

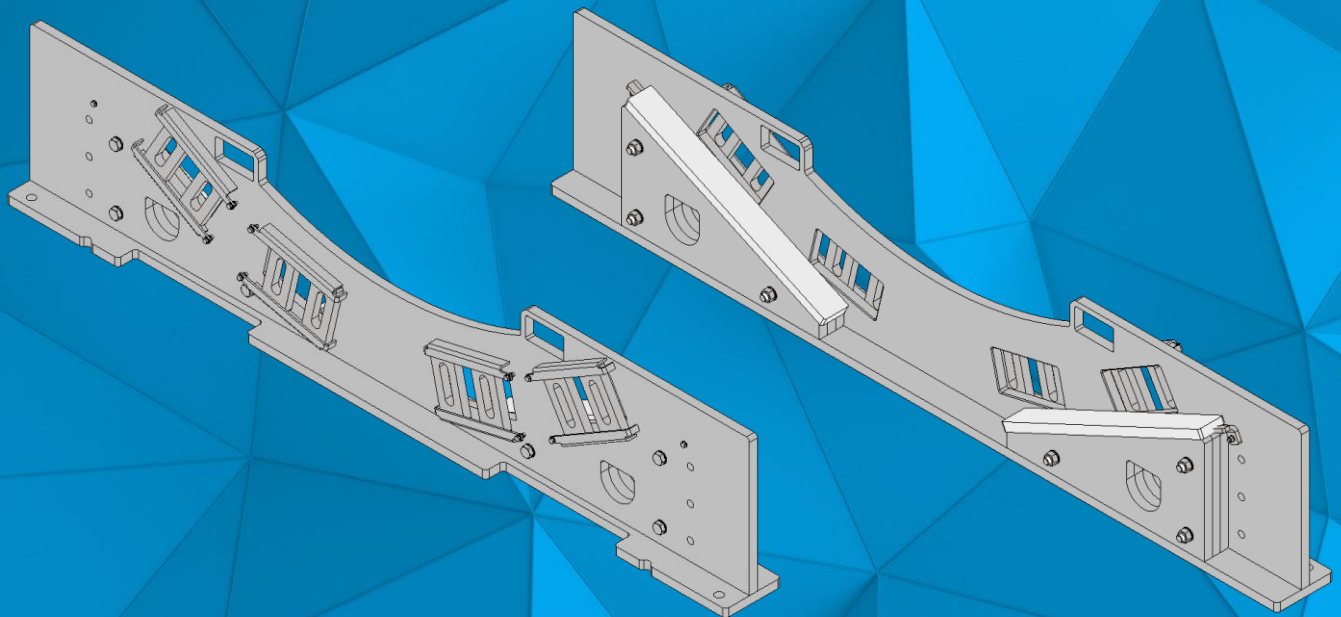
User Manual

CTT – Common tower tool

Customer:

Siemens Gamesa Renewable Energy A/S
MHI Vestas Offshore Wind A/S
10040

Version 5.0 – November 5, 2019



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Revision history:

Approved revision: 3.0

Revision	Date	Author	Approver	Description
1.0	March 16, 2019	APE	PSE	Creation of user manual
2.0	June 27, 2019	PSE	APE	Updates according to SGRE review
3.0	September 3, 2019	APE	KDJ	Updated design and usage
4.0	October	PSE	KDJ	Updated design and usage from FAT & SAT
5.0	November 5, 2019	PSE	KDJ	Updated instructions with bolt length

1 Introduction


This is the user manual including instructions for "CTT – Common tower tool for turbine tower section" developed by Advantis Engineering ApS.

1.1 Use of equipment – IMPORTANT!

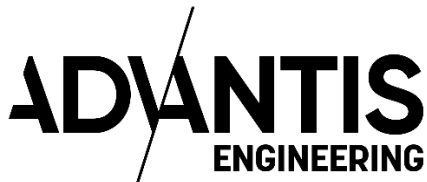
Everyone who use this equipment must read and fully understand the user manual and following instructions to be able to use this equipment. If operator somehow deviate from the user manual and instructions, then this could lead to damaged parts or in worst case injury personal close to the equipment, which Advantis Engineering ApS cannot be held responsible for.

User manual and instructions must follow the equipment wherever it is used in the world, so operators always know exactly how to use the equipment.

Equipment label for CTT:

	Advantis Engineering ApS Inge Lehmanns Gade 10 DK-8000 Aarhus C Phone: +45 25 29 75 86
Product name:	CTT – Common tower tool
Product ID:	10040-001
Serial ID:	10040-001-00001 (ongoing)
Year of production:	2019-05
SWL:	150t up to 135t end weight, 24m conical 160t up to 135t end weight, 40m bottom / middle 200t up to 135t end weight, 30m bottom / middle

1.2 Manufacturer information



Advantis Engineering ApS
Inge Lehmanns Gade 10
DK-8000 Århus C
Phone: +45 25 29 75 86
www.advantis.dk

2 Description of equipment

CTT – Common tower tool has the purpose to transport turbine tower sections in various ways with various diameter ranging from Ø4200 and up to Ø7000mm with length up to 40m and total mass up to 200 ton.

Turbine towers can either be transported by vessel, road transport on trailer or on pre-assembly site with use of SPMT where SPMT interfaces to specific hook interface on CTT. CTT can also be used with various storage equipment when stored on harbour or pre-assembly site.

IMPORTANT – it is strictly forbidden to lift the tower sections in the CTT – the CTT is only applicable for the described scenarios within this manual!

