Francis & Lewis International Ltd, Waterwells Drive, Waterwells Business Park, Gloucester, GL2 2AA.

Sales@fli.co.uk
+44(0)1452 722200

Installation & Maintenance Manual
Tapered Monopoles

Job Ref: General

Prepared for: General Guidance

DOCUMENT No 2018/32

Revision	Date	Prepared By	Checked By	Authorised By
01	28/09/2018	D McClune	A.Viol	T.Burden

CONTENTS

1.0 INTRODUCTION

FLI Structures (FLI) design and supply a range of products, including towers, steel grillages and frames, monopoles & screw piles. These products provide a safe foundation and support for antennas and other services.

This document contains general information required for the safe installation and maintenance of Tapered Monopoles. This document includes a summary of the designer's residual hazards, a maintenance statement and general installation guidance.

Furthermore, this document is intended only to provide general guidance and is not a method statement. It is essential that FLI's products are installed using proven techniques by competent Contractors. The installers should provide a method statement outlining the proposed method prior to commencing any works. The statement of Designers Residual Hazards addresses general issues regarding the installation, maintenance and dismantling of structures, however all projects will require task specific risk assessments.

1.1 DESCRIPTION

Tapered monopoles are constructed from folded & galvanised steel plate and may vary in the following respects:

- They may have varying number of sides (typically 16 or 18)
- The shaft may come as a single piece or in multiple sections
- Sections may be connected by slip connection or flanged connection
- Height will vary from low level to 40m and over although will typically be 12-35m
- The shaft may have optional mounted headframes
- Headframe(s) connected may be top mounted or fixed to the shaft
- Shafts may be designed with a hinge at the base, may be bare or climbable
- Feeders may rise internally or externally
- Tapered monopoles can be used for tree structures (read in parallel with tree IMM)
- Bases may be connected to piled foundations, structural members or concrete pads

This document includes general information on tapered monopoles, thereby covering all the monopole variants specified above. Therefore not all information in this document will be relevant to a site-specific monopole. For details of a site-specific monopole, refer to the relevant General Arrangement drawings.

2.0 DESIGNERS STATEMENT OF RESIDUAL HAZARDS

Design Residual Hazard	Description	Activity
Tripping	It is likely there will be trip hazards in the form of uneven ground, and other encumbrances protruding from the surface. (In some cases piles and grillages).	Installation Maintenance Dismantling
Use of inappropriate lifting techniques or equipment	Injury or product damage can result from employing inappropriate lifting techniques or equipment. The weights of individual elements and assemblies are shown on the relevant general assembly drawings.	Installation Dismantling
Handling heavy individual pieces	Injury could result from manual lifting of heavy items. Individual elements have been limited in weight as much as is possible. The weights of the items are listed on the relevant General Arrangement Drawing (GA).	Installation Dismantling
Entrapment by hinged or rotating parts	During assembly of hinged or rotating items, body parts (fingers, arms, legs) can become trapped between the parts as they hinge into position.	Installation Dismantling
Separation of hinged or rotating parts during lifting	During installation, hinged or rotating items may separate during lifting. It is important that the hinged items are secured using an appropriate method. Refer to installation guidance in the relevant FLI document.	Installation Dismantling
Injury from Vehicle and Plant Movements	Vehicles and Plant is likely to be operating around the site, and serious injury can result from inappropriate man-machine interfaces.	Installation Dismantling
Use of under strength bolts	The structural bolts used on all FLI general products are generally grade 8.8. Substitute bolts from other sources shall not be used or structure failure could result.	Installation Maintenance
Use of hazardous material: touch-up paint and zinc rich paint	Damage to the galvanised coating can be repaired using zinc rich paint. Painted products are similarly repaired using touch-up paint. Inappropriate use of these materials can cause harm to operatives or the environment.	Installation Maintenance
Falls from height	Many structures require working at height, or pose a potential path for the general public to access unsafe areas. The use of unsuitable fall arrest systems or climbing techniques can result in falls. Inadequate security (lack of anti-climb measures) can give the public access to unsafe locations.	Installation Maintenance Dismantling
Falling objects from height	Items can be dropped by operatives working at height. This can include tools, bolts, structural items or equipment. Falling items can seriously injure persons in the fall zone.	Installation Maintenance Dismantling
Installation of multi piece monopoles – damage due to incorrect shaft orientation	Some monopoles will be delivered to site in two or more pieces. Misalignment of mating faces can result in damage to the shafts.	Installation Dismantling
Installation of multi piece monopoles – separation during lifting	Monopole shafts can separate during lifting if inadequately held together. This may result in damage to elements and serious injury to nearby persons.	Installation Dismantling
Use of incomplete ladder/climbing face during installation	Climbing ladders or access equipment before a “safe to climb” certificate has been issued can result in serious injury or death.	Installation Dismantling

Design Residual Hazard	Description	Activity
Lightning strikes	Serious injury can result if structures are climbed during electrical storms or if the earth lugs provided at the base of monopoles are not connected to the earthing system.	Installation Maintenance Dismantling
Use of inappropriate foundation designs	It is the responsibility of the foundation designer to ensure that appropriate base sizes have been designed for above-ground structures. Refer to the relevant drawings for more information on the unfactored base forces and foundation connections.	Installation
Ice damage to headframe uprights / tubular sections	If uprights are manufactured from tubular sections they could be damaged by trapped water freezing at low temperatures if there is no provision for drainage and regular inspection.	Installation Maintenance
Collapse during dismantling	Structures can collapse unexpectedly if dismantled in an inappropriate manner. A competent person must always prepare a suitable method for dismantling.	Dismantling

A full risk assessment or each of the relevant identified hazards above and any other hazards that present themselves needs to be completed by the inspector and/or maintainer.

This list is not exhaustive and site specific risks should always be considered.

3.0 INSTALLATION GUIDANCE

Refer to the relevant General Arrangement drawings for details of the monopole layout, elements and fixings used on the structure.

It is essential that the structure is installed using proven techniques by competent Contractors. Refer to Residual Risks prior to determining the preferred installation method for each site.

