each mast given by the customer or set by Exel composites
5. Height adjustment is explained in appendix 642074
6. Nominal module measurements are shown as reference
7. Detailed measurements of light bar for each position. This only applies to lattice masts.

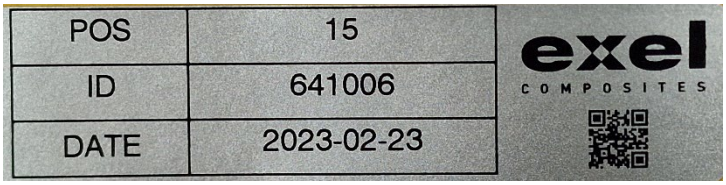


FIGURE 5. EXAMPLE OF A MAST IDENTIFICATION STICKER

4. TUBULAR MAST ASSEMBLY

- Check that mast sections have not been damaged during previous actions.

- Always wear gloves when shortening D51 tube and drilling the holes for the top sleeve as well as when fixing the top sleeve. Some glass fibre splinters or dust irritating the skin may get to your hands from machined glass fibre surfaces.

- In these instructions the part numbers have been given in parentheses (n). The numbers refer to the Parts lists in this document.
- The design of the masts has been explained more in detail in the assembly drawings (and in the layout drawings).

4.1 TOOLS NEEDED FOR JOINING TUBULAR MAST MODULES

Tubular mast	Action	Tool	Size
D51	Joint between mast and base	Fork spanner or adjustable spanner	S = 57 mm
D51	Fixing of top sleeve	Spanner Hex socket screw key	S = 8 mm S = 4 mm
D86L/106L	Joint between mast and adjustment tube	Hex socket screw key	S= 6 mm

TABLE 4. TOOLS NEEDED FOR JOINING TUBULAR MAST MODULES

4.2 TIGHTENING TORQUES APPLIED IN JOINING TUBULAR MAST MODULES

Tubular mast	Action	Size	Torque
D51	Threaded joint between adjustment tube and base	Threaded insert 2”	50 Nm
D86L/106L	Joint between adjustment tube and tubular mast	Hex socket head screw M8	2 Nm

TABLE 5. TIGHTENING TORQUES APPLIED IN JOINING TUBULAR MAST MODULES

4.3 ASSEMBLY OF D51 TUBULAR MAST

4.3.1 PARTS LIST OF D51 TUBULAR MAST

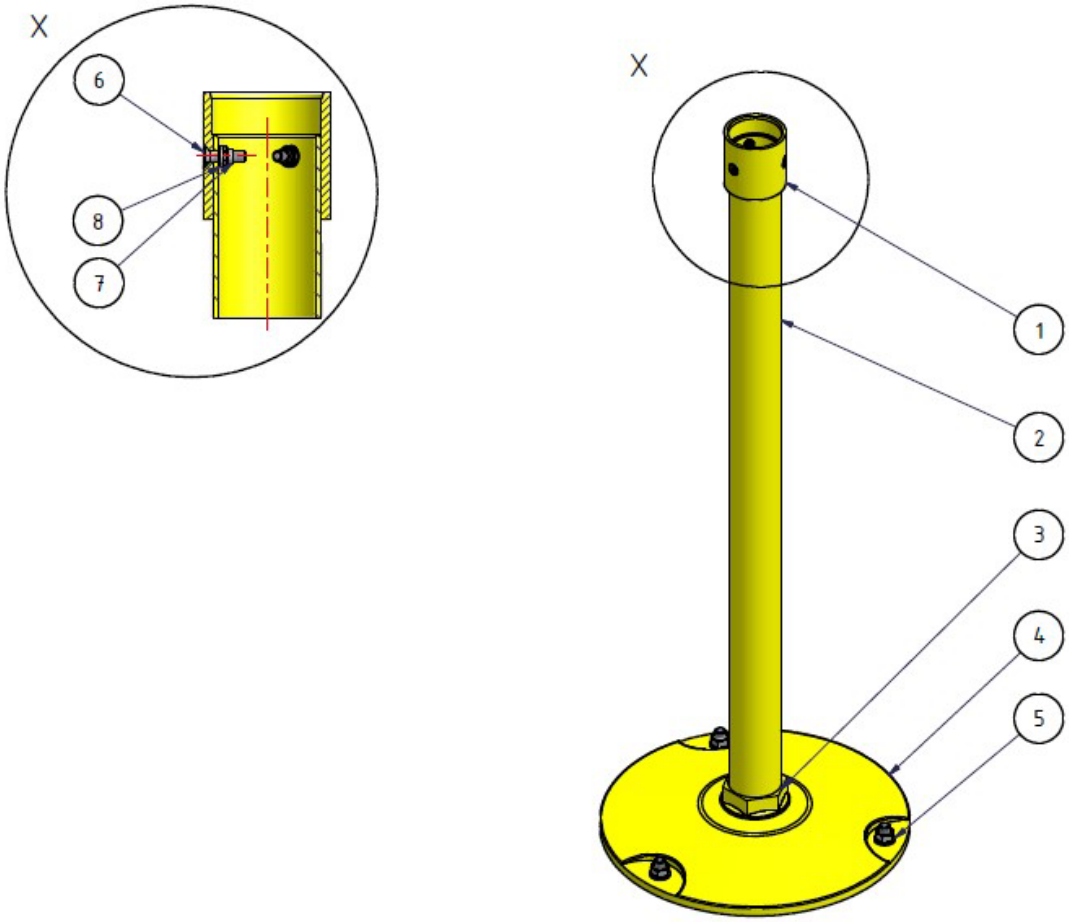


FIGURE 6. ASSEMBLY OF D51 TUBULAR MAST

No.	Name of part	Size / Model / Reference	Qty.
1	Top sleeve (fixed on the location of erection)	Ø60/51	1
2	Glass fibre tube	Ø51	1
3	Threaded sleeve for base	Thread 2”	1
4	Base	Ø300, internal thread 2”	1
5	Anchor bolt	M10 x 80 mm	3
6	Hex socket head screw	M5 x 20 mm	3
7	Hex nut	M5	3
8	Bonded washer	Ø5,3 mm	3

TABLE 6. PARTS OF D51 TUBULAR MAST

4.3.2 WORK INSTRUCTIONS FOR ASSEMBLY OF D51 TUBULAR MAST

The mast has been assembled to the following modules at the factory.

Top sleeve
Aluminium top sleeve (part 1). 3 hex socket head screws as well as their nuts and bonded washers (parts 6, 7 and 8).

Adjustment tube / mast module
Glass fibre adjustment / mast tube ø51 (part 2). A threaded insert has been bonded at the lower end of the tube (part 3).

Base
Aluminium base plate (part 4). 3 expander bolts for the base in a separate package (part 5).

Screw the mast module into its' base. Use a fork spanner or an adjustable spanner, but do not tighten the joint too much. The adjustment tube has to be detached one more time for its' shortening to the final length. Leave the top sleeve loose. It will be fitted on the assembly site.