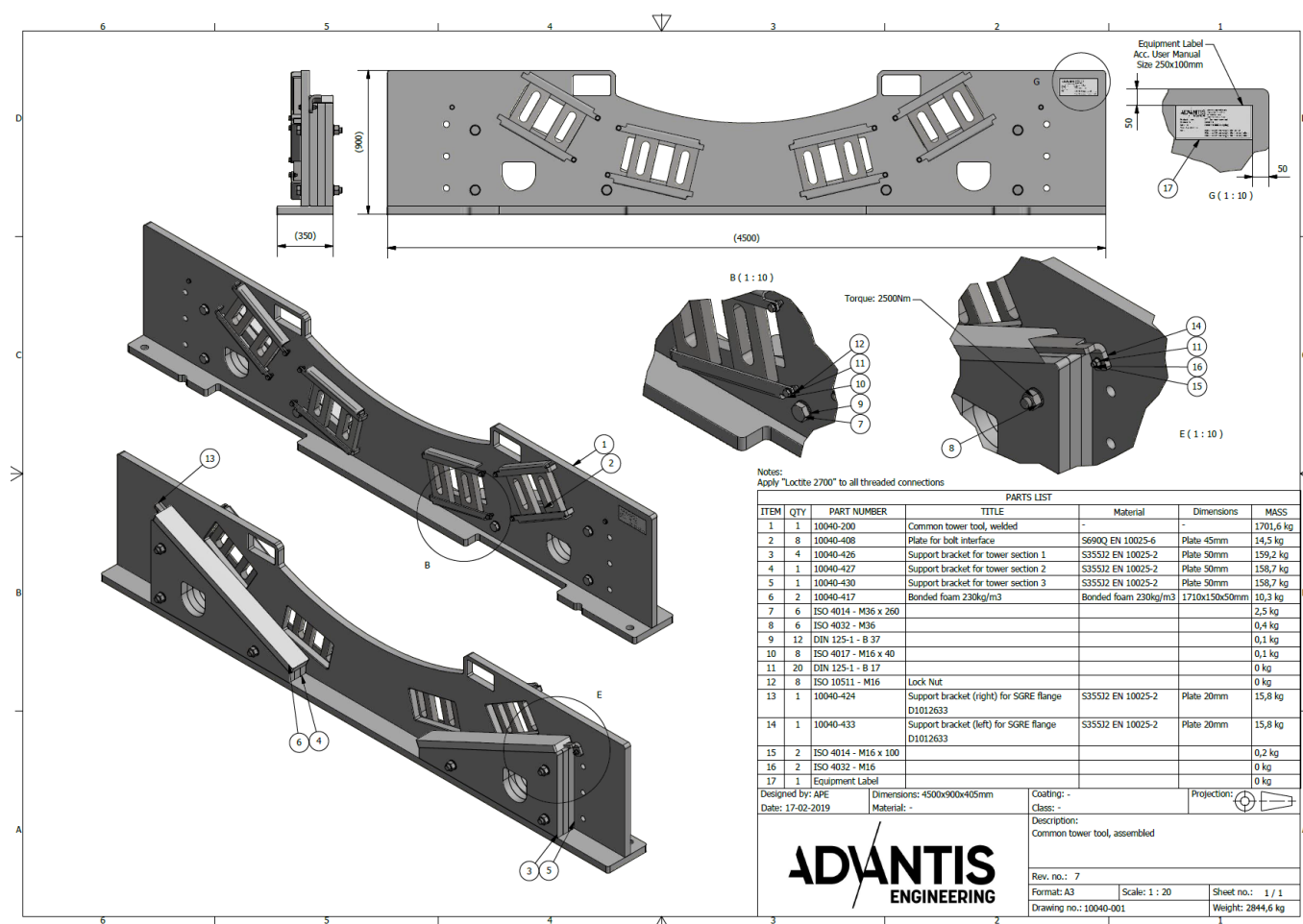


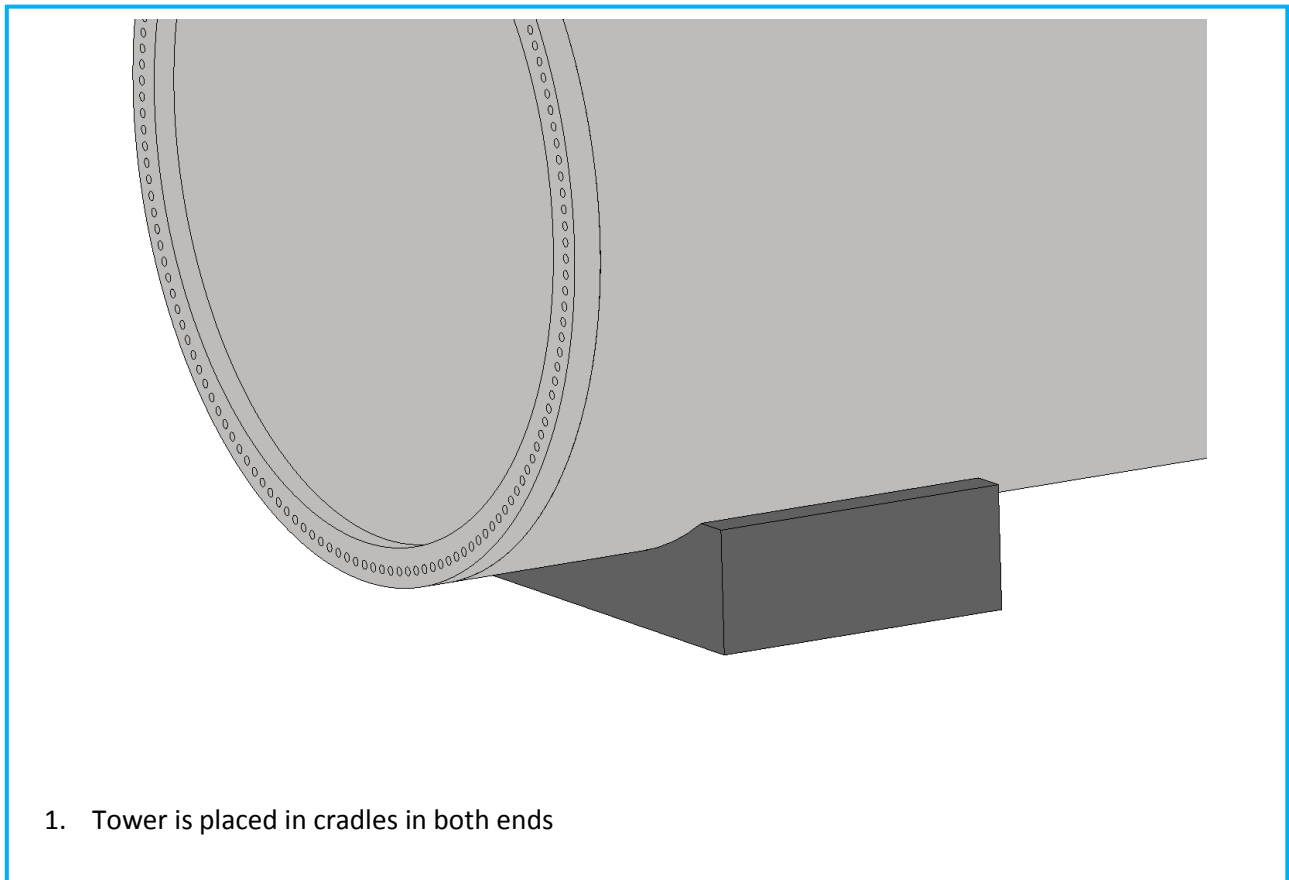
Figure 1: 10040-001 Common tower tool, assembled

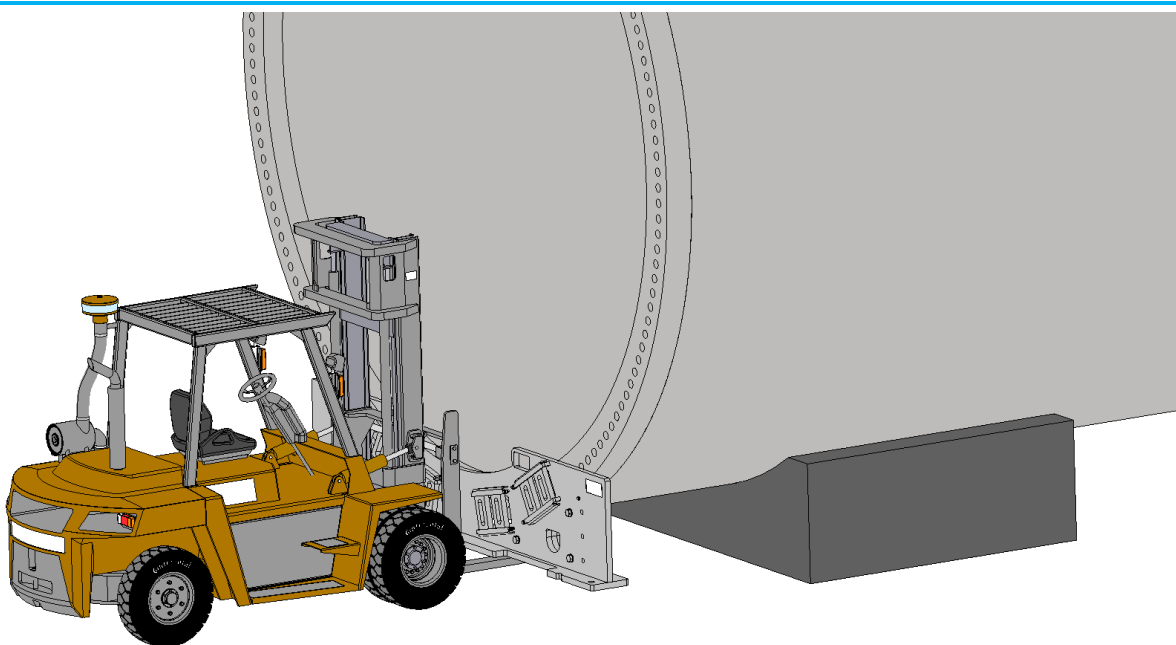
3 Process for use of equipment

Following procedure describes how to use the equipment:

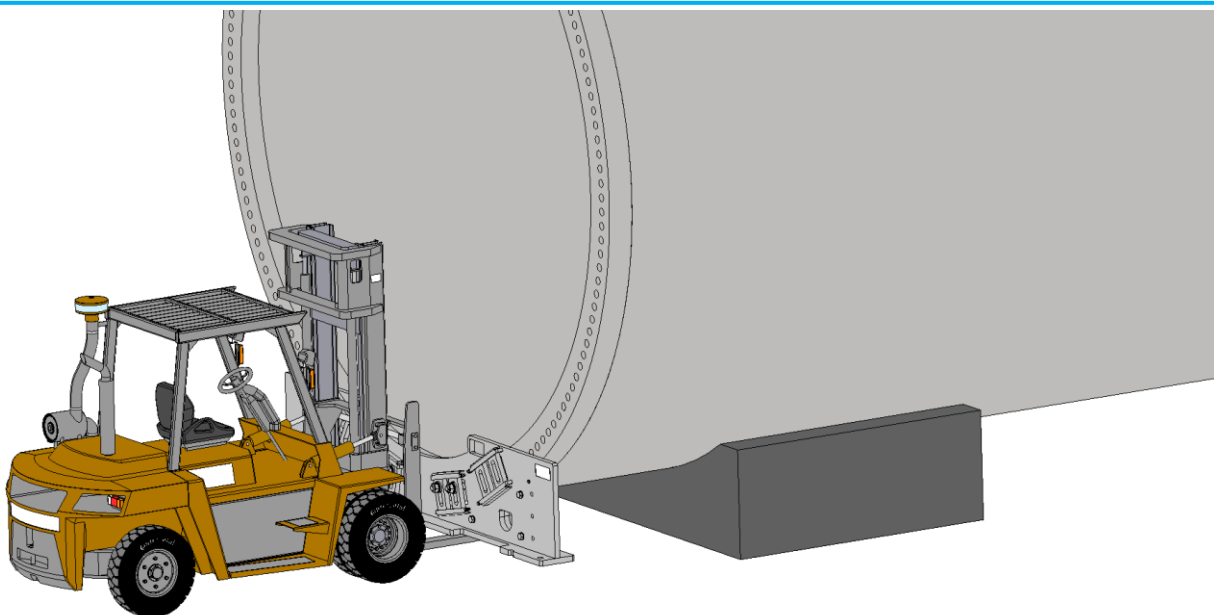
3.1 Procedure for mounting the CTT to tower section:

- Check which tower sections is to be mounted on CTT.
- Prepare bolted connection setup, so it matches the bolt size hole for the specific tower section – check bolted connection matrix for CTT according to figure 3.
- Ensure that CTT and its components are in good condition and have no damaged parts.
- **IMPORTANT** – before mounting the CTT ensure the surface interfacing to the tower is clean with no burrs – remove if present
- Ensure the bonded foam 230kg/m³ is brand new – **MUST NOT BE REUSED!**
- Ensure 10040-417 bonded foam 230kg/m³ is secured properly on tower interface support, before CTT engage with tower section.
- Use only calibrated torque tool and apply as per manual and instruction specified torque setting – use appropriate lubrication for bolted connection

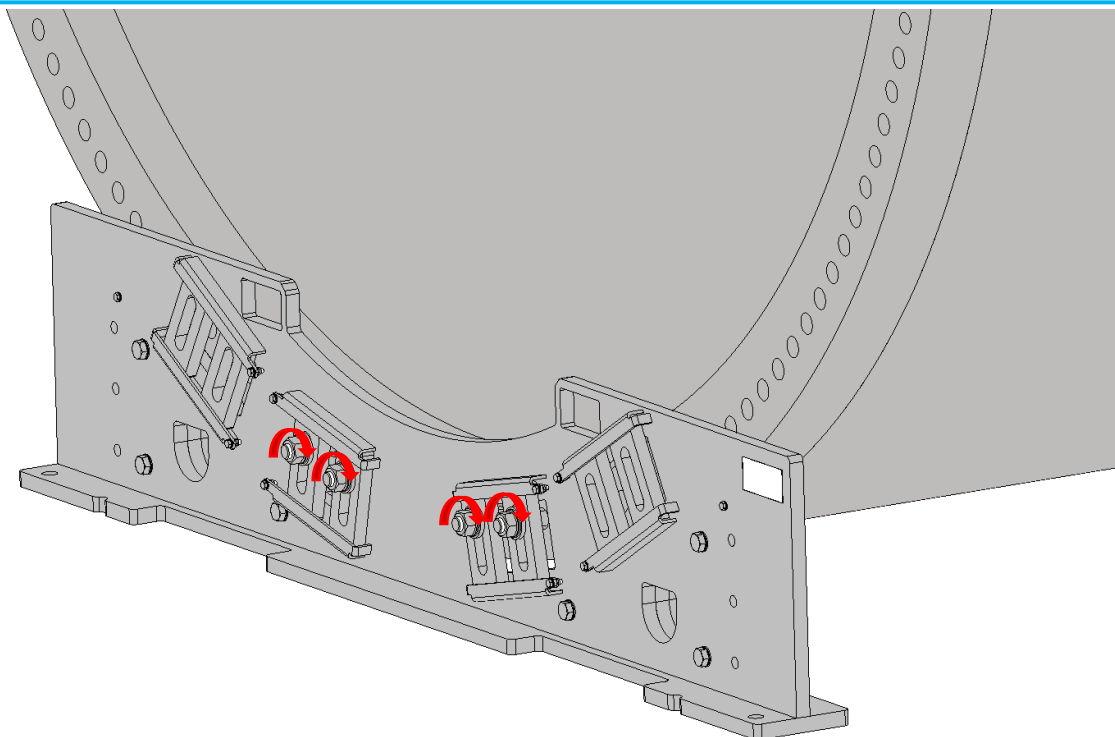




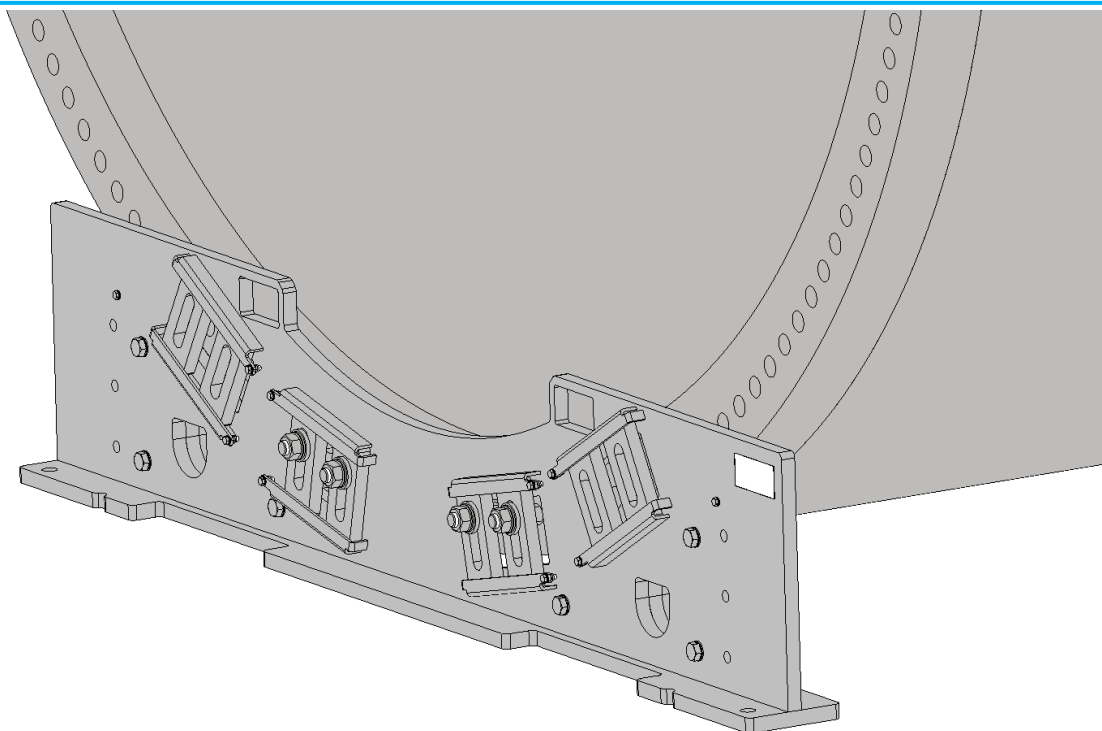
2. Mount CTT with forklift – can be done by engaging underneath the CTT or in the appointed forklift pockets – make sure CTT cradle mounted with bonded foam is in contact with tower



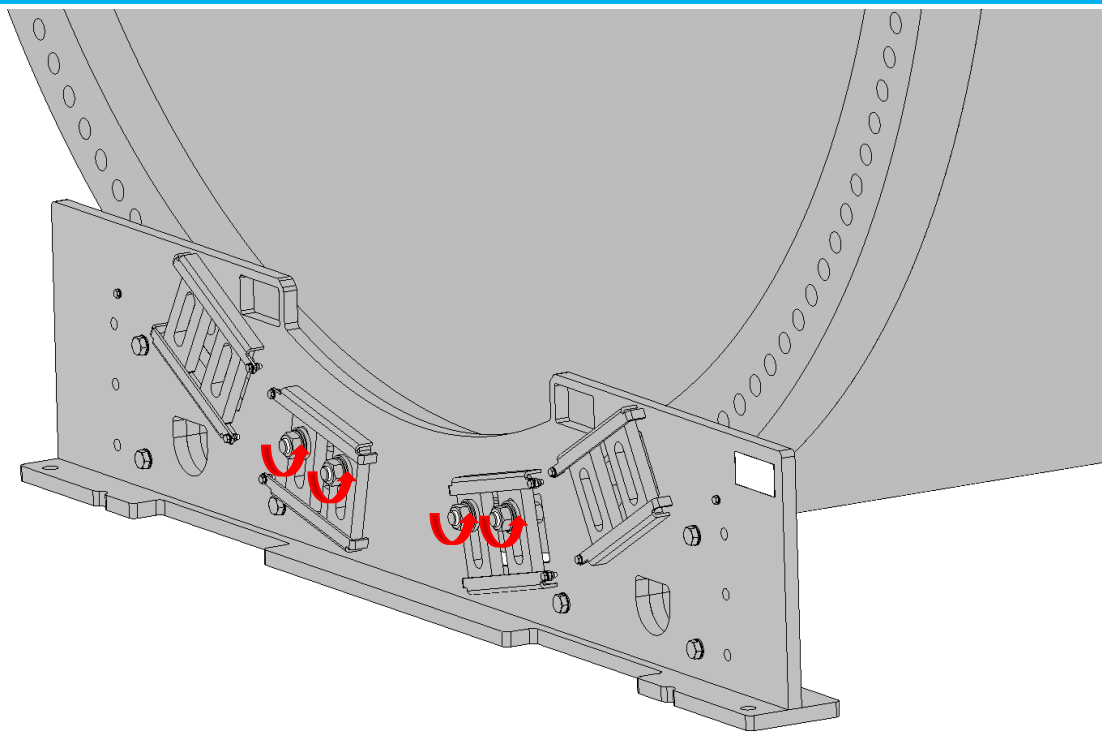
3. Mount the inner four bolts of the CTT by applying 200-300Nm – repeat for both ends of tower