3.1 Assembly and Erection

The assembly and lifting method and sequence will vary between structure types, equipment availability and site constraints.

When planning the structure assembly and erection the installer must consider the health and safety of the workforce as his first priority. Good practice in this regard is to follow the Working at Height Hierarchy of control:

a. Avoid working at height, e.g. pre-assemble as much as possible at ground level.
b. Prevent falls using appropriate access equipment such as Mobile Elevated Work Platforms (Cherry pickers) or rope access techniques.
c. Reduce the distance and consequences of a fall should one occur, e.g. use fall arrest systems or catch nets.

Practicality and efficiency should also be considered. Where structurally possible, lifting structures in one piece is preferable to multiple lifts or as a last resort, derrick build. However the cranes available and the site constraints will also influence the assembly and erection methods.

Prior to lifting structures onto the foundation or grillage, the position of the Hold Down Bolts or base stubs should be checked against the layout of the structure base plates or legs. Any discrepancy shall be noted and clarity sought.

3.2 Bolt Configuration

Bolt assemblies supplied by FLI Structures are typically Grade 8.8 spun galvanised to BS EN ISO 10684:2004 and usually comprise a Bolt, Nut and flat washer for use under the nut. Spring washers are not supplied, nor desired.

U-Bolts and N-Bolts are typically Grade 4.6. and comprise the shaft, and one washer and 2 nuts per threaded end, the second nut being used as a lock nut.

Special bolts, fixings and configurations are utilised from time to time, as detailed on the structure specific General Arrangement Drawing. Where special fixings are supplied, appropriate tightening methods must be used.

3.3 Bolt Tightening – Ordinary Bolts (non-preloaded)

Refer to ‘Guidance Notes for Tightening Non-Preloaded (Ordinary) Bolts’ Document No. FLI-GN-0007.

3.4 Bolt Tightening – Pre-loaded Bolts

Pre-loaded bolts shall be tightened in accordance with a specific method appropriate to the bolt assembly type.

4.0 TYPICAL GUIDANCE ON CRANE BUILDING

1) The site team should include 2 people, one of whom shall be the **Team Leader.**
2) **'Slinger Banksman'**. The Slinger Banksman shall be trained and CITB approved and all crane operations are to be conducted in accordance with BS 7121.
3) Prior to commencing work, the **Slinger Banksman** shall satisfy himself that the site is safe for plant access and lifting operations by completing the actions on the Method Statement.
4) During all work on site the installation team shall wear appropriate PPE (climbing helmet if climbing or hard-hats if on the ground, hi-viz, gloves and steel toecap safety boots) as listed in section 8.0. Harnesses shall be worn with double lanyards for climbing activities. During climbing, each installer shall be connected at all times by at least one lanyard to the structure. Tools will be stored in a tool belt during climbing and working on the structure and shall, in any case, be tethered to the climber.
5) If personnel not involved in the structure installation are in the vicinity of the site, an exclusion zone shall be established around the work area (using barriers, cones & bunting, plus appropriate signage) prior to starting, and only authorized persons allowed within. Should unauthorized persons venture into the working area, all operations shall cease and the trespasser will be escorted from the site before works are re-started and/or, if necessary, the client notified.
6) On arrival of the lifting vehicle, the driver's test and maintenance documents will be checked. The equipment is to be operated in accordance with the Code of Practice for the Safe Use of Cranes, BS 7121.
7) The monopole will arrive with the main shaft in two or more pieces. The monopole shall be checked for transportation damage and any found, reported to FLI's project manager. The **team leader** shall check off all parts against the packing list supplied. Any anomalies will be noted and reported to the FLI's project manager immediately.
8) Prior to commencement and throughout assembly and erection, reference shall be made to the G.A. and sub-assembly drawings, particularly with regard to lift weights.
9) Any "splash" on the H D Bolts should be cleaned off the stubs and these should then be checked for level. Additionally, the following items on the Hold Down Bolts shall be checked against the drawings:
   - H D Bolt Diameter
   - PCD
   - Projection above foundation (typically 125mm)
   - All Nuts & washers accounted for: Typically each bolt will have 3 nuts and 2 flat washers.
10) The monopole shall not be installed in high wind speeds, (in excess of 27 mph) in icy or slippery conditions, during thunderstorms or in any weather conditions deemed unsafe. It will be the **installation Team Leader**'s responsibility to decide when the monopole is safe to install. Similarly the Hiab crane shall not be used in inclement weather and it shall be the Crane Operator's responsibility to decide when the crane is safe to use, however the crane shall not be operated in wind speeds greater than 25mph. Furthermore, no monopole shall be installed on concrete bases that have had less than 7 days curing time.
11) Remove the upper nuts and flat washer from each H D Bolt & store securely.
12) The lower nut and washer on the holding down bolts must now be leveled. Generally the top of any nut & washer assembly should not be greater than 50mm above the finished concrete level, unless noted on the drawings. Excessive mismatch shall be reported to the project manager. The project manager shall approve any remedial work.

13) The **team leader** shall confirm the notional **North** point to enable the pole to be correctly aligned and suitably mark the base.
14) The **Slinger Banksman** shall be in contact with the crane driver by clear verbal / hand signal communication.

15) **Multi-piece shafts shall be assembled as described below: -**

- Off load the lower section of the shaft in a horizontal position and place on suitable trestles, with ladder brackets uppermost and shaft chocked to prevent rolling.
- Mark off specified overlap of slip joint on the lower section. (Refer to FLI's general assembly drawing for dimension of overlap). It is prudent to extend markings beyond the design slip length to allow for measurement of 'over-slip'. Check the overlap area for any damage, excess zinc or weld, which could impede fitting and rectify as necessary.
- Lubricate the portion of the lower section forming the slip joint using liquid soap.
- Offload next section of the shaft in a horizontal position, with ladder brackets uppermost, and offer the wide end of this section to the slip end of the lower section ensuring that the ladder brackets and shaft facets are aligned. Refer to **Figure 1** below.