4.4 ASSEMBLY OF D86L TUBULAR MAST

4.4.1 PARTS LIST OF D86L TUBULAR MAST

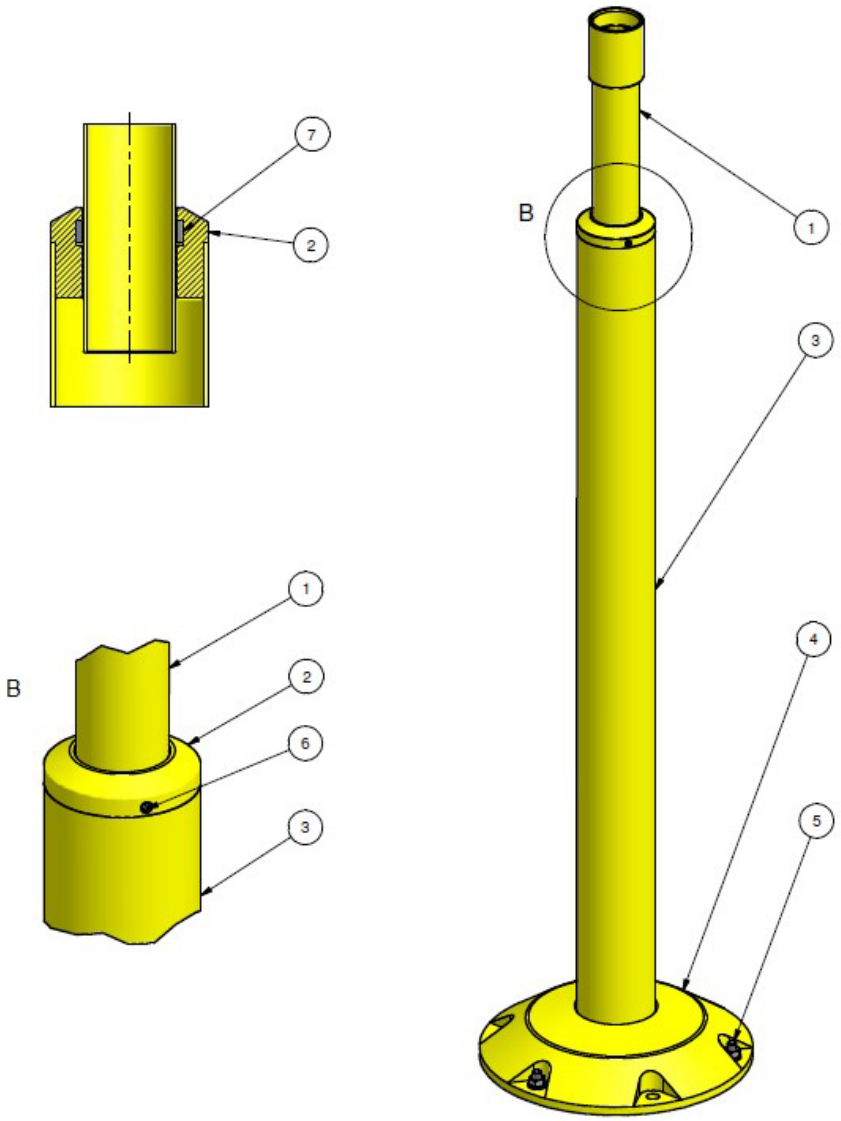


FIGURE 7. ASSEMBLY OF D86L TUBULAR MAST

No.	Name of part	Size / Model / Reference	Qty.
1	Adjustment tube	Ø51	1
2	Conic sleeve	Ø86-51	1
3	Mast tube	Ø86	1
4	Base	Ø300	1
5	Anchor bolt	M10 x 80 mm	3 or 6
6	Hex socket head screw	M8 x 20 mm A4	1
7	Locking ring	ALDE 50 x 56 x13	1

TABLE 7. PARTS OF D86L TUBULAR MAST

- D86L masts anchor bolt quantity depends on mast height. When mast height ≥2 m six anchor bolts are used. Otherwise, the number of bolts is three.

4.4.2 WORK INSTRUCTIONS FOR ASSEMBLY OF D86L TUBULAR MAST

The mast has been assembled to the following modules at the factory.

Adjustment tube module
Adjustment tube Ø61/51 (part 1), a top sleeve made of aluminium bonded to its upper end.

Mast module
Mast tube module Ø106 (part 3), a hinged baseplate has been bonded to its lower end (parts 6, 7, 8, 9 and 10).

Connect the adjustment tube module Ø61/51 by attaching it into the upper end of the mast module. Tighten the screws with a suitable Allen wrench and a torque wrench. Using the torque wrench ensures that the adjustment tube cannot collapse when the screws are being tightened.

4.5 ASSEMBLY OF D106L TUBULAR MAST

4.5.1 PARTS LIST OF D106L TUBULAR MAST

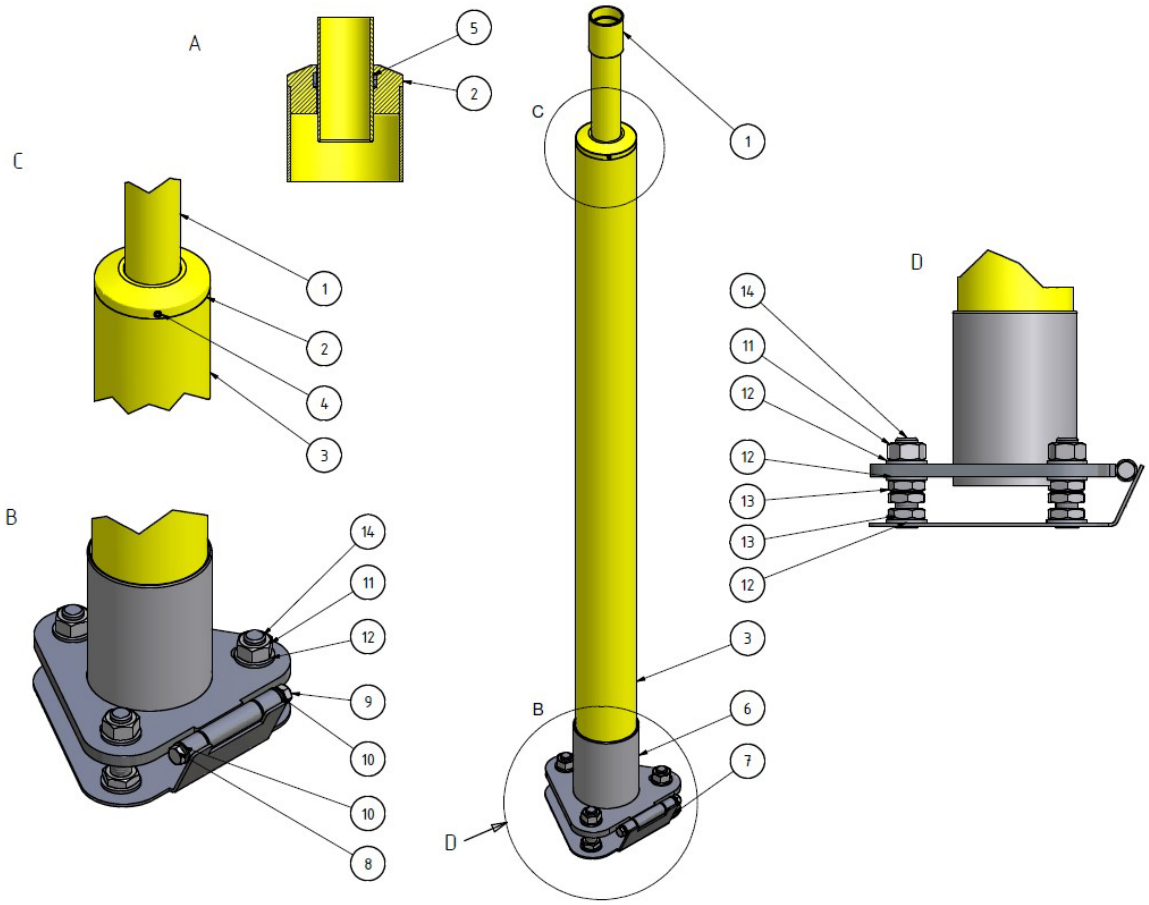


FIGURE 8. ASSEMBLY OF D106L TUBULAR MAST

No.	Name of part	Size / Model / Reference	Qty.
1	Adjustment tube	Ø60/51	1
2	Conic sleeve	Ø106-51	1
3	Mast tube	Ø106	1
4	Hex socket head screw	M8 x 20 mm A4	2
5	Locking ring	ALDE 50 x 56 x13	1
6	Hinged base, upper end	HDG	1
7	Hinged base, lower end	HDG	1
8	Hinge screw	M10 x 140 HDG	1
9	Hinge nut	M10 HDG	1
10	Washer	Ø21 HDG	2
11	Locking nut of hinged base plate	M20 EN ISO 4032 HDG	6
12	Washer	Ø37 HDG	9
13	Adjustment nut of hinged base plate	M20 EN ISO 4036 HDG	9
14	Foundation bolt	HPM20/L	3

TABLE 8. PARTS OF D106L TUBULAR MAST

5. MOUNTING TUBULAR MAST TO ITS POSITION

5.1 TOOLS NEEDED FOR MOUNTING TUBULAR MASTS

Tubular mast	Action	Tool	Size
D51/86L	Drilling holes in foundation	Masonry drill bit	Ø10 mm
D51/86L	Driving in anchor bolt	Hammer	
D51/86L	Nut of anchor bolt	Spanner	S = 17 mm
D51/86L	Measuring adjustment tube length	Tape measure	5 m
D51	Cutting adjustment tube	Hacksaw	
D51	Drilling holes for top sleeve	Metal drill	Ø5 mm
D51	Fixing top sleeve	Socket wrench	S = 8 mm
D51	Fixing top sleeve	Hex socket screw key	S = 4 mm
D106L	Fixing mast to hinged base plate	Spanner	S = 17 mm
D106L	Locking nuts of hinged base plate	Spanner	S = 30 mm
D51/86L/106L	Installation of light	Hex socket screw key	S = 6 mm
D51/86L/106L	Light height adjustment	Optic device	
D86L / D106L	Fixing of adjustment tube	Torque wrench	c. 10 Nm

TABLE 9. TOOLS NEEDED FOR MOUNTING TUBULAR MASTS

5.2 TIGHTENING TORQUES APPLIED IN TUBULAR MAST ASSEMBLY

Tubular mast	Action	Size	Torque
D51/86L	Joint between mast and base	Anchor bolt M10	30 Nm
D51	Fixing of top sleeve	Hex socket head screw M5	2 Nm
D106L	Fixing mast to hinged base plate	Nut M10	5 Nm
D106L	Locking hinged base plate	Nut M20	100 Nm
D106L	Fixing adjustment tube	Hex socket head screw M4	2 Nm