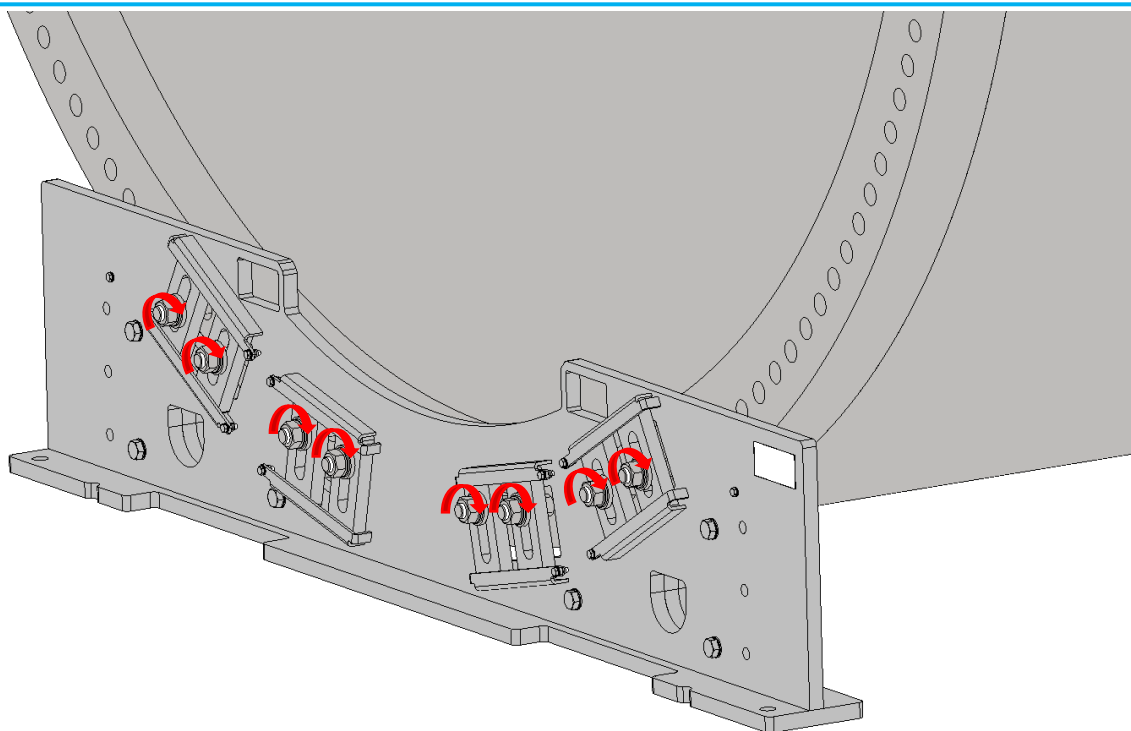
3. Mount the inner four bolts of the CTT by applying 200-300Nm – repeat for both ends of tower
IMPORTANT – use specified torque and appropriate lubrication for bolted connection!



4. Place the tower mounted with CTT on ground or storage equipment as specified per instructions



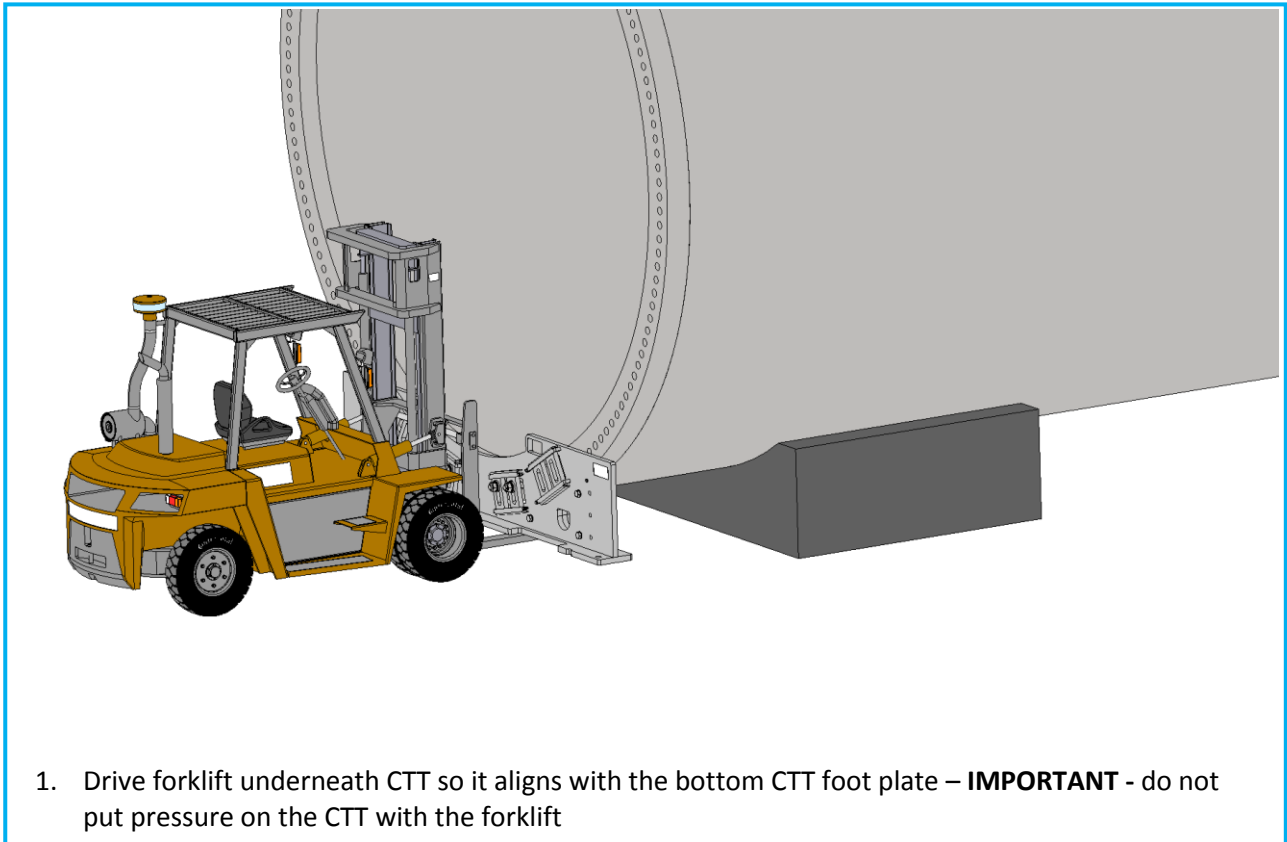
5. Loosen inner bolts – **IMPORTANT** – do not remove nuts – to allow the tower to fully settle in the foam cradle



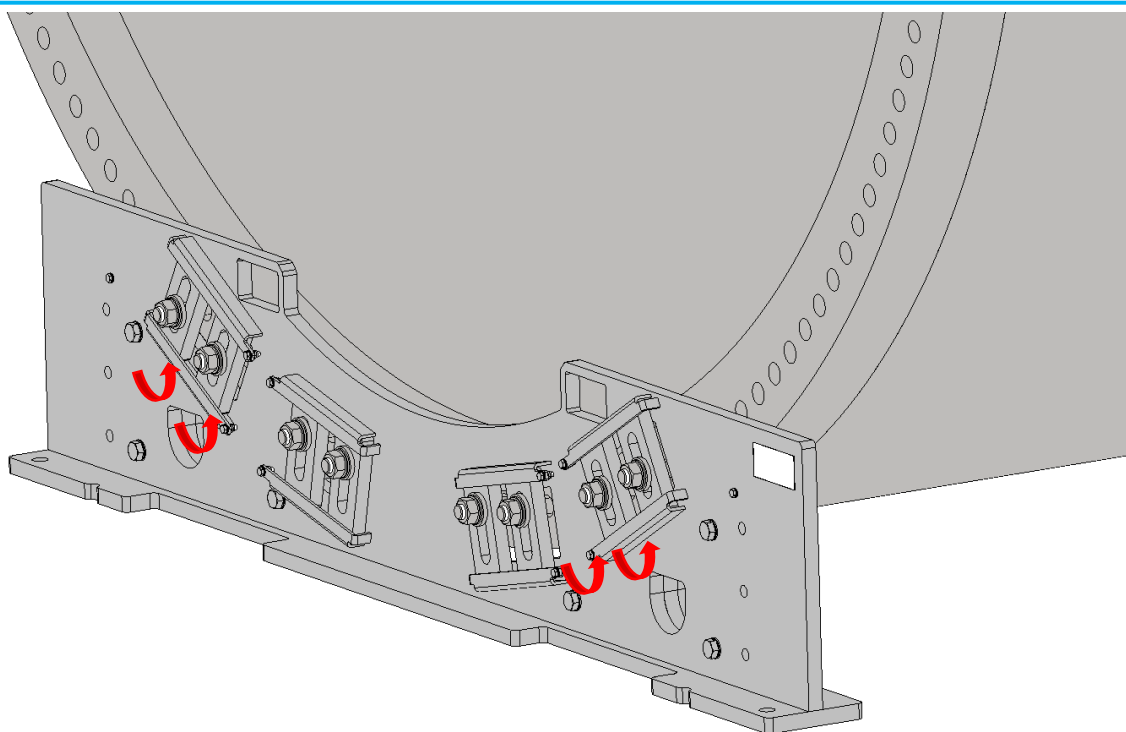
6. Torque all bolts as per specified torque setting in figure 3 – repeat step 5. & 6 for other end.
IMPORTANT – use specified torque and appropriate lubrication for bolted connection!