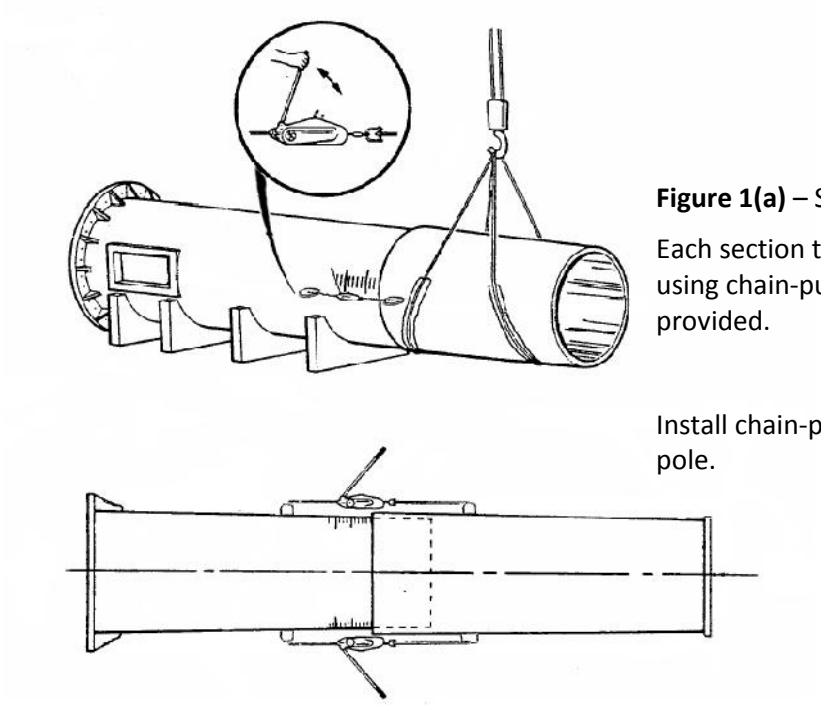


Figure 1(a) – Shaft Assembly

Each section to be winched together using chain-pulls attached to the lugs provided.

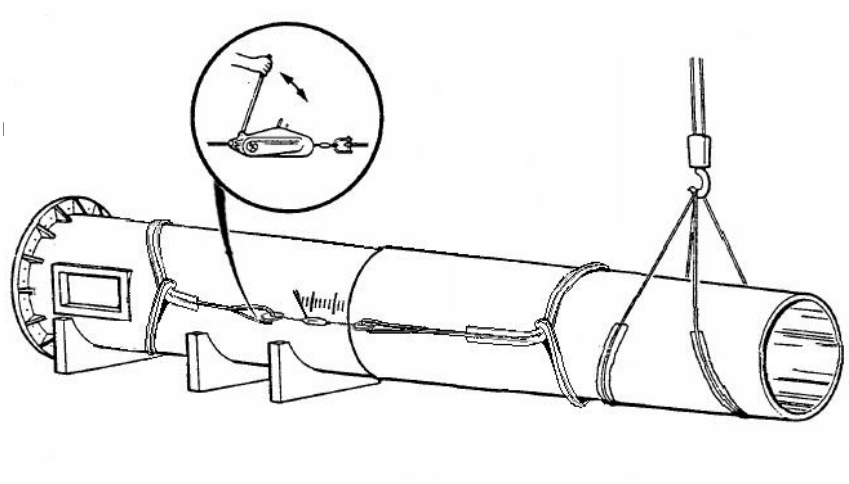
Install chain-pulls to either side of the pole.

Figure 1(b) – Shaft Assembly

Each section to be winched using tirfor connected to lifti wrapped around monopole.

(Second set of straps omitted for clarity)

Install tirfors to either side of the pole as in 1(a).



- Attach tirfors to lifting straps wrapped around the monopole as shown in **Figure 1(b)** above. With chain pull winches/tirfors installed to either side of the pole, winch the two sections of the shaft together taking care that the shaft facets remain properly aligned, as shown in **Figure 2.** Keep winching both sides until no further movement is achieved.

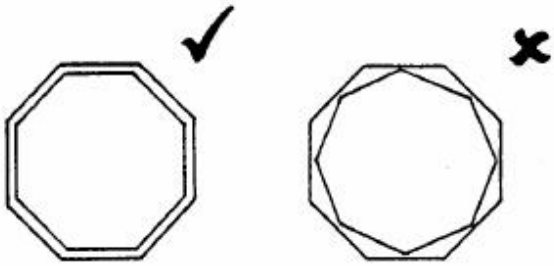


Figure 2 – Shaft Orientation

8 sides shown for clarity, generally shafts have 16 or 18 sides.

- The tirfors shall remain in place until after the pole is erected, plumbed and the holding down bolt nuts tightened. Where lugs are present, replace chain pull winches with fixed chains, which shall remain in place until after the pole is erected, plumbed and the holding down bolt nuts tightened.
- Clean off any surplus soap from around the joint.
- Re-position the trestles to support the assembled shaft and release crane.
- Repeat the above for any additional shaft sections

16) Overlap should be ± 10% of design dimension shown on drawings. **If overlap is outside this tolerance the Project Manager should be informed**.

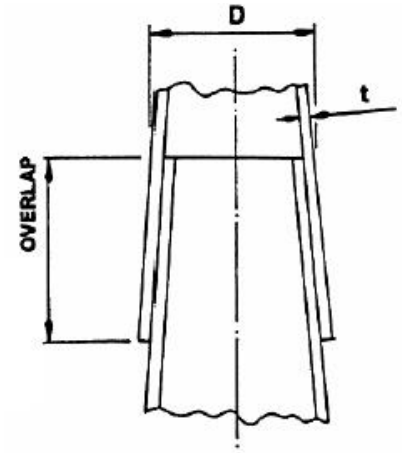


Figure 3 – Shaft Overlap

The design dimension of overlap is shown on drawings. Mark this out on the lower section together with additional lines that will allow measurement of how much the achieved overlap is over or under the designed overlap.