TABLE 10. TIGHTENING TORQUES APPLIED IN TUBULAR MAST ASSEMBLY

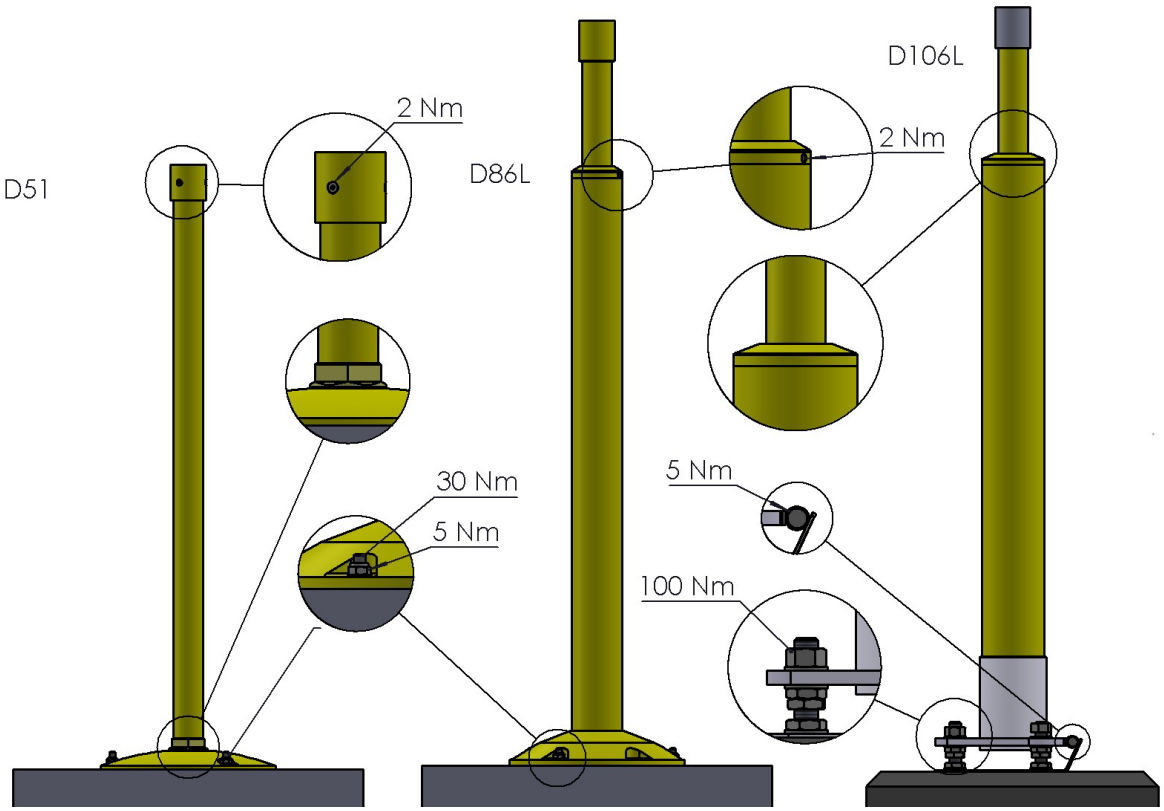


FIGURE 9. INSTALLATION TORQUES OF TUBULAR MASTS

5.3 TRANSPORTING TUBULAR MAST TO INSTALLATION LOCATION

When mast modules have been connected, the mast is transported from the place of assembly to the installation location. The mast is placed laying on the ground next to its foundation for erection.

- Positioning i.e. locations of masts is specified in the layout drawing and in the mast list.

5.4 WORK INSTRUCTIONS FOR ERECTING TUBULAR MAST

The erection requires 1 - 2 persons.

- Erect the tubular mast carefully to an upright position and place the mast on its foundation, supported by its base.
- Position the mast carefully onto its' base. For masts higher than 2 m, take into consideration the falling direction of the mast for approach light maintenance. There must be sufficient room for both the mast and the person carrying out the maintenance operations in the falling direction.
- Drill holes for the anchor bolts in the concrete foundation. Use the mast base for locating of the holes.
- Drive in the anchor bolts. Tighten the base plate of the mast lightly to the concrete foundation. If the concrete surface is inclined or uneven, use washers to get the mast to an upright position (fixed base plate).

- Anchor bolt hole diameter is 10-11 mm and depth 50–60 mm.
- Use water level to check the vertical alignment of the mast.

- Always check in the mast list and the (layout drawing) that you have chosen the correct mast for each base.
- D106L masts are equipped with hinged base plate.
- Prior to erecting masts ensure that they have not been damaged during handling.

5.5 Work Instructions for Mast Length Adjustment

- If the mast is equipped with a hinged base plate (D106L), adjust the mast to a vertical position by lowering or raising the adjustment nuts.
- Measure the final length of the adjustment tube and mark it to the tube.
- The adjustment tube of D51 tubular masts is delivered with approximately 200 mm of excess length. The height from the top of the foundation to the light beam center is given in the mast list. If the foundation has been cast to the given height, the height of the mast can be calculated by deducting the distance between the light beam center and the light fitting seat in the luminaire (varies according to type, normally 130 – 140 mm, to be checked from the supplier) from the light height given in the mast list. Detach the adjustment tube and cut it by sawing to its' final length.
- Fix the top sleeve of D51 tubular mast to the top of the sawed to length adjustment tube. Set the aluminium top sleeve flush with the top of the glass fiber tube, drill one Ø5 mm hole through the screw hole in the top sleeve. Fit the top sleeve with one screw and drill the remaining two holes. Fit the top sleeve to the adjustment tube with countersunk hex socket screws as well as with the respective nuts. Do not forget to place bonded washers under the nuts on the internal surface of the tube.
- Add a few drops of liquid thread locker, Loctite or similar. Screw the adjustment tube into the base plate of the mast (D51 mast) or into the lower module and tighten to the correct tightness.

- Adjustment tubes can be cut with an ordinary hacksaw.

- Always wear gloves when shortening D51 tube and drilling the holes for the top sleeve as well as when fixing the top sleeve. Some glass fibre splinters or dust irritating the skin may get to your hands from machined glass fibre surfaces.

- Height of centre of light from the top of the foundation is given in mast list.

5.6 Work Instructions for Fitting and Adjusting Lights

- Lead the electrical wires through the tubular mast. It is recommended to use only leads inside the mast, and not for example rubber cable. This would affect the frangible design of the mast in case of a collision.
- Fit the approach light on top of the adjustment tube.

- Cut the leads to suitable lengths and connect the leads to the luminaire. For masts with hinged base plate, take into consideration the additional lead length required for lowering of the mast.
- Perform the final alignment of the approach lights only after all lights of the approach line have been fitted.

- Use a water level to check the vertical alignment of the mast.
- When wiring the mast, it is recommended to only use leads that will be detached in case of an accident.

- Height of centre of light from the top of the foundation is given in mast list.

5.7 Final Tightening of Masts

- Once lights have been adjusted the tightening of base plate nuts (D106L) and anchor bolts (D51 and D86L) to torques given in chapter 5.2 can be done.

6. TILTING AND MAINTENANCE OF TUBULAR MASTS

Tubular Exel masts are normally service and maintenance free. For servicing lights it's not typically necessary to lower masts with height shorter than 2 m which includes D51 and usually all D86L masts both of which have fixed bases. In case they need to be lowered tilting can be done by following the instructions in chapter 6.2. For D106L masts the easiest way to do maintenance work is to tilt the mast down. Depending on the mast height, 1-2 persons are needed when lowering and raising the mast. Servicing can also be done from a basket of an access platform. Please follow the instructions of instrument supplier.

6.1 Regular Maintenance

After six months of installation tightening torques of mast connections should be checked as shown in chapters 4 and 5 of this manual. It is also recommended to check masts for possible issues every two years.

Most important parts to check:

- Base frame connection to foundation or anchor bolts
- Joint between tubular mast and adjustment tube
- Threaded joint between D51 tubular mast and base plate
- Visual check for cracks on tubes.

6.2 Tilting and Raising Fixed Base Tubular Masts

Lowering

- Detach the nuts of the anchor bolts. At the same time, make sure that the mast will not fall down accidentally.
- Lift the mast by hand from its foundation and lower it down to the ground carefully.

Raising

- Raise the mast to an upright position carefully by hand and place to its position so that the expander bolts will come through the fixing holes of the base.
- Tighten the nuts of the expander bolts.

6.3 TILTING AND RAISING D106L TUBULAR MAST WITH HINGED BASE

Lowering

- Make sure that there are no obstacles in the falling zone.
- Detach the lock nuts on top of the base plate. Do not touch the locknuts below the base. This ensures that the mast will settle automatically to the same position where it was prior to tilting.
- Lower the mast down carefully.

Raising

- Erect the mast back to the upright position, observing that the upper flange of the base is perfectly aligned to the locking bolts.
- Fix and tighten the locking nuts. Use a water level to check the vertical alignment of the mast.

- When erecting or lowering the mast observe especially that the mast base will not damage the threads of the anchor or locking bolts.