3.2 Procedure for de-mounting the CTT to tower section:

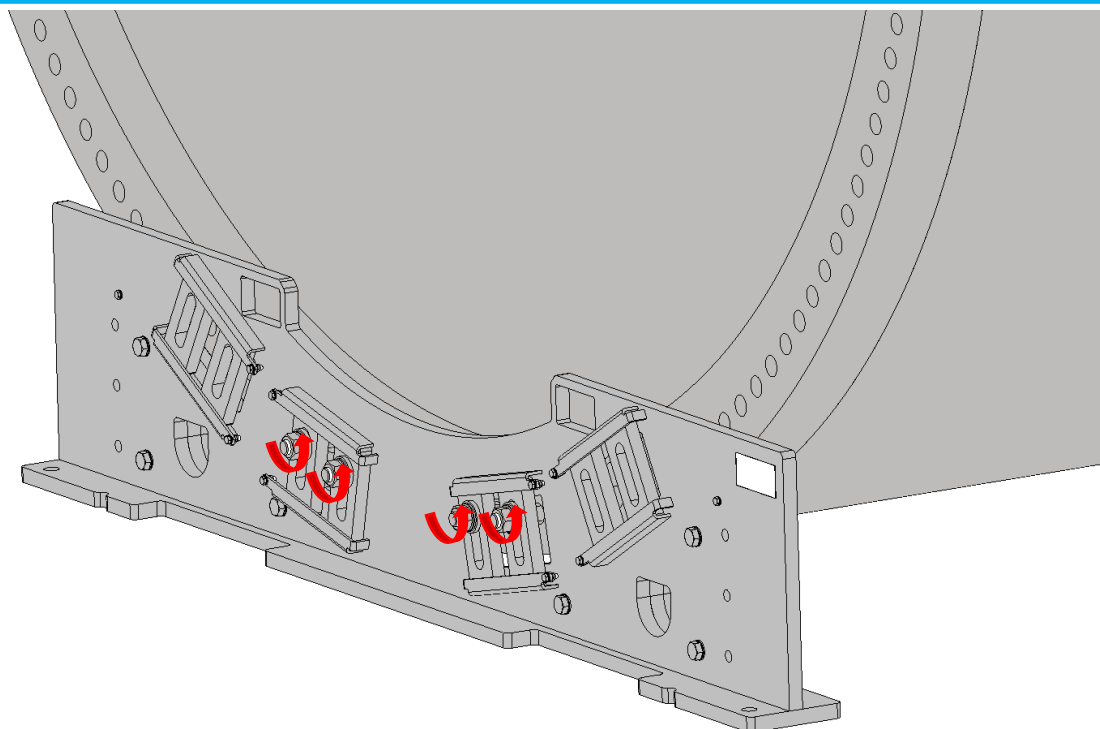
- Before removing the CTT ensure the tower section and CTT are placed level to the ground in the cradle



1. Drive forklift underneath CTT so it aligns with the bottom CTT foot plate – **IMPORTANT** - do not put pressure on the CTT with the forklift



2. De-mount outer bolts with appropriate tooling



3. De-mount inner bolts and the CTT are ready to be moved with the forklift

3.3 Instructions

When CTT is mounted on tower sections and all requirements has been met for mounting of CTT, it is now allowed to either transport tower sections on sea, road or with SPMT for pre-assembly site or use it on storage with various storage solutions.

IMPORTANT!

Whenever ready to transport tower sections it strictly important to follow the instructions for each scenario. It's **NOT** allowed to deviate from instructions, and if operator deviates from instructions, this could lead to damage on CTT, tower section or even worse – personal injury!

If OEM would use CTT for other scenarios than described below or deviate from current instructions, Advantis Engineering ApS must verify if this is allowed before use!

CTT is prepared for following scenarios:

- 10040-002 SPMT Pre-assembly and harbor site
- 10040-003 Truck transport with CTT
- 10040-004 Vessel transport with CTT
- 10040-005 Storage with MHI Vestas Type 1
- 10040-006 Storage with MHI Vestas Type 2
- 10040-007 Storage with SGRE wedge
- 10040-009 Lifting instruction for CTT

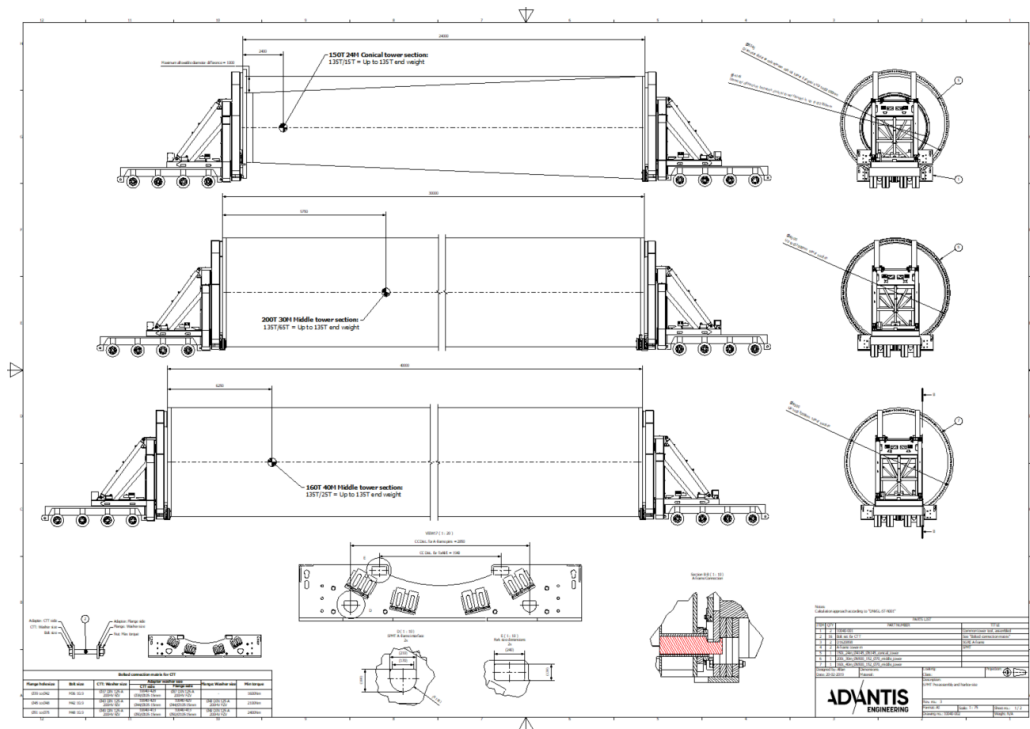


Figure 2: Instruction example

3.4 Bolted connections

CTT – Common tower tool equipment is to be used with various type of turbine tower sections and therefor there is made an assembly matrix on how to use the CTT equipment with various tower sections.

It is the bolt hole size in the flange that determines which bolted connection setup that should be used. There are three different setups for the CTT in combination with tower sections.

- If bolt hole size I **Ø39 up to Ø42** then operator must use **M36 bolt 10.9 FZV** in combination with shown washer and adapters.
- If bolt hole size I **Ø45 up to Ø48** then operator must use **M42 bolt 10.9 FZV** in combination with shown washer and adapters.
- If bolt hole size I **Ø51 up to Ø75** then operator must use **M48 bolt 10.9 FZV** in combination with shown washer and adapters.

Minimum torque for the bolted connection must meet torque specified in Figure 3: Bolted connection matrix for CTT.

IMPORTANT!