17) When the main shaft has been assembled the ancillaries shall be fitted in accordance with the assembly drawings, including where possible; headframe, dish poles, ladders, anti-climb devices and fall arrest system. Note: Latchway fall arrest must be fitted by a trained installer, in accordance with the relevant installation instructions, and should not be tensioned until the pole has been landed in its final, vertical position. This is to allow any additional slip to occur prior to commissioning the Latchway system. (For Latchway Installation Instructions refer to the relevant Method Statement).

18) **Monopole lifting and installation:**

a. When fully assembled with all nuts and bolts checked for tightness, the monopole can then be lifted upright using crane and slings.
b. Any chips to the galvanised finish of the tower should be touched up: refer to relevant method statement.
c. The shaft should be lifted with suitable sling(s), by forming a choke knot around the shaft below the top cap plate. **Slings must not be attached to any part of the headframe, (or any of the ancillaries) for lifting nor shall the sling be choked around shaft and passed up through the headframe.** Ensure no part of the ladder or other ancillaries will be damaged by the lifting sling or rope as the shaft pivots to vertical; any part that clashes may need to be removed. **The tirfors/chains must remain in place throughout the lifting process**.
d. At least one tag-line shall be attached low-down on the shaft to enable safe manipulation of the pole as it is being lowered.
e. The monopole will then be lifted, rotated to the vertical and lifted and landed over the holding down bolts. Care should be exerted when first lifting and rotating the tower not to drag the base of the monopole along the ground. Lower the monopole over the HDB'S ensuring the orientation is correct with the 'N' on the base plate aligned to the notional North point marked on the base. The upper flat washers & Nuts can now be fitted and fully tightened. Ensure earth lugs and earth tapes, if present, are fitted securely. ***Note: Care must be taken by the installers to ensure that no part of their body – fingers, hands, etc., are at risk from potential 'pinch-points' , (flange - HDB's) when guiding the monopole down into its' final position.***
f. The tower should then be checked for level and plumb: The monopole should be level and plumb to within ±H/600 or ±25mm per 15 meters in height. If the monopole is not within tolerance level and plumb can be adjusted using the nuts underneath the baseplate.
g. Once the alignment is satisfactory, the upper nuts can be tightened and the lifting slings and tirfors removed. (For non-climbable structures, a MEWP shall be used for accessing this and all further high-level works.) Check the under nuts to ensure they are all tight to the underside of the base plate, tighten as necessary.
h. The upper nuts should then be checked and the monopole double-checked for plumb and level.
i. All nuts are given a final tightness check: Bolts shall be made "snug tight", being that tightness achievable by the effort of one man using a normal sized spanner. Ref. Eurocode standard for Execution of Steel Structures BS EN 1090-2 Cl 8.3 note 2. Refer to QP18 Annex A.

j. Immediately following the landing of the monopole the earthing shall be connected. If no earthing is in place report the matter to the project manager.
k. Once the Latchway/fall-arrest cable has been tensioned a functionality check shall be made of the system.
l. The 'safe to climb' certificate and fall-arrest/Latchways certificate will be issued on completion.

Demobilisation:

19) Tidy up site and remove all the plant and equipment prior to the installation team leaving site. Any damage or defects to the site or adjacent areas will be reported by the **installation team leader** to FLI's project manager and subsequently the client.

5.0 MAINTENANCE STATEMENT

BS8100 recommends that inspections for Class A structures (towers, monopoles, grillages, etc.) be completed at intervals no greater than 2 years. Fall Arrest systems should be inspected at least once a year.

As a minimum, the following items are to be examined:

Item	Description
Ground Works and Foundation	Any concrete foundation shall be checked for general deterioration. This may include cracking, spalling and discolouration. The ground around the foundation shall be checked to ensure there is no visible movement, erosion or subsidence. Any drainage or surface water problems in the vicinity of the foundation should be noted as these can affect the stability of the foundations. The interface between towers and their foundations should be checked to ensure the drainage paths for the uprights are clear.
Earthing	The earthing system must be checked for electrical resistance in accordance with the original customer specification.
Monopole Structure and ladder	An ascent of monopoles shall be made to inspect all members and connections for corrosion and any form of distress, e.g. bent or fractured members.
General Bolt Tightness (Headframes)	A 5% representative sample of all bolts shall be tested for tightness. Tightness checks need to be appropriate to the type of bolt. If there are any problems, check another 5%. If further problems are encountered all bolts in similar locations must be checked and tightened.
Fall Arrest Systems	The fall arrest system should be checked in accordance with the OEM installation and maintenance statement.
Galvanising and Painting	Members shall also be checked for signs of any damage to the galvanised surface. Any damaged surface shall be identified and remedial measures proposed. Refer to the following section 5.1 for guidance.
Antennas and feeders	Equipment and power or other feed cable mountings should be checked for any loose fittings. Any obvious damage to equipment should be reported.

5.1 Galvanising Coating Repair

These notes are an example only and the Relevant manufacturer's product details and BS EN ISO 1461 should be referenced.

Repair Materials:

- Zinc rich paint (Manor Coating Systems or equivalent).
- Zinc sheen aerosol spray.
- Paint brushes.
- Protective gloves.
- Wire brushes.
- Sheets of emery paper.
- PPE as identified by task Risk Assessments shall also be used.

Repair Procedure:

1. Visually inspect all galvanising components to identify areas of coating damage.
2. Wire brush any damaged areas to remove loose coating material, signs of staining and corrosion products.
3. Exposed steel and the edges of any mechanically damaged areas are to be abraded with emery paper and the edges 'feathered' to provide a keying surface.
4. Clean area of damage with a clean cloth removing all dust/dirt from damaged area.
5. Observe good painting practice and do not apply paint in wet or damp conditions, or when the air temperature is below 5 ⌈C.
6. Apply 2 coats of zinc rich paint to the repair area (Touch dry approximately 1 hour). The total Dry Film Thickness (DFT) shall be no less than 100µm. (as per Clause 6.3 of BS EN ISO 1461:2009)
7. When dry, the painted area should be over sprayed with a zinc sheen spray to give a similar appearance to the galvanise coating. Note that when first applied, zinc sheen spray may appear bright but will fade quite quickly to match the galvanised surface.