6.4 REPAIR PAINTING

6.4.1 MATERIALS NEEDED FOR REPAIR PAINTING

Description	Quality / Color / Size
Sandpaper	Fine, 200-400
Acetone	
Paper or cloth towel	
Two-component polyurethane paint	Aviation yellow (RAL 1021 or NCS 0580-Y05R)
Brush	Width approximately 20 – 50 mm
Tape	Polypropylene, PP
Mixing stick	Wood, plastic etc.
Rubber gloves	

TABLE 11. MATERIALS NEEDED FOR REPAIR PAINTING OF LATTICE MASTS

6.4.2 WORK INSTRUCTIONS OF REPAIR PAINTING

- Clean all surfaces with sandpaper.
- Wipe the dust off with acetone and paper/towel.
- Mix the paint carefully. Follow the paint manufacturer’s instructions.
- Brush the paint on the clean surface.

- Read the instructions of the paint manufacturer for painting conditions.
- Recommended temperature during painting work: minimum 18° C

- Read and follow the manufacturer's safety instructions.
- Wear safety glasses all the time.
- Use rubber gloves all the time.
- Wear a dust respirator filter when necessary.
- Assure good ventilation.
- Avoid skin contact.
- Acetone is flammable.

6.5 GLASS FIBRE TUBE REPAIR

6.5.1 MATERIAL NEEDED FOR GLASS FIBRE TUBE REPAIR

Description	Quality / Color / Size
Sandpaper	Fine, 200-400
Acetone	
Paper or cloth towel	
Pre-accelerated Epoxy Vinyl Ester Resin (Component A)	Derakane 411-45/ (e.g. Ashland)
Hardener (Component B)	Butanox 50 (e.g. Nauryon)
Syringe	20 ml
Glass fibre mat reel	Reel B=35–50 mm For example Weight 425g/m^2 Ward 70 x 320 mm Weft 53 x 272 mm Plain weave, thickness 0,32
Two-component polyurethane paint	Aviation yellow (RAL 1021 or NCS 0580-Y05R)
Brush	Width approximately 20–50 mm
Tape	Polypropylene, PP
Mixing pots	PE/PP-plastic, 1litre
Mixing sticks	Wood, plastic etc.
Rubber gloves	

TABLE 12. MATERIALS NEEDED FOR GLASS FIBRE TUBE REPAIR

- Arrange the repair conditions as instructed by the resin/hardener producer.
- Recommended minimum temperature for repair and painting is +18° C

6.5.2 REPAIRING THE DAMAGE

Pre-treatment

- Remove dirt and old paint with acetone and paper.
- Abrade and clean the surfaces with sandpaper.
- Wipe off the dust with acetone and paper/towel.

Mixing the components

- Carefully read the manufacturer's instructions and follow them.
- Use a syringe and/or a scale to measure the quantities of different components.
- Do not mix more than 100 g at a time, you have only about 25 min to work.

Normal mixing ratio: $\frac{\text{Component A}}{\text{Component B}} = \frac{100g}{2g}$

Doing the repair

- Spread the mixed resin on the damaged area.
- Try to soak the damaged area with the resin.
- Wind glass fibre mat tightly around the damaged area spreading more resin over the mat at the same time. Make sure that the mat is fully soaked, this is to obtain as much strength as possible.
- Wind minimum of 2 full layers, 3-4 layers where possible. Direct the layers in 30-45˚ angle to each other.
- Finish the repair by winding polypropylene tape around the repaired area to squeeze air out and to penetrate the resin into the tube structure.

Hardening

- Let the resin cure in the instructed temperature for 24 hours.

Surface finishing

- Remove the polypropylene tape.
- Abrade the surface with sandpaper.
- Paint the repaired area as instructed earlier in this manual.

i	• The damage can be repaired if it is less than half of the circumference of the tube. • If the tube is fully broken, contact the representative of Exel Composites Plc.
⚠	• Read the manufacturer's safety instructions and follow them carefully. • Wear safety glasses all the time. • Use rubber gloves all the time. • Wear a dust respirator filter. • Assure good ventilation. • Avoid skin contact. • Acetone is flammable.

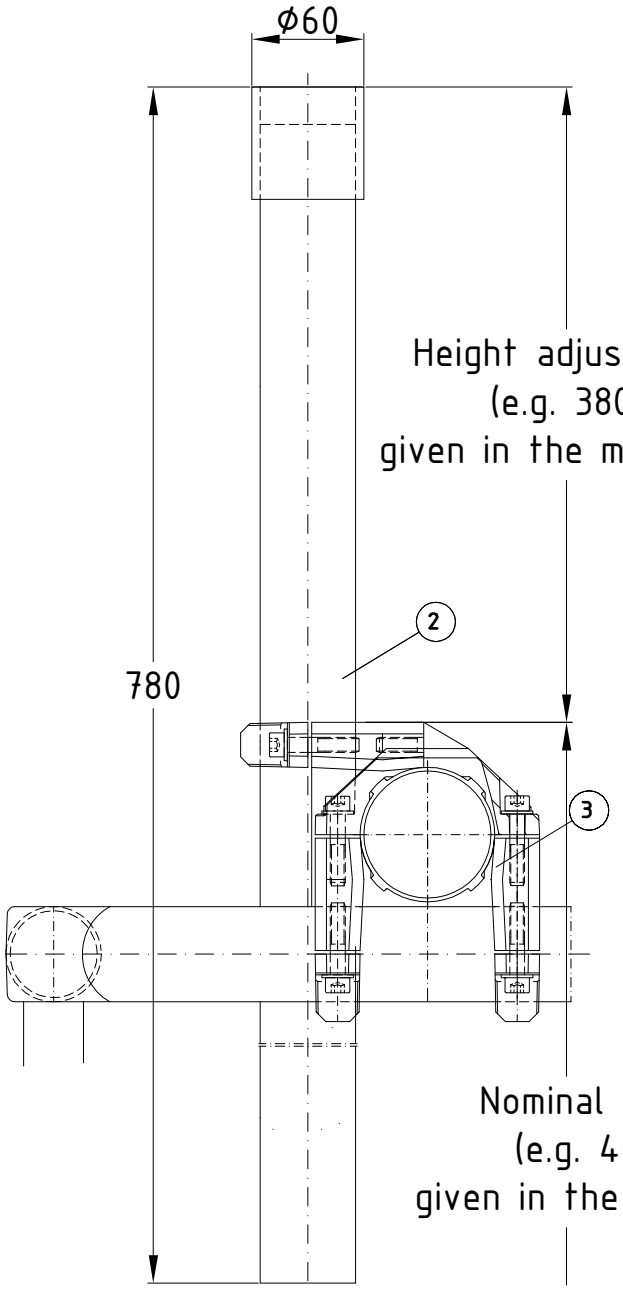
7. LISTS OF TABLES & APPENDICES

LIST OF TABLES

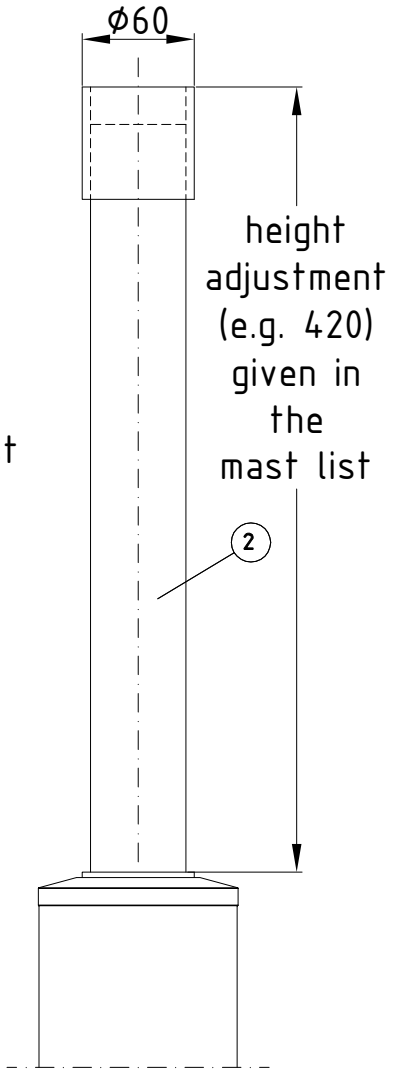
APPENDICES

Name of document	Number and revision
Mast list	
Adjustment of light height	642074
Tubular mast D51	640979H
Tubular mast D51 (without base plate)	640822H
Tubular mast D86L	642385
Tubular mast D106L	642354
Height adjustment tube D51/780	641172A
Location of foundation bolts, D106L	642360