- It is **NOT** allowed to use a minor number of bolts or lower torque than specified on the instructions! Always use exact specified number of bolts and torque whenever foot is in mounted on tower sections
- All bolts shall be grade 10.9 bolts
- Bolts shall be visibly marked with the month in which they were first used, e.g. "09-2019" written on the bolt head.
- M48 flange bolts shall be replaced every 9 months of equivalent use, corresponding to 24 weeks of sea voyage.
- All flange bolts shall be visually inspected before re-use between voyages.
- Any visibly damaged bolts (bends, cracks, dents etc.) shall be discarded and replaced.

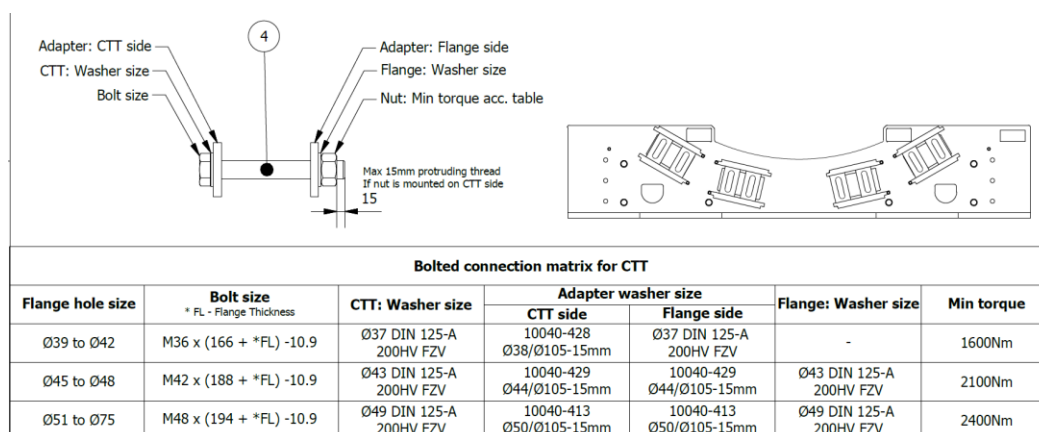


Figure 3: Bolted connection matrix for CTT on turbine tower sections

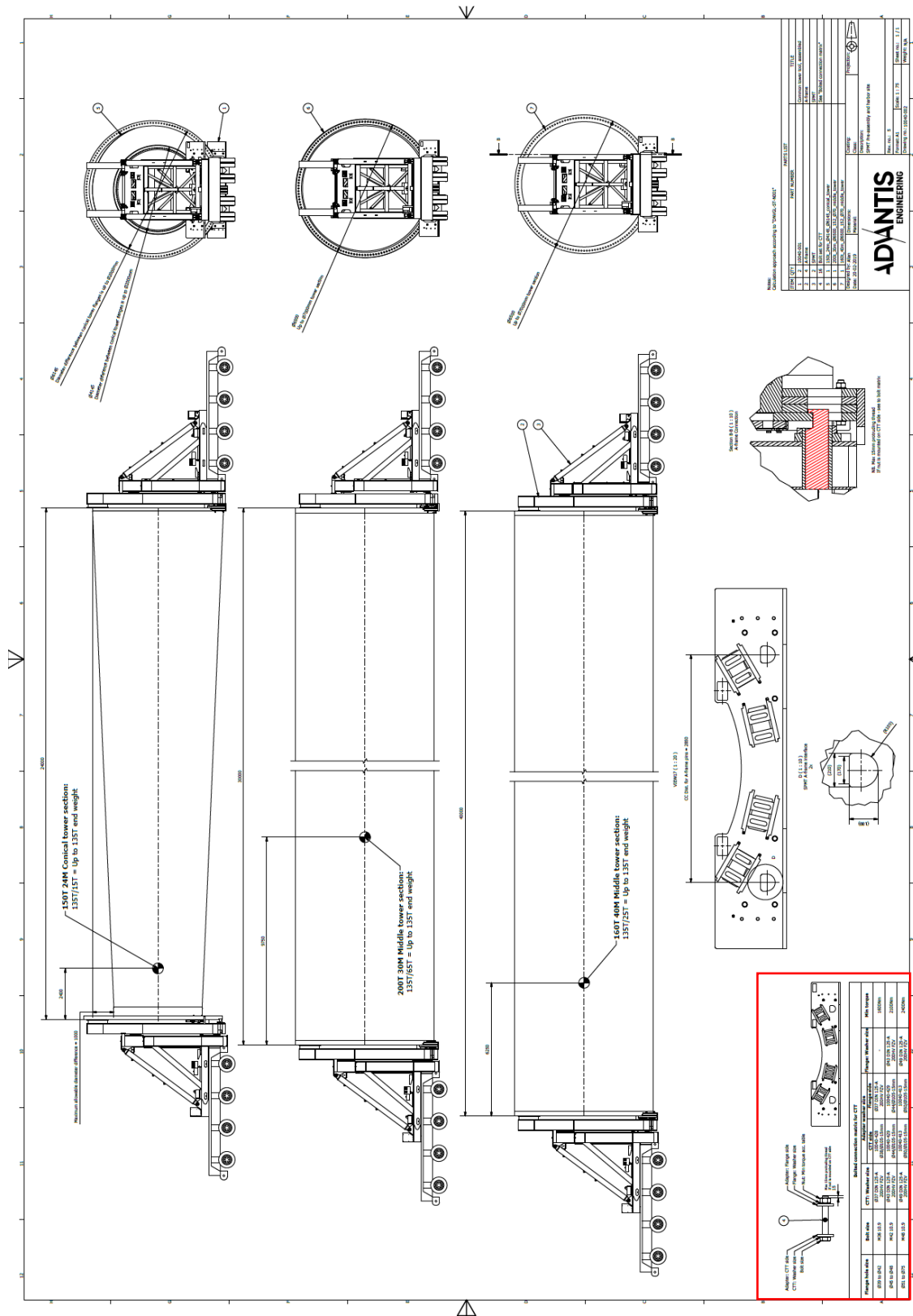


Figure 4: Instruction example where bolted connection matrix is shown in lower left corner

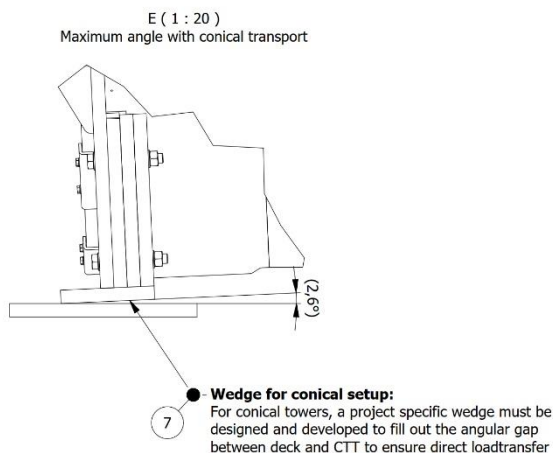
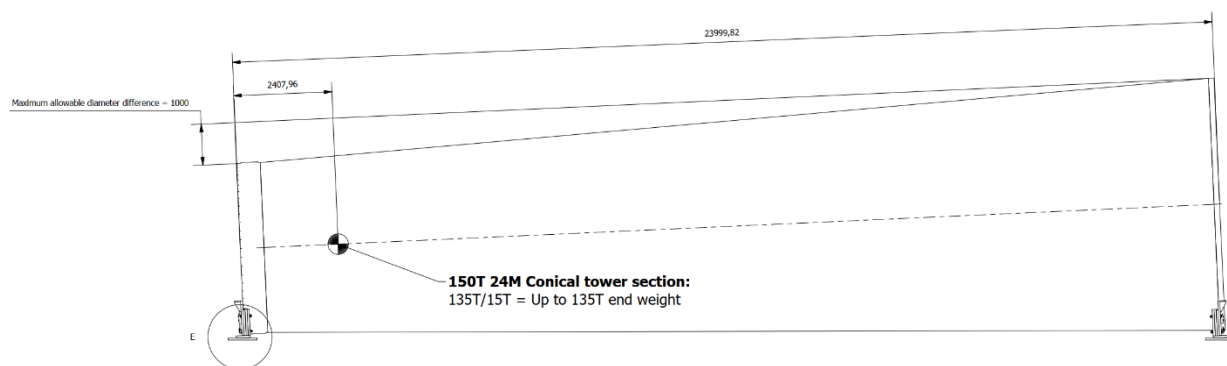
3.5 Support wedge for conical tower sections during transport


When CTT – Common tower tool is mounted on conical tower sections is it required to use a project specific wedge as support between deck and CTT whenever the tower is transported on sea or road.

As conical tower sections vary in dimensions, the angular gap will also change, so therefor the wedge must be project specific and analyzed before CTT in transported on either sea or road.

IMPORTANT!

If a wedge is **NOT** used during transportation, this could lead to permanent failure off the CTT and damages on the tower sections! Support wedge **MUST ALWAYS** be used whenever transport of conical tower sections is needed!



