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BEST PRACTICE GUIDE FOR SELF-PROPELLED MODULAR TRANSPORTERS

PREFACE

Established in 1976, the "Europaische Schwertransport Automobilkran" group (ESTA) was initially founded by a small group of Transport and Crane associations from Belgium, Germany, France, the Netherlands and Switzerland, in order to share their experiences and to discuss the problems that all parties faced when operating internationally across borders. Now, still with ESTA as acronym, the organisation is known as the 'European Association of Abnormal Road Transport and Mobile Cranes' and membership is open to all European countries.

One of the purposes of ESTA is to promote and represent the industry in which we work, with the aim of creating a safe and more efficient working environment. It was with this purpose in mind that ESTA in 2009 accepted the challenge to establish guidelines for the use of SPMTs. A number of ESTA members joined forces in a working group made up of stakeholders from within the industry of SPMT operations. Participating parties ranged from manufacturers, operators, government permit authorities to representatives from the 'clients' of these operators.

The process has taken time and it has been challenging throughout. ESTA is proud however to be able to now present to you this 'Best practice guide'. The document is offered for free distribution and use and it is the intention that this document will be adopted as a 'world standard'.

It should be noted that the document has been produced and should be read with the view that such a complex subject as the 'use of SPMT's' means it cannot be prescriptive, or offer engineering calculations due to the many complex possibilities for this unique transport method. The objective of this document is to correlate the chain of responsibility for all stakeholders involved with SPMT operations, to recommend best practice and to serve as a 'baseline starting point' for the use of SPMT's from where the more complex transport engineering jobs can then go forward.

Finally I would like to offer my sincere thanks to the members of the working group who had the patience and ability to put this document together; without them it would never have happened.

Yours sincerely

David Collett, ESTA Chairman

BEST PRACTICE GUIDE
FOR
SELF-PROPELLED MODULAR TRANSPORTERS

With special thanks to Max Tack, Wagenborg Nedlift B.V.

SUPPORTING THE BEST PRACTICE GUIDE

This *Best Practice Guide for the use of SPMT´s* is the result of the joined effort of different global stakeholders in the world of self-propelled modular transporters. The document has been composed under the guidance of the European association of abnormal road transport and mobile cranes (ESTA).

Stakeholder	Country	Type of player
Collett Group Ltd.	United Kingdom	Operating company
Fagioli S.p.a.	Italy	Operating company
Goldhofer AG	Germany	Manufacturer
Mammoet B.V.	The Netherlands	Operating company
RDW	The Netherlands	The Netherlands Vehicle Authority
Sarens N.V.	Belgium	Operating company
Scheuerle/Tii Group GmbH	Germany	Manufacturer
Shell Projects & Technology	The Netherlands	Industrial client
The Works International	Aruba	Heavy Transport Consultancy
Wagenborg Nedlift B.V.	The Netherlands	Operating company

Table 1: Overview of players supporting the BPG

The following stakeholders support this Best Practice Guide and will work according to the guidelines that are outlined in this document.

The list above is subject to change. An up-to-date overview can be found online on the website of the ESTA (www.estaeurope.eu).

If you or your company would like to support this Best Practice Guide too and if you intend to work according to the guidelines as outlined in this document, please contact the ESTA via info@estaeurope.eu. You or your company/organisation will then be included in the online overview and will be added to the list in this document as soon as a new issue is released.

LEGAL NOTE

This publication is only for guidance and gives an overview regarding to the assessment of risks related to the use of Self-Propelled Modular Transporters. It neither claims to cover every aspect of the matter, nor does it reflect all legal aspects in detail. It is not meant to, and cannot, replace own knowledge of the pertaining directives, laws and regulations. Furthermore the specific characteristics of the individual products and the various possible applications have to be taken into account. This is why, apart from the assessments and procedures addressed in this Best Practice Guide, many other scenarios may apply.