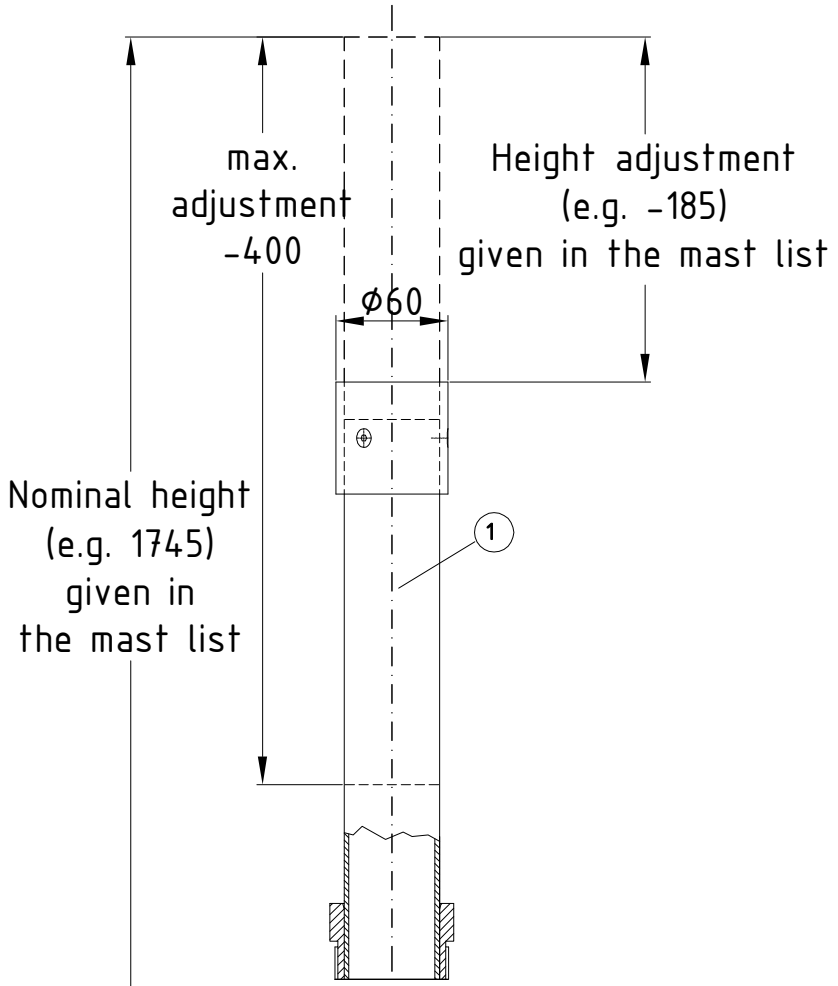
Item	Qty	Name	Stock, dim., drw. no.	Material	Weight
1	1	ADJUSTMENT TUBE D51	640822H		
2	1	ADJUSTMENT TUBE L=780	641172A		
3	1	ADJUSTMENT TUBE CLAMP ASS'Y	641184		



LATTICE MASTS L400, L500



TUBULAR MASTS D86L, D106L



TUBULAR MASTS D51, D86

Rev.	Date	Information	Design.
1	15.10.2003		JMa

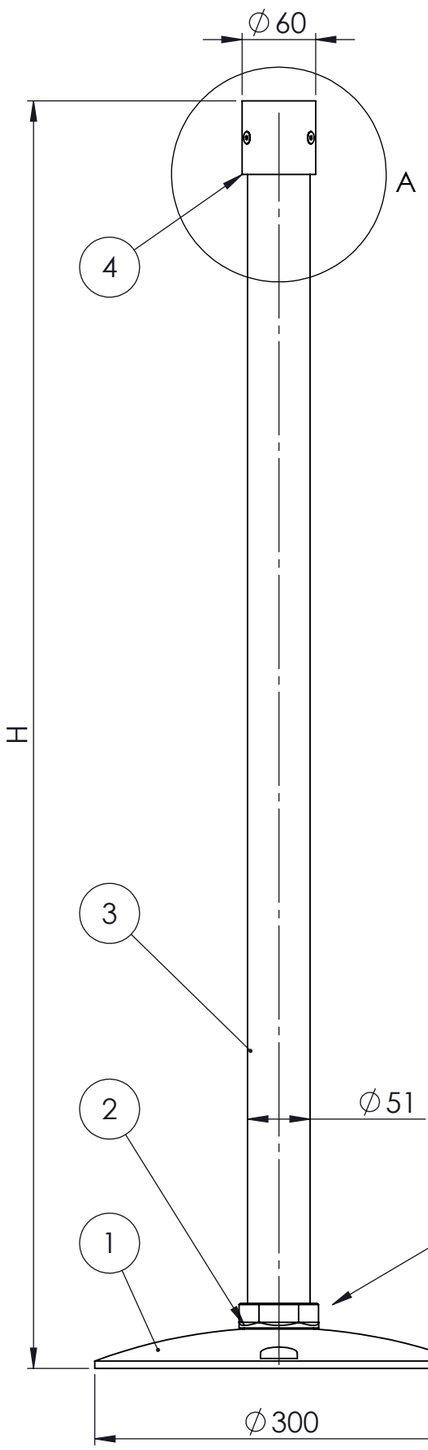
Project	
Reference	
Scale	1:1

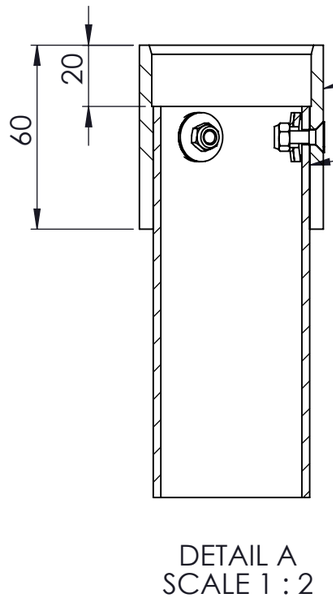
Title
ADJUSTMENT OF LIGHT HEIGHT
TUBULAR MASTS D51, D86(L), D106L
LATTICE MASTS L400, L500

exel composites
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
642074

ITEM NO.	DESCRIPTION	QTY.
1	Base Plate ∅300	1
2	R2" insert	1
3	GRP Tube Ø51	1
4	Light adapter Ø60/51	1
5	WEDGE BOLT M10x95 A4	3





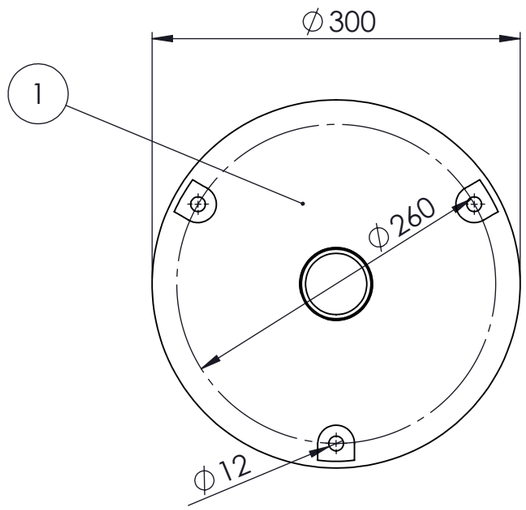
DETAIL A
SCALE 1 : 2

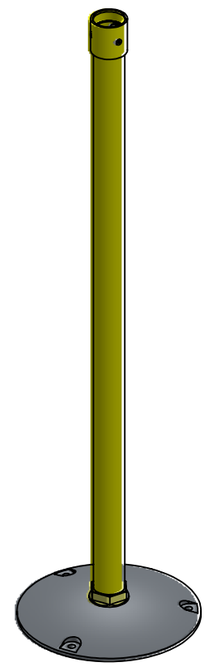
Aling notch inside the sleeve with top of the tube

Bonded washer, rubber against fibre glass

H = Total height of the pole

The height can be adjusted by cutting the tube to the correct lenght with a hack saw. The top sleeves (anodised aluminium) is then attached by drilling three holes Ø5 mm on the tube (use the sleeve as template) and attaching the top sleeve with screws to the tube. The rubber side of the bonded washer against fibre glass.





	NAME		DATE
DRAWN	M.Tauriainen		28.9.2018
APPV'D			

TITLE: Polemast D51/R2"