PARTS LIST			
ITEM	QTY	PART NUMBER	TITLE
1	2	10040-001	Common tower tool, assembled
2	2	10040-416	Hardwood white oak T=50mm or Regupol LSE 1000 T=20mm
3	4	-	TK 40 chains - traverse
4	4	-	TK 26 chains - longitudinal
5	4	-	TK 26 chains - vertical
6	2	-	TK 13 chains - ovalization
7	2	-	Wedge for conical tower - Hardwood (project specific)
8	16	Bolt set for CTT	See "Bolted connection matrix"
9	1	150t_24m_04145_06145_conical_tower	
10	1	200t_30m_06500_152_070_middle_tower	
11	1	160t_40m_06500_152_070_middle_tower	
Designed by: APE		Dimensions:	Coating:
Date: 20-02-2019		Material:	Class:
			Description:
			Vessel transport with CTT
			Projection:
			
Rev. no.: 4		Format: A1	Scale: 1 : 75
Drawing no.: 10040-004		Sheet no.: 1 / 1	
		Weight: N/A	

4 Repair and maintenance

Repair and maintenance

All personal that performing maintenance must be qualified to carry out maintenance on CTT and must be instructed in how to act safely when carrying out maintenance on CTT.



Cleanliness of equipment

CTT and its CTQ interfaces must be kept clean from dust, oil, bolt grease etc – use appropriate cleaning agent to ensure clean interfaces.

Preventive actions

CTT must be checked for wear and tear before each use, to ensure the CTT is safe is to use. If CTT doesn't meet the approval check, it must be taken out of use and then a service must be performed until it safe to use or meet necessary standard.

Return inspection on CTT / Annually inspection on CTT

A visual inspection must be carried out when CTT returns from site – **however the equipment should as a minimum be inspected every year.**

- ✓ Visual inspection of the weld between vertical plate and foot plate (10040-200 AREA – E8) – if any damage to the weld is spotted they shall be repaired of the CTT shall be discard
- ✓ Visual inspection of the inside edges of the four rectangular cut-outs for bolts – if any initial cracks are spotted they shall be repaired of the CTT shall be discard
- ✓ Visual inspection of the adjustable blocks 10040-408 if any damage of excessive bending is spotted, they shall be replaced
- ✓ Check for deformation
- ✓ Check for general condition and for corrosion
- ✓ Check for label of signs condition
- ✓ Check if maintenance interval has been met
- ✓ Visual inspection of the support plates (PL50) – cradle blocks. Denting of the support plates is to be expected, but if any significant crack growth is spotted, it shall be repaired or replaced.
- ✓ Visual inspection of the metallized surfaces of the welded CTT. If any significant damage to the metallization is spotted, the metallization shall be locally re-established.
- ✓ All flange bolts shall be visually inspected before re-use between voyages.
- ✓ Any visibly damaged bolts (bends, cracks, dents etc.) shall be discarded and replaced.
- ✓ Any bolt that has reached full fatigue life as indicated by the marked date shall be discarded and replaced - M48 flange bolts shall be replaced every 9 months of equivalent use, corresponding to 24

weeks. Bolts (item 7,8 & 9) on 10040-001 bolts shall be replaced every 5 years of equivalent use, corresponding to 160 weeks of sea voyage.

5-year inspection on CTT

Extended inspection should be carried out after 5 years.

✓ It is recommended that the weld between vertical plate and foot plate (10040-200 AREA – E8) is NDT tested after 5 years of use.

✓ Bolts (item 7,8 & 9) on 10040-001 should be replaced after 5 years

Discard CTT if:

- ÷ Visible cracks or tear on materials
- ÷ Permanent deformations on materials
- ÷ Unreadable or missing type plate and warning signs, etc.

5 Spare Parts List

PARTS LIST						
ITEM	QTY	PART NUMBER	TITLE	Material	Dimensions	MASS
1	8	10040-201	Support bracket for SGRE flange D1012633	-	-	15,5 kg
2	16	10040-408	Plate for bolt interface	S690Q EN 10025-6	Plate 45mm	14,5 kg
3	4	10040-417	Bonded foam 230kg/m3	Bonded foam 230kg/m3	1710x150x50mm	10,3 kg
4	40	10040-413	Adapter washer Ø50/Ø105-15mm	S355J2 EN 10025-2	Plate 15mm	0,8 kg
5	40	10040-428	Adapter washer Ø38/Ø105-15mm	S355J2 EN 10025-2	Plate 15mm	0,9 kg
6	40	10040-429	Adapter washer Ø44/Ø105-15mm	S355J2 EN 10025-2	Plate 15mm	0,8 kg

6 Applicable standards

- OE-RP-01
- DNVGL-ST-N001

7 DNV GL Certificate – Design Approval



Advantis ApS
Att: ape@advantis.dk
Inge Lehmanns Gade 10
DK-8000 Aarhus C

DNV GL Denmark A/S
Region Cont. Europe, Eurasia,
Middle East, India and Africa
Rotating Equipment & Lifting
Appliances
Dokken 10
6700 Esbjerg
Denmark

Date:	Our reference:	Your reference:
2019-10-11	O-ED-RELA/TRAM/ 346.1-J-4532 <i>Mod.</i>	SFA-201901172 signed 26-04-2019

Job ID:
A0701209-1

VERIFICATION OF PRODUCTS, Id. No. 346.1 Uploaded Tech Docs for order A0701209

Reference is made to your letter dated 2019-09-09. The following documents are stamped 2019-10-10 and given the status as shown below:

Document No	Rev	DNV GL No	Title	Code	Status
10040-40	5	81508	Center plate for CTT		Examined
10040-40	3	81509	Bottom plate for CTT		For Inf.
10040-40	1	81510	Plate for stacking 3		For Inf.
10040-40	1	81511	Plate for stacking 1		For Inf.
10040-40	1	81512	Plate for stacking 2		For Inf.
10040-40	3	81513	Plate for bolt interface		For Inf.
10040-4	2	81514	Bracket for adjustable plate		For Inf.
10040-41	2	81515	Adapter washer Ø50/Ø105-15mm		For Inf.
10040-41	4	81516	Bonded foam 230kg/m3		For Inf.
10040-42	2	81517	Plate for Support Bracket		For Inf.
10040-42	2	81518	Plate for Support Bracket		For Inf.
10040-42	1	81519	Support bracket for tower section 1		For Inf.
10040-42	2	81520	Support bracket for tower section 2		For Inf.
10040-42	1	81521	Adapter washer Ø38/Ø105-15mm		For Inf.
10040-42	1	81522	Adapter washer Ø44/Ø105-15mm		For Inf.
10040-43	1	81523	Support bracket for tower section 3		For Inf.
10040-00	6	81524	Common tower tool, assembled		Examined
10040-20	5	81525	Common tower tool, welded		Examined
10040-2	3	81526	Support bracket for SGRE flange D101263		For Inf.

DNV GL Headquarters, Veritasveien 1, P.O.Box 300, 1322 Høvik, Norway. Tel: +47 67 57 99 00. www.dnvgl.com

DM00778b

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10040	.0	81527	User Manual for CTT	For Inf.
4597-DB-001	04	81528	Design Basis - Verification of CTT	Examined
4597-DB-001	05	81528	Design Basis - Verification of CTT	Examined
4597-REP-001	02	81529	Calculation Report Sea-Transport	Examined
PRS	00	81530	Common Equipment Towers PRS v2	For Inf.
4597-REP-002	02	82180	Calculation Report Other Load Cases	For Inf.

Document No. **10040-40/5**, "Center plate for CTT",
Document No. **10040-40/3**, "Bottom plate for CTT",
Document No. **10040-40/1**, "Plate for stacking 3",
Document No. **10040-40/1**, "Plate for stacking 1",
Document No. **10040-40/1**, "Plate for stacking 2",
Document No. **10040-40/3**, "Plate for bolt interface",
Document No. **10040-4/2**, "Bracket for adjustable plate",
Document No. **10040-41/2**, "Adapter washer Ø50/Ø105-15mm",
Document No. **10040-41/4**, "Bonded foam 230kg/m3",
Document No. **10040-42/2**, "Plate for Support Bracket",
Document No. **10040-42/2**, "Plate for Support Bracket",
Document No. **10040-42/1**, "Support bracket for tower section 1",
Document No. **10040-42/2**, "Support bracket for tower section 2",
Document No. **10040-42/1**, "Adapter washer Ø38/Ø105-15mm",
Document No. **10040-42/1**, "Adapter washer Ø44/Ø105-15mm",
Document No. **10040-43/1**, "Support bracket for tower section 3",
Document No. **10040-20/5**, "Common tower tool, welded",
Document No. **10040-2/3**, "Support bracket for SGRE flange D101263",
Document No. **10040/.0**, "User Manual for CTT",
Document No. **4597-REP-001/02**, "Calculation Report Sea-Transport",
Document No. **PRS/00**, "Common Equipment Towers PRS v2", and
Document No. **4597-REP-002/02**, "Calculation Report Other Load Cases" have all been reviewed in accordance with Client specification