Notes:

a) Superficial marks such as band staining and footmarks should be wiped clean and sprayed with zinc sheen.
b) White rusting rarely progresses past the superficial stage and will generally wear off in normal weather. No remedial treatment is required for light white rusting.
c) White rusting which has progressed past the superficial stage is characterised by a noticeable darkening and apparent etching of the galvanised coating. In such cases less than 5% of the galvanised coating has been removed and repair may be limited to removal of the white rust by wire brushing and over spray of the affected area with zinc sheen.
d) Severe white rust is characterised by heavy oxide deposits, with the area underneath almost black and showing signs of red rust.

5.2 Removal/Decommissioning

To remove the structure and decommission the site, typically, the reverse of erection procedures should be followed. A new Method Statement must be produced (by an appropriate authority) that takes into consideration any changes to the site and to the structure since the original design and construction (as this may impact on plant that can be used, space within which the decommissioning team can operate and the types of risk present on site).

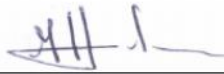
Care should be taken to identify primary, secondary, tertiary(etc.) structural members so as to ensure that the dismantling process is safe and does not lead to instability, partial or total collapse of the structure. If in doubt, professional advice must be sought.

ANNEX A: COSHH DATA SHEETS

The Following Data sheet has been included as an example. Other touch-up products are available and other hazardous products may be required on-site. All hazardous materials used on site will require a COSHH data sheet.

FRANCIS & LEWIS INTERNATIONAL

Substance Identification Record (COSHH) and Assessment Record

Substance: Paint-Zinc Rich Primer (Manor Product)	**Record No:** 54	
Manufacture: Shipley Paint Limited	**Manufactures Health & Safety Identification Number:** UN 1263	
Process: Repair/ touch-up of damaged hot dip galvanised steel.	**Process Location:** Workshop and Site.	
Ingredients	**Occupation Exposure Limit**	**Date**
Xylene (mixed isomers) Ethylbenzene	100ppm 8hr TWA 100ppm 8hr TWA	02/02/04 02/02/04
Physical Properties	**Suppliers**	
Liquid Aromatic Odour Boiling Point 138-185ºC Vapour heavier than air Auto-flammability 490ºC	Shipley Paint Ltd Otley Road Shipley West Yorkshire BD17 7DP Tel No: 01274 587351	
Frequency & Duration of Exposure	**Hazard Identification**	
Intermittent, (as required for repairs), Maximum duration 3 hours.	- Highly Flammable - Harmful by inhalation - Harmful in contact with skin - Irritating to skin	
Assessment of Exposure: The level of exposure is considered acceptable providing this Product is applied in a well-ventilated area.		
Exposure Controls: -Use only in well-ventilated areas. -Keep container sealed when not in use. -Store in cool dry place	**Personal Protection:** -Wear eye protection, gloves and overalls. -Do not smoke when using this product. -If insufficient ventilation wear suitable respiratory protection.	
Approved for Use: Providing controls and personal protection requirements are followed. **Safety Officers Signature :**____  _____ **Date :**_____18/01/06		

Form 25H Issue 01

ANNEX B: LATCHWAY INSTALLATION

LATCHWAYS FALL ARREST SYSTEMS

Technical Datasheet

TESTING & INSPECTION OF LATCHWAYS SYSTEMS

Inspection and Commissioning of Vertical Systems

For systems supplied in kit form by Latchways the swaged connection between the V-Xtenda and cable has been proof tested to 15 kN. Therefore, the system can be directly installed on to the structure without the need for proof testing on site.

For systems supplied as individual parts the swage connection will need to be completed on site using the recommended hexagonal dies with a minimum of 3 swage bites. The connection shall be proof tested to 15 kN before installation of the system. After swaging it is recommended that the across flats dimension is checked. The maximum across flats dimension is 11.2 mm. Any swages greater than 11.2 mm must be rejected. To test the swage connection fit the proof test tool or dummy Xtenda. Fit this arrangement to the Hydrajaws swage tester.

Apply the recommended test load and hold for 3 minutes, checking for any slippage of the cable. This will be indicated by the gauge not holding load and a gap appearing between swage slip indicator (85025) and the end of the swage termination.

If any signs of slippage are detected the swage joint must be rejected and replaced.

Resin / chemically fixed top anchors shall be subjected to an axial pull test of 10kN. This load shall be held for 3 minutes. End anchors not sustaining the test load must be rejected and replaced.

For mechanically fixed top anchors secured to structural steelwork the fixing bolts shall be subjected to a torque check to the recommended values. If the tightening torque value is not achieved the fixing bolts shall be replaced.

For top anchors secured using expansion anchor bolts the anchor bracket shall be subjected to an axial pull test to 10 kN. This load shall be held for 3 minutes.

Check all wire guides ensuring they are securely attached to the structure.

Check the bottom anchor arrangement is securely attached to the structure.

Check the system pre-tension by using the spinning disk arrangement situated at bottom anchor assembly. The disk should spin freely under light pressure once the correct pre-tension is achieved.

Check for free passage of the ClimbLatch/LadderLatch/Towerlatch unit through the wire guides and check that the self-locking mechanism is functioning i.e. the device 'locks on' under it's own weight when released.

Check the system warning notice (aluminium tag or Scaftag) is fixed at the bottom of the system and states the criteria for use i.e. maximum number of users, inspection dates etc.

When all of the above checks have been successfully completed issue the test certificate. This should itemize the checks carried out.

LATCHWAYS FALL ARREST SYSTEMS

Technical Datasheet

TESTING & INSPECTION OF LATCHWAYS SYSTEMS

Annual Inspection of Installed Vertical Systems

Ground Inspection (or pre-climbing checks)

As part of the annual system inspection and before climbing the system to carry out a detailed visual inspection the following checks must be made.

- Check that the V-Xtenda shock absorber has not been deployed. Deployment will be indicated by exposure of the pink warning shaft or by slack cable.
- Ensure the bottom anchor is securely fixed to the structure.
- Check the cable pre-tension by spinning the tension indicator disk. Adjust if necessary.
- Check that the cable is securely fitted through the wire guides and the cable is not fouling the structure.
- Check for any signs of corrosion to the system components or fixing bolts.
- Check that the system warning notice is present stating the limitations of use.