PROJECT

DWG NO. 640979H

A3

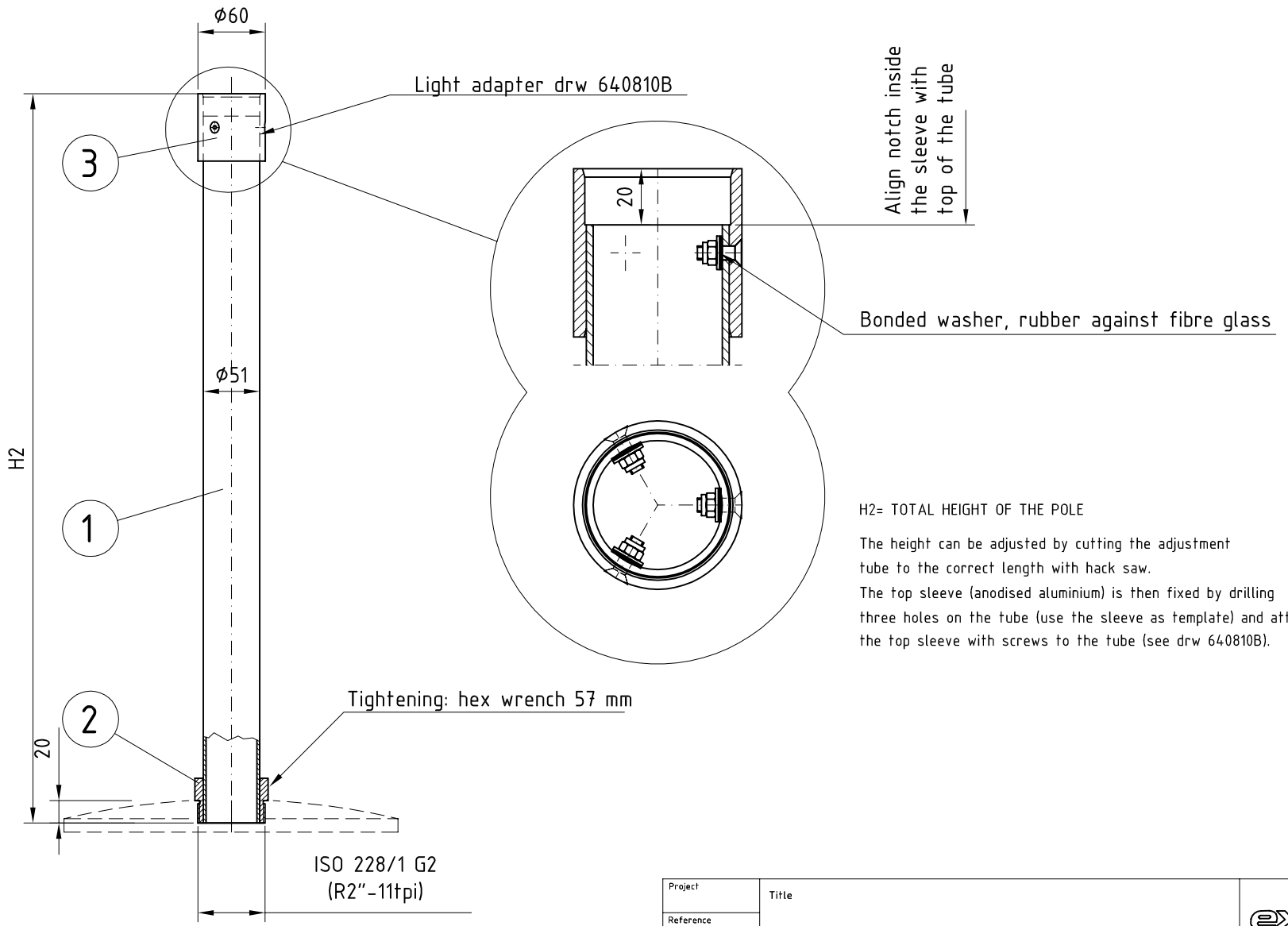
WEIGHT kg:

SCALE:1:5

SHEET 1 OF 1

G:\KVA\Asiakirjat\Tuoteryhmat\Mastot\Dwg\640979H

Item	Qty	Name	Shape, dim., drw. no.	Material	Remark
1	1	GRP-TUBE	ø51	GRP	
2	1	R2" INSERT	R2"	AL	640807F
3	1	LIGHT ADAPTER	ø60/51	AL	640810B



H2= TOTAL HEIGHT OF THE POLE

The height can be adjusted by cutting the adjustment tube to the correct length with hack saw.
The top sleeve (anodised aluminium) is then fixed by drilling three holes on the tube (use the sleeve as template) and attaching the top sleeve with screws to the tube (see drw 640810B).

Rev.	Date	Information	Design.
H	2005-12-09	Light adaptor changed	JMA

Project

Reference

Scale

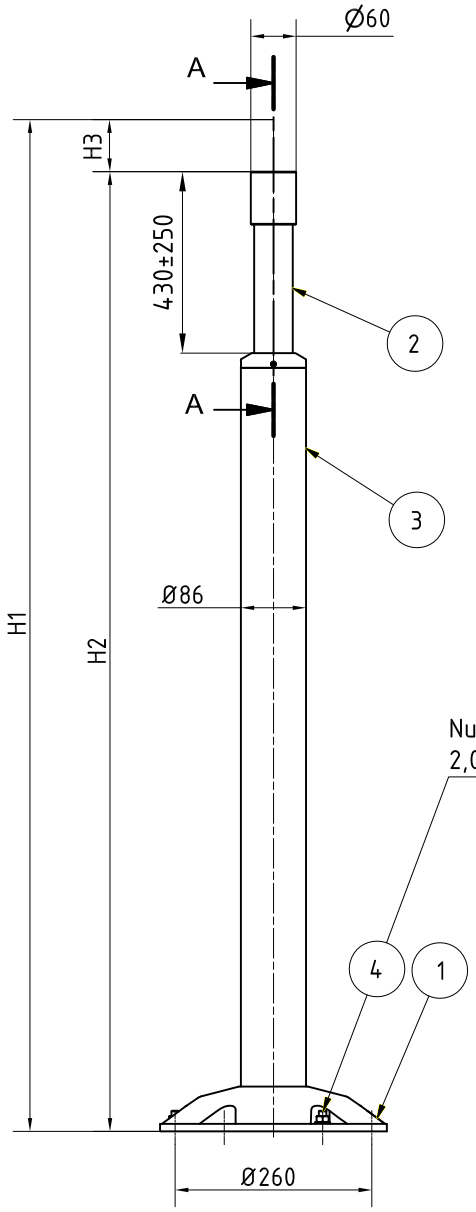
Title

POLE D51/R2" (WITHOUT BASE PLATE) / ADJ. TUBE
PUTKIMASTON SÄÄTÖPUTKI D51/R2"

exel COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FIN-82110 HEINÄVAARA

Drw. no.

640822H



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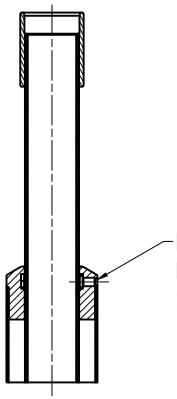


M8x12 Hex Socket Set Srew;
Do not overtighten!
See installation manual

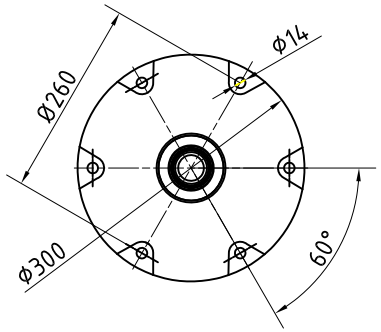
H1 = LIGHT HEIGHT FROM BASE LEVEL

H2 = TOTAL HEIGHT OF THE POLE

H3 = LIGHT HEIGHT FROM THE TOP END OF THE POLE

Number of anchor bolts: for light height up to 2,0 m – 3 pcs; light height over 2,0 m: 6 pcs