Page 3 of 4

Document No. **10040-00/6**, "Common tower tool, assembled" has been reviewed in accordance with Client specification, with the following comment:

1054	Design limitations.	Important Note
Design limitations.		
Design Temperature:	-20°C – +50°C	
Design Lifespan	10 years	
Max tower weight:	200.000 kg	
Max weight one end:	135.000 kg	
Tower range:	Ø4,2m - Ø7m	
Stacking:	Not allowed	
Transport accelerations:		
Road:		
Transverse:	0,2g	
Forward:	0,8g	
Backward:	0,5g	
Vertical:	1,2g	
SPMT:		
Longitudinal:	0,4g	
Transverse:	0,4g	
Vertical:	1,2g	
Sea:		
Combined vertical:	0,777g	
Combined transverse:	0,547g	
Combined longitudinal:	0,292g	
Pitch:	0,844g	
roll:	0,027g	
Materials:		
Structure:	S355	
Washers:	S690Q	
Bolts:	grade 10.9	

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Document No. **4597-DB-001/04**, "Design Basis - Verification of CTT", and Document No. **4597-DB-001/05**, "Design Basis - Verification of CTT" have both been reviewed in accordance with Client specification, with the following comment:

987

Bolt loadings

Important Note


It is noted that a higher pretension is used in calculations ref. 4597-REP001 rev. 2. It is also noted that these higher pretensions have been approved by the customer.

This comment was released 2019-09-19

Approval Expert for this approval is Troels Amdi.

Sincerely

for DNV GL Denmark A/S


 Olav Mogens Thorsteinsson
 Principal Engineer, Head of Pipelines &
 Risers, Head of Rotating Equipment &
 Lifting appliances

Troels Amdi
 Contact Person

DM00778b

8 Risk assessment

Customer: SGRE & MVOW
Prepared by: PSE
Project: Common Tower Tool
Project number: 10040
Date & Revision: 21-10-2019 - Version 1.0

Risk Assessment - Common Tower Tool (CTT)

Risk Assessment Scale

Likelihood (L)

- 1 - Unlikely, not likely to occur
- 2 - Unlikely, but may occur
- 3 - Likely, could occur occasionally
- 4 - More likely, could occur often
- 5 - Frequently, could occur regularly

Severity (S)

- 1 - Minor injury, no absence
- 2 - Reversible injury with absence less than 14 days
- 3 - Absence more than 14 days due to reversible injury or disease
- 4 - Absence due to irreversible injury or disease
- 5 - Loss of life

L X S = R

Risk (R)

1-4 Low risk
5-6 Medium risk
7-25 High risk

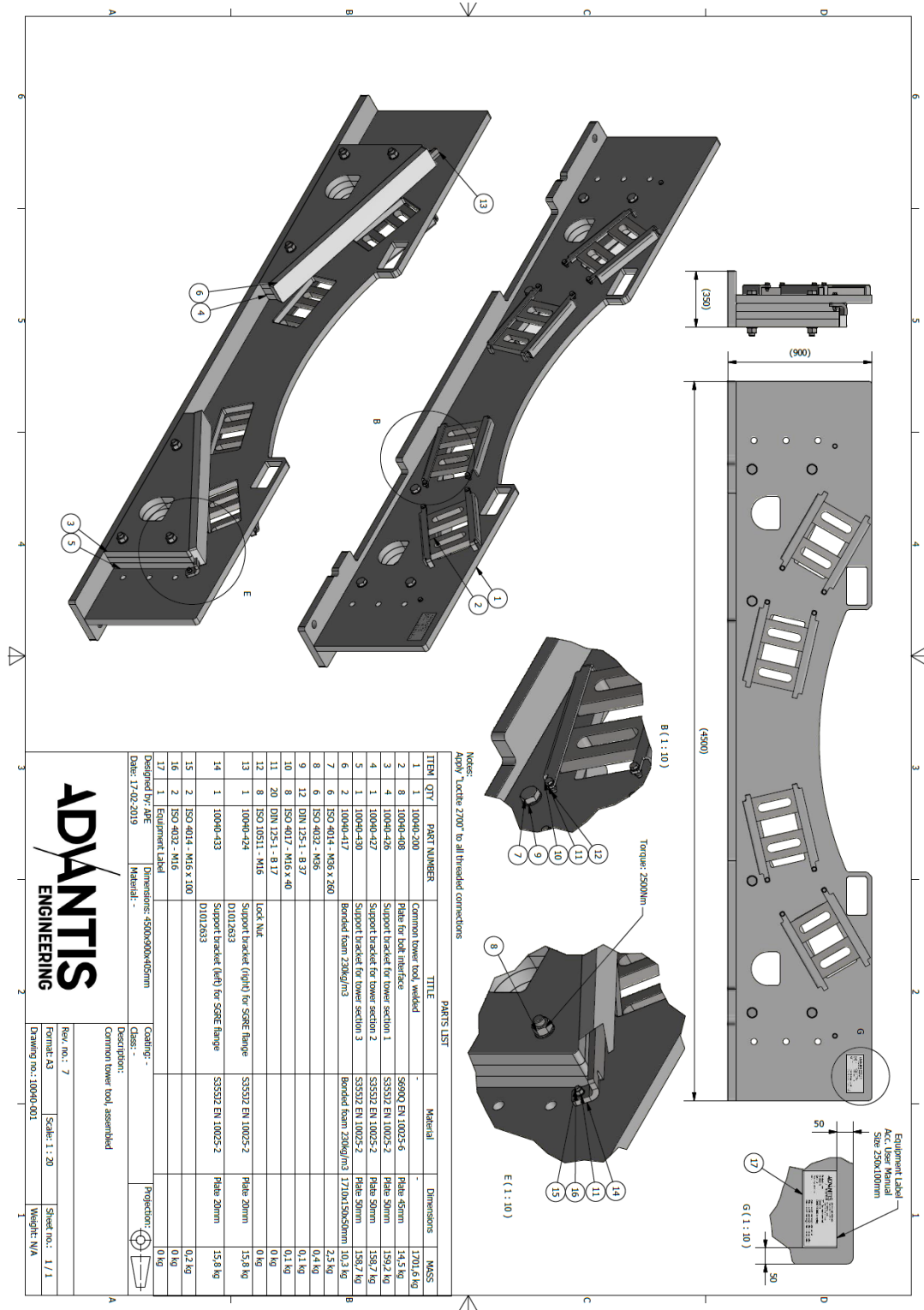
Action Required

No or minor risk
Attention needed
Correction needed

ID#	Conditions Under Assessment	Description of Hazard	L	S	R	Action Required	Action to Reduce Risk	Residual Hazard	L	S	R	Reference
1.1	Misuse of Equipment	Mounting CTT on not specified tower sections - collapse of structure - loss of life	2	5	10	Correction Needed	Specific tower sections that can be used with the CTT are marked on the sign on CTT (SMU) - Only instructed personnel of mount CTT	Handling of heavy components	1	5	5	CTT User Manual & Instructions
1.2	Mounting of CTT	Squeezing fingers & Suspended Loads	2	5	10	Correction Needed	Forklift pockets and installation process - the CTT can be mounted with forklift. Place tower in wood cradle and mount CTT on tower. The tower should be fully supported by CTT before instructed personnel of mount CTT	Squeezing fingers	2	2	4	CTT User Manual & Instructions
1.3	Mounting of CTT	Heavy bolt handling and tooling	3	2	6	Attention needed	Pre-tension of bolts on 1000kNm - can be handled with normal battery driven tools, e.g. B-RAD or similar tool with counter-hold on interface plates eliminating heavy hydraulic tools - Only instructed personnel of mount CTT		1	1	1	CTT User Manual & Instructions
1.4	Stability of CTT	CTT loose of stability - squeezing fingers and limbs	2	5	10	Correction Needed	Follow instructions and user manual for return transport - lifting setup for return transport	Squeezing fingers	2	2	4	10040-008 - Return transport of CTT
1.5	Stability of CTT & Towers	Sliding of tower section on deck - loss of life	1	5	5	Attention needed	Use appropriate lashing setup as described in instructions to secure the tower sections on vessel deck. Lashing provisions on equipment provided		1	3	3	10040-004 - Vessel transport with CTT
1.6	Dropped objects	Adjustable plates for bolted interface to tower - loose parts	2	5	10	Correction Needed	The adjustable plates should be safely secured in the CTT interface in the guide groove - follow user manual and lifting instruction for handling of CTT		1	5	5	10040-009 - Lifting instruction for CTT
1.7	Mounting of CTT	Mounting procedure for "re-torque" of bolts to allow tower to fully settle in crane	2	5	10	Correction Needed	Described in manual to only loosen bolts not remove nuts - to be done for each end separately - the tool is engaged in the opposite end securing the tower		1	5	5	CTT User Manual

9 Appendix

9.1 2D Drawings



9.2 Instructions