If there is any doubt regarding the condition of the system alternative safe access methods shall be used to inspect and correct system defects.

Detailed Visual Inspection (climbing the system)

Following completion of the above checks connect to the system using either the Ladderlatch, Towerlatch or Climblatch device.

- Climb the system checking that all wire guides are securely attached to the structure and are correctly orientated to allow the device to pass. The correct orientation is when the legs of the bracket are on the left hand side of the tube. Check all fixing bolts are tight by using a torque wrench / spanner. Refer to the torque values specified in the installation instructions.
- Check the cable is clear of the structure and does not foul any protruding steelwork.
- Check the swage slip indicator meets the swage termination of V-Xtenda. If there is any doubt that the gap between the swage slip indicator and swage housing has increased withdraw the system from service. Contact Latchways for advice.
- Inspect the V-Xtenda for deployment. This will be indicated by exposure of the pink warning shaft or by exposure of the plain section of the V-Xtenda shaft.
- Check the top anchor is in good condition and securely attached to the structure. Check the fixing bolts are tight by using a torque wrench / spanner. Refer to the torque values specified in the installation instructions.
- Check for any signs of corrosion to the system components or fixing bolts.

LATCHWAYS FALL ARREST SYSTEMS

Technical Datasheet

TESTING & INSPECTION OF LATCHWAYS SYSTEMS

- Check the clevis bolt and castellated nut connecting the V-Xtenda to the top anchor is in good condition and secured with the castellated nut and split pin.

Following successful completion of the above checks the system can be re-certified by recording the inspection checks carried out. The system certification can be issued.

Inspection of Fall Arrest Devices

The following checks should be carried out annually to ensure the device remains in a safe operational condition.

- Check the starwheel(s) are freely rotating (LadderLatch, TowerLatch and Climblatch).
- Check that the device locks on to the cable under its own weight. This can be achieved by fitting the device to the cable from a safe position. Raise the connector/karabiner as high above the device as possible then release. The device should lock onto the cable. If there is any doubt regarding the operational performance of the device it must be withdrawn from service and returned to Latchways (all devices)
- Check the opening and closing mechanism operates smoothly by pressing the release catch and pulling open the starwheel (Ladderlatch / TowerLatch).
- Check the anti-inversion feature is operating correctly by inverting the device and pressing the release catch. The release catch cannot be operated if the device is operating correctly (LadderLatch / TowerLatch).
- Check the webbing strop is in good condition with no signs of modification, cuts, abrasion, exposure to heat or burns, chemical damage, UV degradation or elongation caused by a fall. If there are any signs of damage or deterioration of the webbing strop the device must be withdrawn from service and returned to Latchways for servicing (TowerLatch).
- The webbing strop has a maximum service life of 5 years. Check the label on the side of the device for year of manufacture. If the date of manufacture is more than 5 years old the device must be returned to Latchways or their authorised agent for servicing.
- Check the starwheel and slipper are fully engaged (ClimbLatch).
- Check for any signs of damage to the external features (all devices).

Following successful completion of the above checks the device can be re-certified by recording the inspection checks carried out and logging the unique serial number for the device.

If there is any doubt about the condition of the fall arrest device it must be withdrawn from service and returned for servicing or replacement.

Technical Datasheet

TESTING & INSPECTION OF LATCHWAYS SYSTEMS

If the device has arrested a fall it must be withdrawn from service and be replaced.

Inspection of Multiple Systems

Telecommunications Towers and Structures

All systems shall be subjected to the ground inspection as previously described.

A 1% sample of systems shall be subjected to a detailed visual inspection (climbing the system) every 12 months. Systems inspected as part of the 1% inspection shall not be included as part of the sample for subsequent 1% sample inspections. Systems in different locations shall be included in the sample inspection.

Where systems are exposed to high wind conditions or environmental pollution it is recommended these systems are included within the 1% sample.

All systems shall be subjected to a detailed visual inspection every 24 months.

Additional Information

For detailed product information refer to component part data sheets.
For systems exposed to high wind locations refer to the data sheet for Specification of Wire Guide Spacing.

ANNEX C: GUIDANCE NOTES FOR TIGHTENING NON-PRE-LOADED BOLTS

(Normal Bolts)

Francis & Lewis International Ltd, Waterwells Drive, Waterwells Business Park, Gloucester, GL2 2AA.

Sales@fli.co.uk
+44(0)1452 722200

Guidance Notes for Tightening Non-Preloaded (Ordinary) Bolts

Prepared for: General Guidance

Document No: FLI-GN-0007

DOCUMENT ISSUE RECORD

Revision	Date	Prepared By	Checked By	Status
00	22/5/2018	T. Burden		For Comment
01	31/05/2018	T. Burden	R. Steel	1st issue

CONTENTS

1.0 INSTALLATION GUIDANCE

Refer to the relevant General Arrangement drawings for details of the tower layout, elements and fixings used on the structure. Refer to the relevant Method Statement and Risk Assessment for the assembly and erection sequence of the structure.

The vast majority of structural bolts on FLI's structures are designed as non-preloaded bolts (ordinary/un-torqued). These guidance notes are only appropriate for non-preloaded bolts.

High Strength Friction bolts (HSFG, Non-Slip) bolts are occasionally utilised. Where HSFG bolts are used, these guidance notes do not apply and a tightening method appropriate to the bolt type must be formulated and used.

2.0 BOLT CONFIGURATION

Bolt assemblies supplied by FLI Structures typically comprise a Bolt (Grade 8.8 spun galvanised to BS EN ISO 10684:2004), Nut and Flat Washer for use under the nut. Spring washers are not supplied, nor desired. Bolts are supplied "dry", i.e. not lubricated. Any quoted torques apply to bolts in this condition.

All bolts shall be fitted such that the nut is underneath. This ensures that if for any reason a nut worked loose the bolt would remain in place. The only exception is where the bolts can only be fitted the other way around.