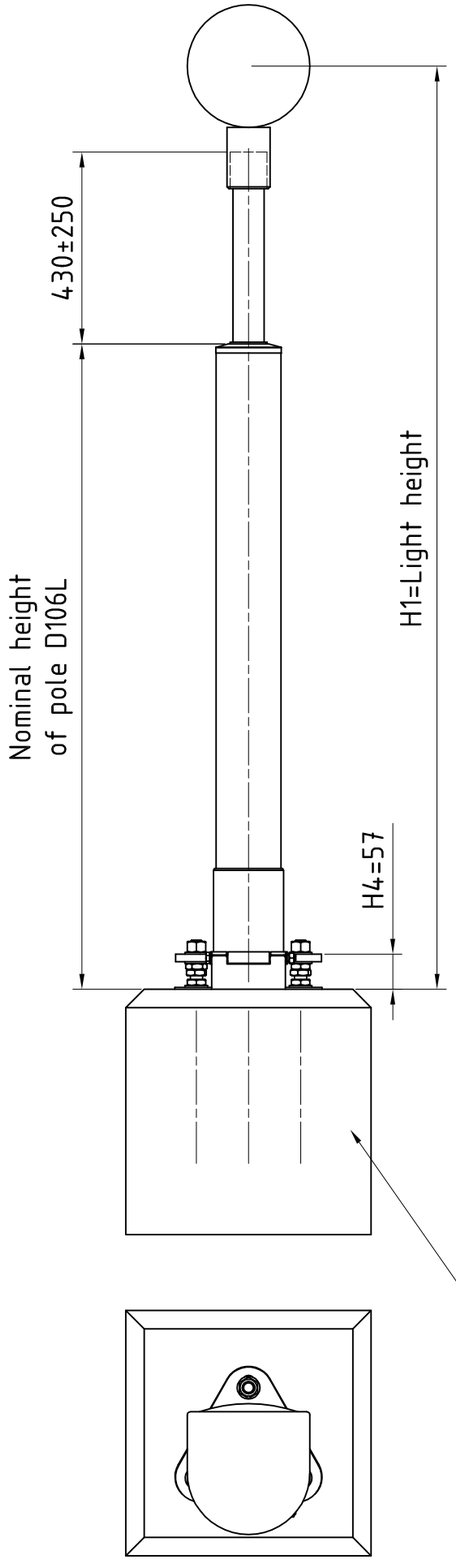
TOP VIEW

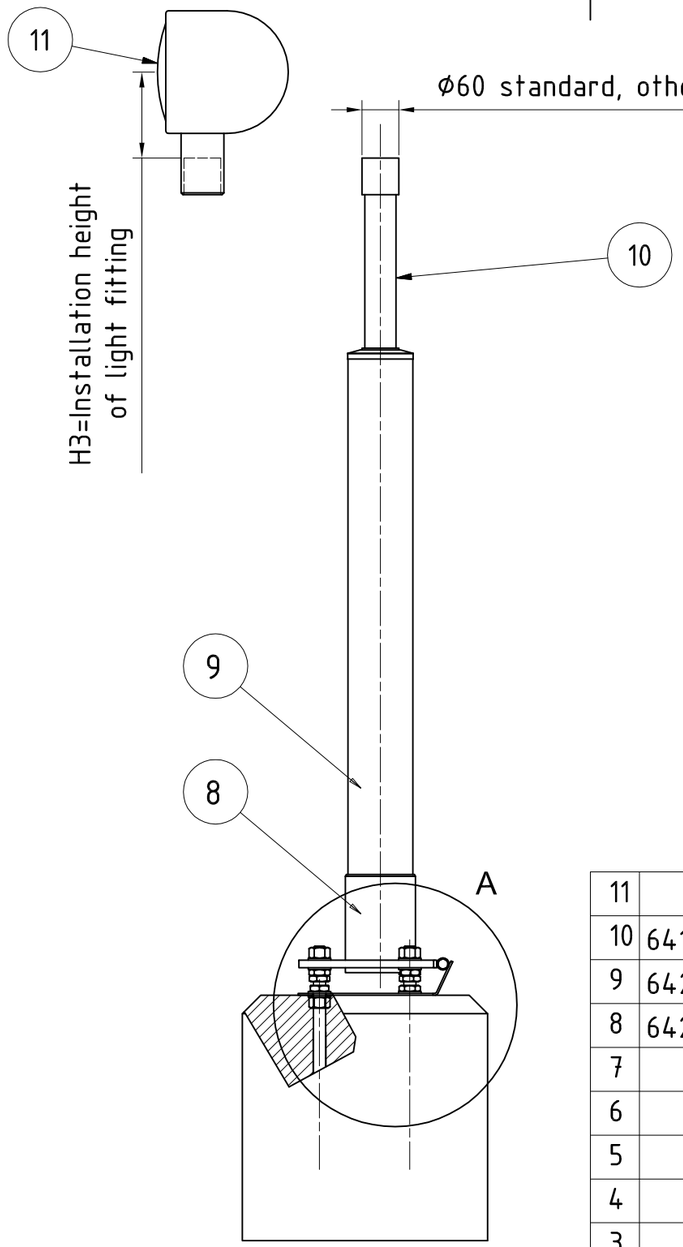


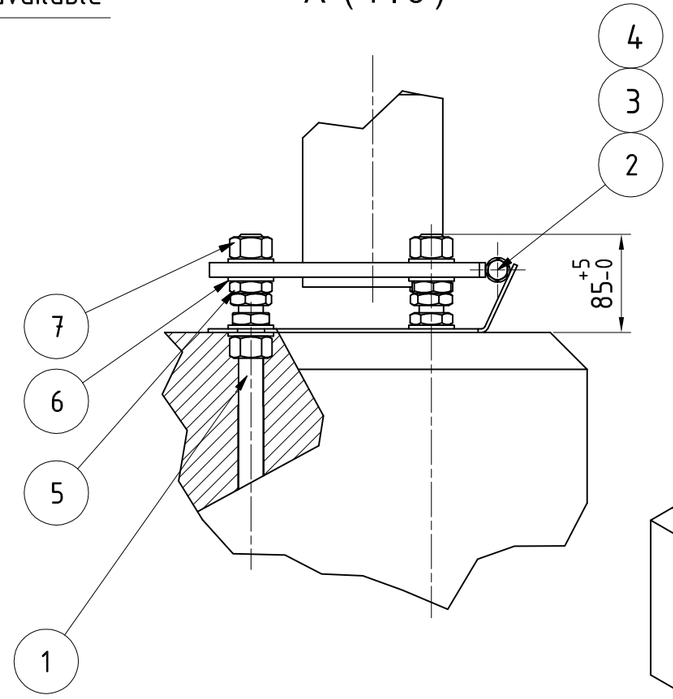
Osa Part	Nimike ID-Code	Nimitys Description	Standardi Standard	Kpl Pcs
4		Anchor Bolt M10x80 A4		3/6
3	642366	Tube D86		1
2	641172A	Height Adjustment Tube		1
1	640646A	Base Plate D300 AL		1

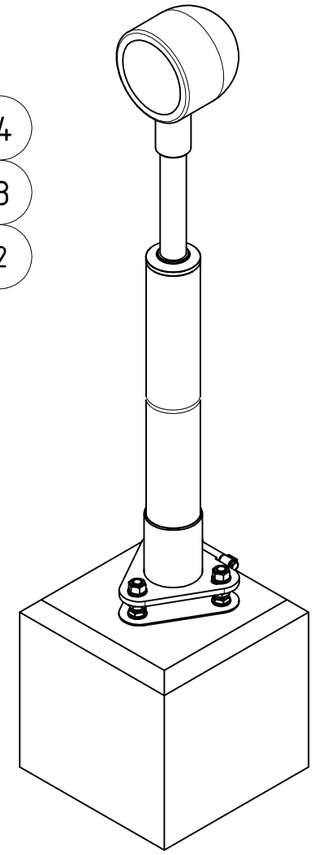
General tol.	Scale A3/	Product	Customer	Pole D86L Putkimasto D86L
KIVARA FACTORY MUOVILAAKSONTIE 2 FI-82110 HEINAVAARA	Mass 0 kg	Rev.		Model name: Nimike 642385
		Design JMu 25.8.2011 Date		
		Check. Date		
		Appr. Date		

Rev.	Change	Date	Changed	Appr.









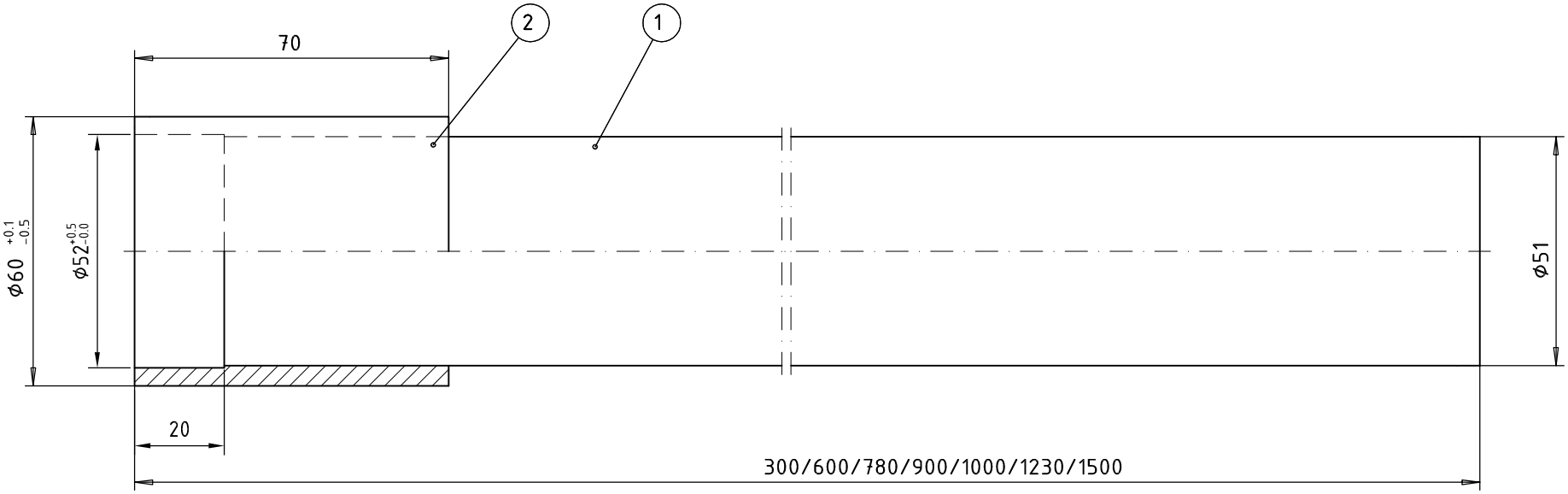
11		Approach light fitting	Not supplied by Exel	3
10	641172A	Adjustment tube L=780	GRP	9
9	642353	Main tube D106	GRP	1
8	642351A	Top half of base plate		1
7		Hex nut M20 HOT GALV	DIN 934	3
6		Washer M20 HOT GALV	DIN 125	6
5		Thin hex nut M20 HOT GALV	DIN 936	6 (+3)
4		Hex nut M10 HOT GALV	DIN 934	1
3		Washer M10 HOT GALV	DIN 125	2
2		Hex screw M10x140 HOT GALV	DIN 931	1
1	642360	Foundation bolt lay-out		1

Osa Part	Nimike ID-Code	Nimitys Description	Standardi Standard	Kpl Pcs

Rev.	Change	Date	Changed	Appr.