CONTENTS

TERMINOLOGY

Term/abbreviation	Definition/Explanation
BPG	Best Practice Guide
Client	Any company or person who has a certain load and requests an operating company to transport this load from any point A to any point B
COG	Centre of Gravity
ESTA	European association of abnormal road transport and mobile cranes
Load	Any object that is transported on an SPMT, including, if applicable, load-spreading equipment and packaging of the load.
Longitudinal	As in *the stability of the transporter in the longitudinal direction*; the stability in the forward and backward direction of the transporter, at a steering angle of 0 degrees (see Appendix 1 for clarification).
Manufacturing company	Any company or person that manufactures SPMTs
Operating company	Any company or person who has access to an SPMT and executes a transport with it
Route	The environment through which a transport will travel from any point A to any point B
SPMT	Self-propelled modular transporter
Transverse	As in *the stability of the transporter in the transverse direction*; the stability in the sideways direction of the transporter, at a steering angle of 0 degrees (see Appendix 1 for clarification).

1. THE RESPONSIBILITY TRIANGLE

As will become clear throughout this guide there are various factors that affect the safety and stability of any transport that is executed with an SPMT. These range from the competence of the operator to the design of the load and from weather conditions on the actual day of the transport to calculations made months in advance. Throughout all these different aspects however, clear communication and clear definitions of responsibility can be seen as the common thread.

Clear definitions of responsibility prevent that certain aspects of the process to increase the safety and stability of a transport are ignored. Clear communication ensures that everybody knows what they need to know.

There are three main stakeholders who play an important role when it comes to the safe execution of a transport. Each of these stakeholders has their own role and responsibilities. What this role is, and what these responsibilities are, will become clear throughout this guide, but the three main stakeholders distinguished in this this guide are introduced here in the responsibility triangle as depicted in Figure 1.

1.1 THE DIFFERENT PLAYERS IN THE TRIANGLE

One of the first steps in assuring that it is possible to safely execute any transport, is making sure that the right equipment is available and that it is clear how the equipment can and should be used. Any company or person that manufactures SPMTs is referred to in this document as the ***manufacturer***.

The second stakeholder mentioned is the ***operating company***. Once the manufacturer has delivered a well-functioning and fit-for-purpose self-propelled modular transporter, it becomes the operating company's responsibility to make sure that they use the SPMT in the correct way and that all necessary steps are taken to assure that the transport can and will indeed be executed safely. Any company or person who has access to an SPMT and executes a transport with it is referred to in this document as the operating company. Please be aware that there is a difference between 'the operator' (being the person who actually executes the transport) and 'the operating company' (basically being the company that employs the operator).

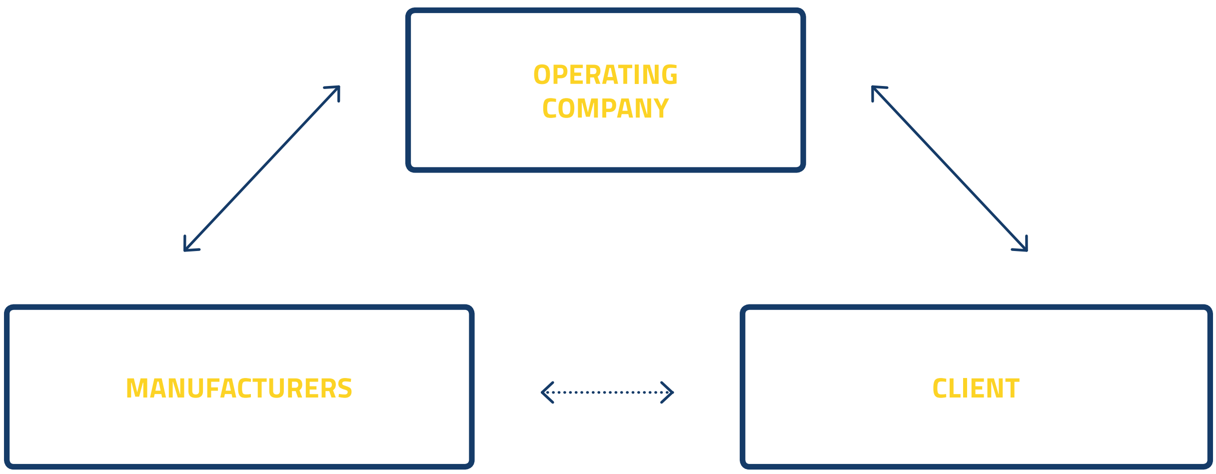


Figure 1: Responsibility triangle

Although the manufacturer and the operating company will do all they can to ensure that a transport is executed safely, it is ***the client*** who has to give them the opportunity to do so. Only if the client provides the right information and gives an operating company the opportunity to do its work professionally can the safety of a transport be guaranteed. Any company or person who has a particular load and requests an operating company to transport this load from any point A to any point B, is referred to in this document as ´the client´.