U-Bolts and N-Bolts are typically Grade 4.6. and comprise the shaft, and one washer and 2 nuts per threaded end, the second nut being used as a lock nut.

Special bolts, fixings and configurations are utilised from time to time, such as Hardlock Nuts and PAL nuts, as detailed on the structure specific General Arrangement Drawing. Where special fixings are supplied, appropriate tightening methods must be used.

3.0 BOLT LENGTH

Bolts have been selected to give a minimum thread projection in accordance with the National Structural Steelwork Specification 4th Edition, pg 41, clause 6.1.4, which states:

'Bolt length shall be chosen such that, after tightening at least one clear thread projects past the nut'

It is therefore important that the correct bolts are used in each connection. FLI's assembly drawings give details of which nuts and bolts are to be used and the quantities of each size required are supplied in individual labelled bags with the tower.

4.0 CORROSION PROTECTION

Bolts and other structural fasteners are typically spun galvanised and as such have an average coating thickness of 50µm (For more information, also see ISO 10684:2004). This may equate to a lower design life than the structure and so the bolts on the structure may have to be replaced, depending on the actual corrosion rate. This can be controlled via the inspection regime.

5.0 BOLT TIGHTENING – ORDINARY BOLTS (NON-PRELOADED)

- Component parts should be identified & collated, using the packing list.
- Components should be assembled, in accordance with the assembly drawings, typically on blocks on a level surface.
- A dimensional check of the assembly should be carried out, before tightening the bolts.

5.1 1st Stage Bolt tightening

- The bolts should be **fully tightened** using an impact driver and spanner or 2 spanners.

For structural bolts designed as ordinary, non-preloaded bolts the following guidance applies.

Initial tightening shall be by hand to the following method.

"Bolts shall be made "snug tight" being that tightness achievable by the effort of one man using a normal sized spanner without an extension arm, and can be set as the point at which a percussion wrench starts hammering." Ref Eurocode standard for Execution of Steel Structures BS EN 1090-2 Cl 8.3 note 2:

- **Caution must be exercised if using percussion wrenches.** Many modern models can apply well in excess of 250Nm, which will certainly overstress bolts and strip threads. It is essential that the correct model of percussion wrench is chosen and that it is suitably calibrated for the task at hand. **If calibration of percussion wrenches is not possible, then they shall not be used.**
- The following table provides the recommended torques to be applied by a percussion wrenches.

Percussion Wrench **Recommended Torque Settings**		
Bolt Size	Bolt Grade	
	4.6	**8.8 & 10.8**
	Torque Nm	
M12	30	**65**
M16	60	**135**
M20	110	**135**
M24	130	**135**
M30	180	**250**
M36	250	**250**
M42	250	**250**

- A table of Maximum permissible torque applied by percussion wrenches is shown in the residual hazards part of this document

5.2 2nd stage Bolt Tightness Check

- 2nd stage Bolt tightness checks shall be done after a minimum of 1 hour, although the longer this can be delayed, the better, ideally 5 days.
- All bolts should undergo the 2nd Stage bolt tightness check and marked with a **RED** marker on the bolt head by the checker.
- Pre-assembled bolts have a **BLACK** mark to indicate they have been checked in the Works (Ref FLI QP15). Thus, all bolts shall either have a **RED** mark to indicate a site assembly and tightness check or a **BLACK** and a **RED** mark to indicate a works and site tightness check.

2nd Stage tightening shall either be by hand as describe above, or if desired, with a torque wrench where the following guidance values may be appropriate.

2nd Stage Tightness Checks **Torque Wrench Settings**		
Bolt Size	Bolt Grade	
	4.6	**8.8 & 10.8**
	Torque Nm	
M12	30	**65**
M16	60	**90**
M20	110	**110**
M24	130	**130**
M30	160	**160**
M36	200	**200**
M42	240	**240**

These values have been set to mimic the approximate hand tightening torque as found in the BCSA/SCI book: P212: Joints in Steel Construction: Simple Connections in Table H.62, taking hand tightness as 250N = 25kg on end of the Podger spanner.

6.0 MAINTENANCE TIGHTNESS CHECKS

If, during maintenance operations, bolts are to be checked with a torque wrench to validate tightness, then the following values may be appropriate.

Maintenance Tightness Checks **Torque Wrench Settings**		
Bolt Size	Bolt Grade	
	4.6	**8.8 & 10.8**
	Torque Nm	
M12	30	**60**
M16	60	**80**
M20	100	**100**
M24	115	**115**
M30	145	**145**
M36	180	**180**
M42	210	**210**

These values have been set at approximately 90% of the hand tightening torque. This is intended to avoid spurious reports of loose bolts, while still being meaningful.

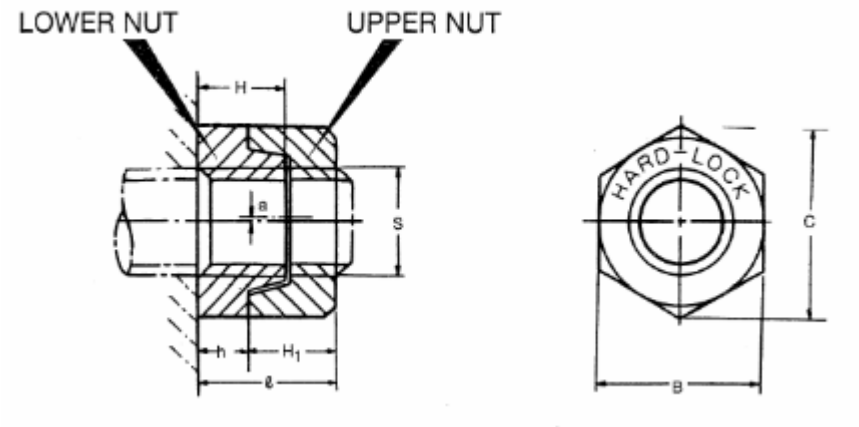
7.0 HARDLOCK NUTS - INSTALLATION AND TIGHTENING

Hardlock nuts require specific installation methods to be followed.