General tol.	Scale A3/	Product	Customer	Putkimasto D106L Pole D106L
EXEL COMPOSITES KIVARA FACTORY MUOVILAAKSONTIE 2 FI-82110 HEINAVAARA	Mass 4m:18.1kg	Rev. Design MKu 15.12.2010 Date Check. Date Appr. Date	Model name	Nimike 642354

Item	Qty	Name	Shape, dim., drw. no.	Material	Weight
1	1	GRP TUBE	QAR 510460 M03		
2	1	LIGHT ADAPTER	641173B		



Rev.	Date	Information	Design.
A	5.7.2005	Position of light adapter sleeve and length of GRP tube changed	JMa

Project

Reference
641171

Scale
1:1

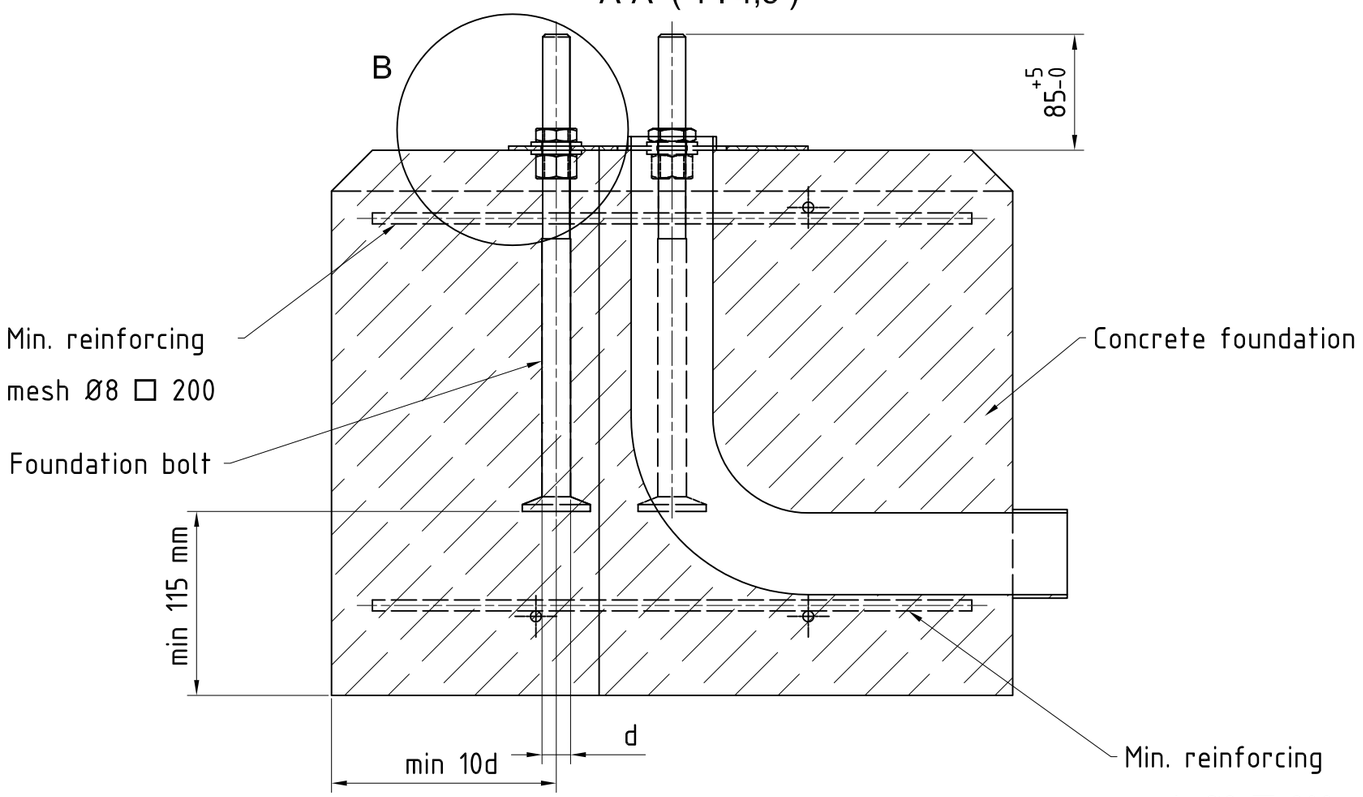
Title

HEIGHT ADJUSTMENT TUBE

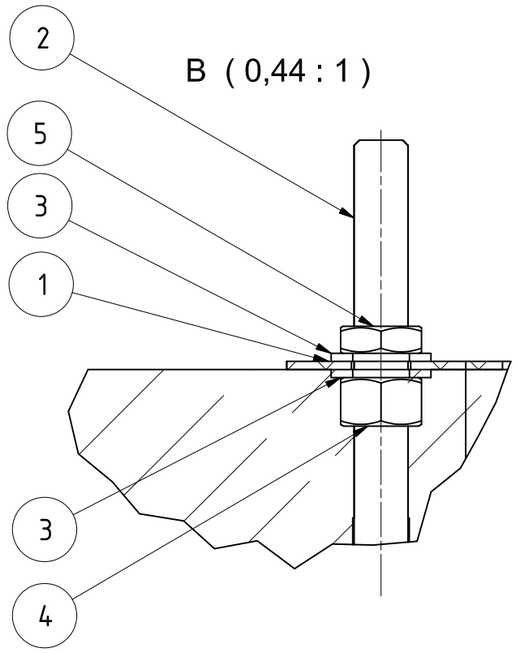
exel COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINÄVAARA

Drw. no.
641172A

A-A (1 : 4,5)

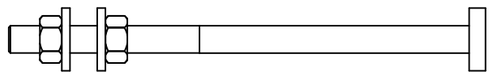


B (0,44 : 1)

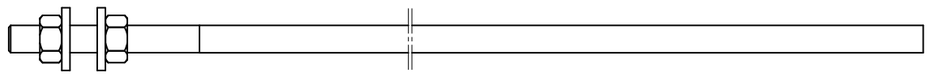


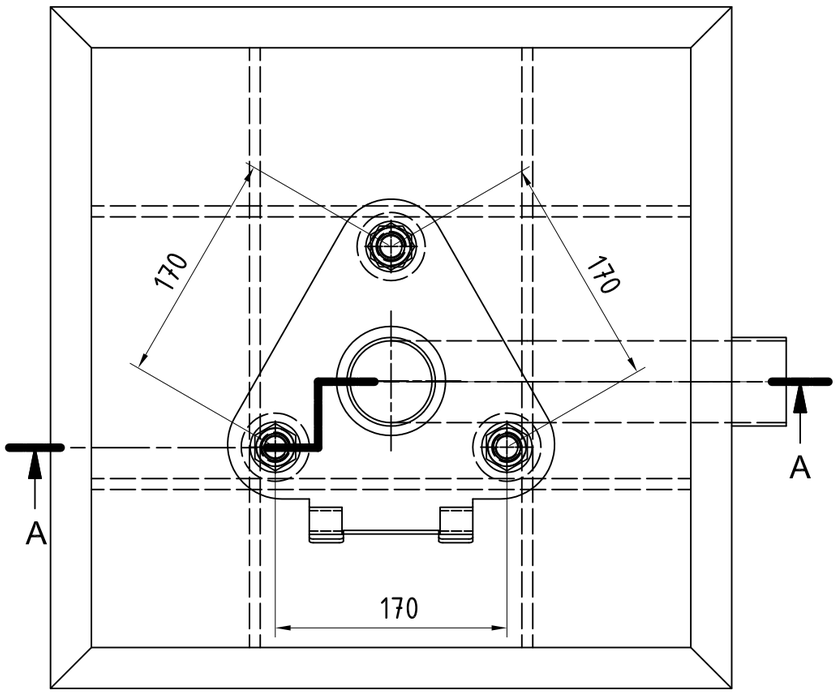
ALTERNATIVE FOUNDATION BOLTS

HPM20/L KZN, L=350 mm (13.8")



HPM20/P KZN, L=1100 mm (43.3")





Tilting direction
of the pole

5		Thin Hex Nut M20 HOT GALV	DIN 936	3
4		Hex Nut M20 HOT GALV	DIN 934	3
3		Washer M20 HOT GALV	DIN 125	6
2		Foundation Bolt HPM20L HOT GALV		3
1	642348	Lower half of base plate		1

Osa Part	Nimike ID-Code	Nimitys Description	Standardi Standard	Kpl Pcs

General tol.	Scale A3/	Product Pole D106L	Customer	Foundation bolt lay out	
		Rev.		Model name	Nimike
		Design JMu	18.2.2011 Date	642360	
	Mass 0 kg	Check.	Date		
		Appr.	Date		

EXEL COMPOSITES
KIVARA FACTORY
MUOVILAAKSONTIE 2
FI-82110 HEINAVAARA

Rev.	Change	Date	Changed	Appr.