In addition to the three stakeholders mentioned above, many other stakeholders can be listed that have a role in the safe execution of a transport with an SPMT, e.g. road authorities, industry associations and engineering companies, to name but a few. However, the three stakeholders mentioned in the responsibility triangle all have a direct stake in ensuring that any executed transport is safe and that a load is transported without problems. The direct (safe) execution of a transport revolves around these three stakeholders, which is the reason why this document focusses on the roles these stakeholders play and the responsibilities they have.

1.2 THE LINES OF COMMUNICATION

The responsibility triangle not only reflects who the main stakeholders are in the safe execution of a transport, but also indicates the lines of responsibility and communication. The two main relationships that can be identified are:

- The mutual responsibility and communication relationship between the manufacturers and the operating companies. The manufacturers have certain responsibilities towards the operating companies and the operating companies have certain responsibilities towards the manufacturers.

- The mutual responsibility and communication relationship between the operating companies and their clients. The operating companies have certain responsibilities towards the clients and the clients have certain responsibilities towards the operating companies.

The third relationship that can be identified in the triangle is the responsibility and communication relationship between the client and the manufacturers. Although this relationship is present to a lesser extent than the aforementioned relationships, and this kind of responsibility and communication will primarily go through or via the operating company, the manufacturers and clients can support each other directly in order to improve the safety standards in the industry.

2. THE EQUIPMENT

It all starts with the right equipment...

In the design phase of a self-propelled modular transporter the manufacturer must already take into account that ultimately it must be possible to safely execute a transport with that transporter. Among other things the capacity, the maintenance instructions and the documentation that is delivered with the equipment have to meet certain minimum standards. All this is the responsibility of the manufacturer.

2.1 REGIONAL GUIDELINES AND REGULATIONS

This Best Practice Guide does not replace regional guidelines or regulations. Neither can all the regionally applicable guidelines or regulations be listed in this document. It is the manufacturer's responsibility to always make sure that the equipment meets the regional guidelines and regulations of the original region in which the SPMT is intended to be used or will be delivered. Any operating company that uses its SPMTs in a region other than where the SPMT was originally delivered or intended to be used, has the direct responsibility to check whether locally applicable guidelines and regulations require them to take extra measures to ensure that the equipment meets these regional guidelines and regulations.

2.2 DESIGN OF THE EQUIPMENT

It is the manufacturer's responsibility to at least make sure that:

- Emergency brake controls work independently and are designed to the principle of 'fail safe'. Furthermore the emergency brake must be designed to stop movement of the transporter as quickly as possible, without creating additional hazards. The emergency brake control will have to be clearly identifiable, visible and quickly accessible. Once the emergency brake control has been applied, it must not be possible to start operating the SPMT again until the activation of the emergency brake control has been reset.

- Any SPMT will be equipped with appropriate lashing and securing points to serve the intended purpose/ use of the transporter. Where they are present, such lashing points should be clearly marked as being solely intended for lashing purposes and placed in such a way that they cannot be mistaken for lifting points. The maximum allowable force on each available lashing or securing point must be indicated in the operating manual. All available lashing and securing points have to be reachable without the risk of entanglement or entrapment.

- In addition to lashing and securing points to enable lashing and securing the load on the transporter, all SPMTs must be equipped with sufficient lifting points, intended for safe and easy lifting of the transporter for (de)mobilisation purposes. The maximum allowable force on each lifting point has to be clearly stated at, or in close proximity to, these points.

- The SPMT is designed in such a way that there is at least one back-up control device that allows the operator to secure the transporter/place the transporter in a safe position in the event that controls (such as the hand-held control)should fail to function properly.

- The controls of each SPMT will be such that they are intuitively correct from the intended controlling position.

2.3 CAPACITY OF THE EQUIPMENT

It is the manufacturer´s responsibility to provide clear and unambiguous information on the maximum allowed static payload on the SPMT. The maximum allowed payload capacity is determined taking into account at least:

- maximum bending moment of spine beam and couplings,
- maximum allowable load on the tyres,
- maximum allowable load on the axles.

All related calculations are to be made in line with applicable European industrial standards (or regional equivalents).

2.4 MAINTENANCE OF THE EQUIPMENT

It is the manufacturer's responsibility to provide clear and unambiguous information on the minimum requirements with respect to maintenance of the equipment. It is the operating company's responsibility to ensure that at least the minimum maintenance requirements are complied with.