Providing the guidance for the installation of these nuts are followed, there is no requirement for a final check on the structural bolt positions. This is because the methods of installation in this document require tightness checks to be completed during the installation process.

Hardlock nuts consist of two separate nuts which when tightened correctly provide an effective locking to any structural fastener.

The nuts are supplied loose and each assembly consists of two separate items. The lower nut has an eccentric cone, which is proud of one of the faces of the nut. The upper nut has a concentric recess machined in one of its faces.



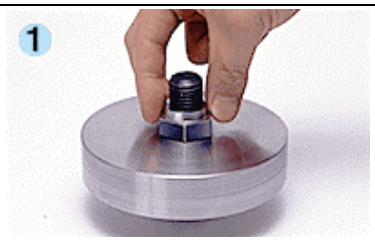
Whilst the tower modules are on the ground, fit the bolt through the parts to be connected and then fit a standard flat washer and the Hard Lock lower nut. It is essential that the lower nut be fitted with the smooth face flush to the washer and fully tightened. Tighten using the 1st stage tightening guidance given above.

Once the tower has been lifted into position and at least 1 hour after 1st stage tightening, the lower nut should be checked for tightness, using the 2nd stage tightening guidance given above.

Then fit the upper nut on the assembly ensuring that the recess in the upper nut will fit over the cone in the lower nut. Using a torque wrench tighten the upper nut to at least the minimum seating torque shown in Table 1.

Pre-assembled tower modules will not have the upper nut fitted when delivered to site. These should be fitted once the tower has been lifted into position and the lower nuts have been checked as above.

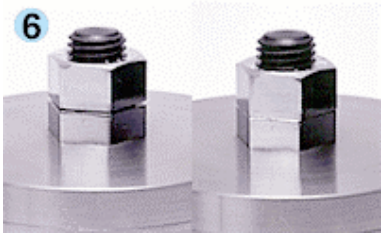
Note: Providing the torque settings have been achieved, there is no need tighten until the gap between upper and lower nuts is fully closed or to make the flat faces of the nuts to coincide.

	
Pass the bolt through the materials to be attached and screw the lower (convex) nut onto the bolt.	Fully tighten using 1st stage tightening guidance above

At this point, the lower nut has exactly the same strength as a general-purpose nut.

Next, screw the upper (concave) nut onto the bolt by hand.

After tightening the upper nut by hand, use a torque wrench to tighten to at least the minimum torque setting given in the Table.



There may be gaps between the upper and lower nuts at this time and nut faces may not coincide. This is perfectly acceptable.

Size	Upper Nut Min Seating Torque Nm	Upper Nut Max Seating Torque Nm
M12	27	39
M16	70	100
M20	120	200
M24	160	300

Table 1: Seating Torques (This Table is for SS400 grade nuts only).

Maintenance Tightness Check on Hardlock Nuts must appropriate to the installation method. Excessive torques must not be applied to the upper nut.

8.0 PAL NUTS – INSTALLATION AND TIGHTENING

PAL nuts require specific installation methods to be followed.

Providing the guidance for the installation of these nuts are followed, there is no requirement for a final check on the structural bolt positions. This is because the methods of installation in this document require tightness checks to be completed during the installation process

PAL nuts are fitted on top of a standard nut as a visual check that 2nd stage tightening has been completed. Due to its design there is no need for either a flat or spring washer beneath the face of the standard nut.

Whilst the tower modules are on the ground, fit the bolt through the parts to be connected, then fit a standard nut and tighten using the 1st stage tightening guidance given above.

Once the tower has been lifted into position, providing a minimum period of one hour has passed since the initial tightening, the standard nut on each assembly should be checked for tightness, using the 2nd stage tightening guidance given above.

Fit the PAL nut onto the assembly and tighten using an open-ended spanner, until tight plus one half turn.

One Half turn of the Pal Nut is best confirmed by match marking the nut and Pal nut on opposite faces and tightening until the lines are coincident.

Pre-assembled tower modules will not have the PAL nut fitted when delivered to site. These should be fitted once the tower has been lifted into position and the standard nuts have been checked as above.

Maintenance Tightness Check on PAL Nuts must be appropriate to the installation method. Excessive torques must not be applied to the PAL nut.

9.0 **DESIGNERS STATEMENT OF RESIDUAL HAZARDS**

<table>
<tr><th>Design Residual Hazard</th><th>Description</th><th>Activity</th></tr>
<tr><td>Loose Bolts</td><td colspan="2">Bolts may remain or become loose if not adequately tightened during installation. Adequate and appropriate control measures must be in place to ensure connections are tightened correctly</td><td>Installation
Maintenance</td></tr>
<tr><td>Stripped threads or rupture of bolts.</td><td>Application of excessive force can lead to stripping of bolt threads or failure of the bolt.
In particular, great care must be taken with Percussion Wrenches.
Maximum permissible values are listed in the adjacent table.</td><td>
<table>
<tr><th colspan="3">Percussion Wrench
Maximum Permissible Torque Settings</th></tr>
<tr><td rowspan="3">Bolt Size</td><td colspan="2">Bolt Grade</td></tr>
<tr><td>4.6</td><td>8.8 & 10.8</td></tr>
<tr><td colspan="2">Torque Nm</td></tr>
<tr><td>M12</td><td>30</td><td>65</td></tr>
<tr><td>M16</td><td>60</td><td>110</td></tr>
<tr><td>M20</td><td>110</td><td>210</td></tr>
<tr><td>M24</td><td>130</td><td>300</td></tr>
<tr><td>M30</td><td>180</td><td>450</td></tr>
<tr><td>M36</td><td>280</td><td>700</td></tr>
<tr><td>M42</td><td>400</td><td>1000</td></tr>
</table>
</td><td>Installation
Maintenance</td></tr>
<tr><td>Failure of locking mechanism</td><td colspan="2">Incorrect tightening of locking nuts or special fasteners can lead to failure of the locking function. Appropriate tightening techniques must be used.</td><td>Installation
Maintenance</td></tr>
</table>

A full risk assessment or each of the relevant identified hazards above needs to be completed by the inspector and/or maintainer.