2.5 DOCUMENTATION AND INFORMATION TO BE PROVIDED WITH THE EQUIPMENT

It is the manufacturer's responsibility to provide at least the following documentation with the equipment:

- A clear, written operating manual in the native language of the country where the operating company, to whom the transporter will originally be delivered, is based.

- A clear, written maintenance manual in the native language of the country where the operating company, to whom the transporter will originally be delivered, is based.

- All certificates and documentation required on the basis of applicable guidelines and regulations (see also 2.1) in the region where the transport has originally been delivered.

- Documentation and information in English, in addition to the versions in the native language, is optional but recommended.

3. THE LOAD

Nothing is impossible...

Risks associated with the transport of abnormal loads can be reduced when in the design phase of a load it is taken into account that the load needs to be transportable. In order to enable an operating company to safely transport each load, sufficient and adequate information about this load has to be provided. This is the responsibility of the client.

3.1 DESIGN OF THE LOAD

With respect to the fact that it might be necessary to transport any object at a certain moment in time the client, either directly or indirectly through the designer of the load, has to make sure that:

- Any load will, for as far as is necessary and reasonably possible, be designed with sufficient support points to ensure the load can be transported safely. The maximum allowable force on each support point has to be indicated at, or in close proximity to, these points. All support points should be reachable without the risk of entanglement or entrapment.

- Any load will, for as far as is necessary and reasonably possible, be designed with sufficient lashing and securing points to ensure the load can be transported safely. The maximum allowable force on each lashing or securing point has to be indicated at, or in close proximity to, these points. All lashing and securing points should be reachable without the risk of entanglement or entrapment.

3.2 DOCUMENTATION AND INFORMATION ABOUT THE LOAD

The client has to provide at least the following information about the load to the operating company:

- Gross weight of the load.
- Location of the centre of gravity.
- Dimensions of the load (including packaging if applicable).
- Allowable point loading forces.
- Location of support points.
- Location of lashing and securing points.

4. TRAINING

Currently there is no widely applicable training program available in the world of self-propelled modular transporters. Setting up such a program is outside the scope of this Best Practice Guide. Instead this guide offers operating companies a training framework, providing them with a method to assess the competence of their employees in an objective way.

4.1 SKILL, EXPERIENCE AND COMPETENCE

The training framework is based on the concept of competence. Competence can be considered to be a combination of skills and experience; skills are what one learns through studying or any other active pursuit of knowledge. Experience cannot be learned, but has to be gained through time by applying one's skills in practice. The more skills and experience any person has with respect to any kind of job, the more competent he or she can be considered to be. Figure 2 shows how experience and skill combine into competence.

In practice nobody develops competence in a linear line as sketched in the figure above. Instead this process is likely to be incremental; it all starts with acquiring some skills, such as basic education. Once these skills have been learned, they can be applied to gain the first experience. Over time this results in a certain competence level (e.g. level 1). After a while the skill set one has learned in the initial stage is no longer sufficient to further develop one's competence by gaining more experience. So more skills will have to be learned, which can then be applied in order to reach the next competence level. Increasing one's competence is a continuous process of combining skills and experience, as shown in the figure below.

4.2 TRAINING FRAMEWORK FOR OPERATORS

It is the primary responsibility of the operating company to ensure their operators are adequately trained to perform their duties. The framework described below offers operating companies a method to assess whether the operator is competent to perform specific jobs.

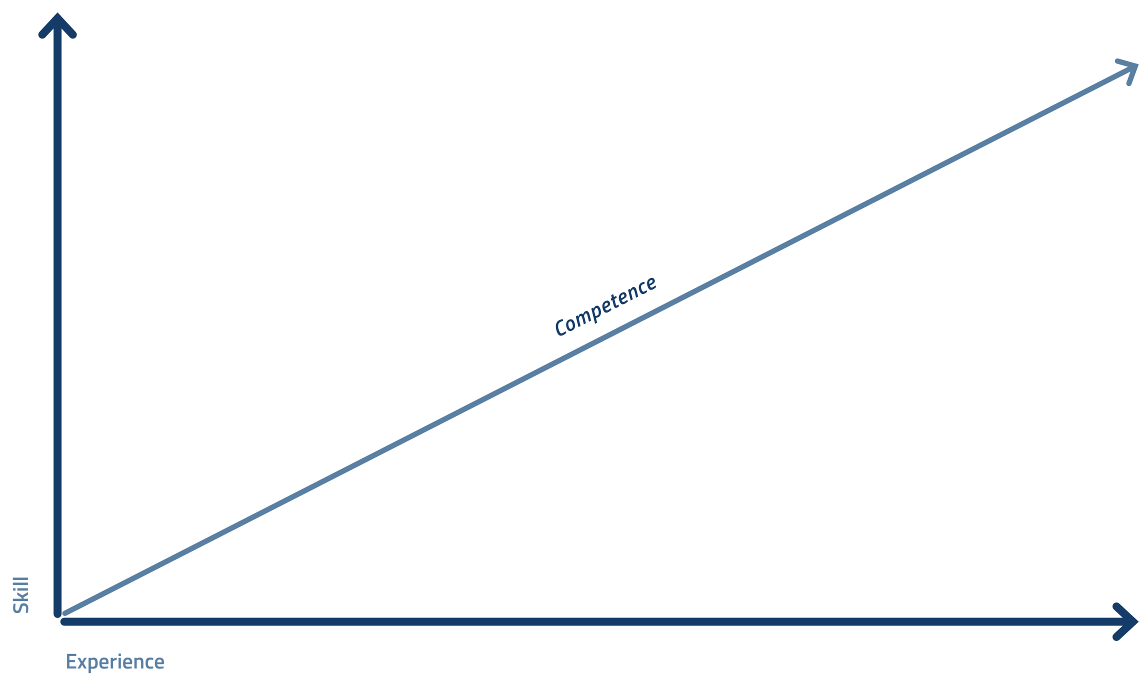


Figure 2: Competence as a function of experience and skill

4.2.1 Basic training

Each manufacturer should at least offer basic training in which operators are instructed how to work with an SPMT. Training should at least cover:

- Basic working method of an SPMT (can be provided by the manufacturer).
- Basic instruction on assembling and disassembling a SPMT.
- Basic instruction on setting different suspension set-ups and implications of these set-ups.
- Basic instruction on controlling an SPMT, including interpretation of gauges.
- Basic instructions on the (physical) working limits of an SPMT.
- Basic safety instructions in relation to working with an SPMT.

4.2.2 Operating company's responsibilities

Operating companies working in line with this BPG should at least ensure that:

- Each operator has followed (an equivalent of) the basic SPMT operating training which is provided by the manufacturers.
- They adopt the 5-step competence assessment methodology for SPMT operators as described below.

4.2.3 5-step competence assessment for SPMT operators

Once an operator has followed the manufacturer's training, competence can be developed through gaining experience and learning additional skills. These additional skills are learned in practice by working under the supervision of more experienced colleagues. The following 5 steps define the competence of SPMT operators. The entry criteria for each new level are described on the competence form for operators in Appendix 4.

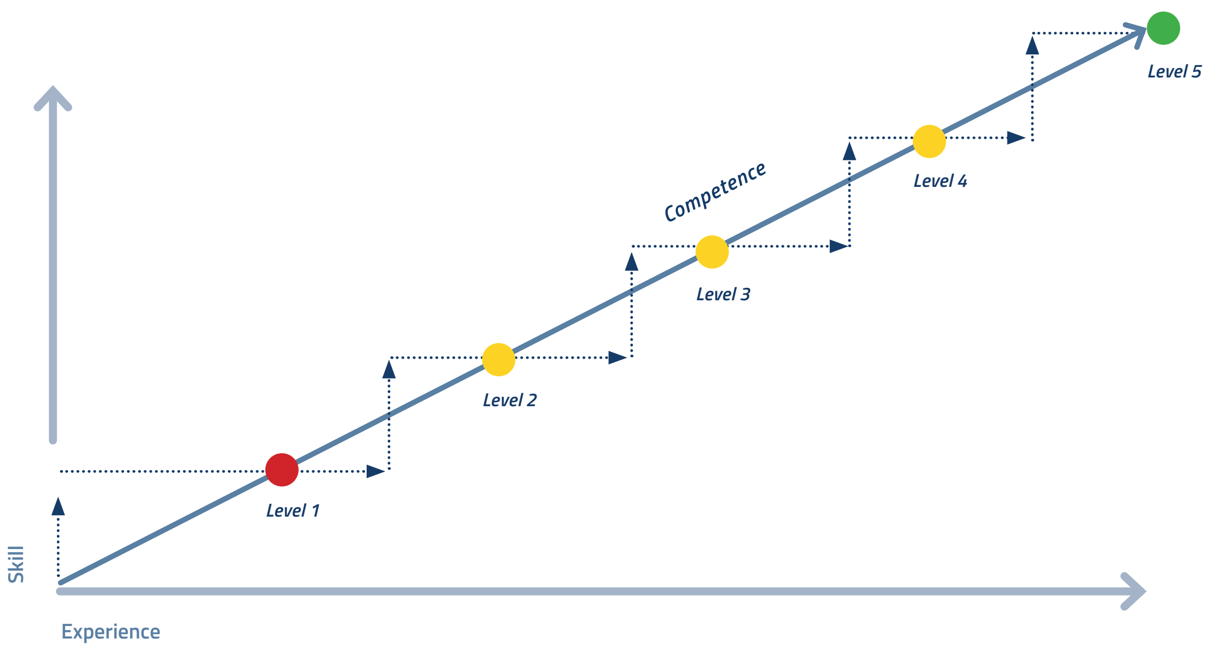


Figure 3: Incremental development

Level 1: Inexperienced SPMT operator.
Received the manufacturer's training. Will be trained on standard jobs under the supervision of level 4 or level 5 SPMT operators. Not allowed to work independently at any time.

Level 2: Moderately experienced SPMT operator.
Capable of working on standard jobs under the supervision of level 4 or level 5 operators.

Level 3: Experienced SPMT operator.
Capable of working on standard jobs without supervision, capable to work on complex jobs under supervision of level 4 operators.

Level 4: Highly experienced SPMT operator.
Able to take the lead in standard jobs and to work on complex jobs without supervision. Capable of supervising less experienced colleagues.

Level 5: Supervisor.
Able to take the lead in complex jobs and to supervise less experienced colleagues. Authorised to instruct less experienced colleagues in order to increase their competence level, authorised to sign-off the competence form of less experienced colleagues.

4.3 TRAINING FRAMEWORK FOR ENGINEERS

It is the primary responsibility of the operating company to ensure their engineers are adequately trained to perform their duties. The framework described below offers operating companies a method to assess whether the engineer is competent to perform specific jobs.

4.3.1 Basic education

Each engineer should have an internationally accredited engineering education or at least a comparable working level, covering the relevant areas with respect to engineering SPMT jobs. This BPG cannot cover all internationally available types of education that provide relevant knowledge and understanding of the engineering of SPMT transports.

4.3.2 3-step competence assessment for SPMT transport job engineers

Once an engineer has a relevant basic education, competence can be developed by gaining experience and learning additional skills. These additional skills are learned in practice by working under the supervision of more experienced colleagues. The following 3 steps define the competence of engineers. The entry criteria for each new level are described on the competence form for engineers in Appendix 5.

Level 1: Inexperienced SPMT engineer.
Capable of engineering standard jobs. All engineering to be checked by a level 2 or level 3 engineer.

Level 2: Experienced SPMT engineer.
Capable of engineering standard and complex jobs, including taking into account different dynamic forces. Qualified to check standard engineering jobs of level 1 engineers. Engineering of complex jobs to be checked by a level 3 engineer.

Level 3: Engineering supervisor.
Capable of engineering any transport job and qualified to check the work of level 2 and level 3 engineers.

5. ENGINEERING A TRANSPORT

No two transports will ever be the same...

This is why the degree to which engineering is required beforehand will always be different. This chapter deals with the basic guidelines for engineering. This Best Practice Guide is not an instruction or training manual on how calculations should be done; other literature and special training courses exist for that purpose.

5.1 A NEED OF ENGINEERING

In the engineering context parallels are often drawn between the world of SPMTs and the crane world, but it should be realised that the current generation SPMTs are equipped with an operating system, contrary to cranes, which are equipped with a fully integrated control system. Consequently a minimum amount of engineering will always be required to ensure that a transport with an SPMT can be safely executed. The detail of engineering required largely depends on the characteristics of the transport. This Best Practice Guide distinguishes between first and second degree engineering.

5.2 THE BASICS

An SPMT can be set up in different suspension modes. The following can be stated about the various suspension set-ups:

- The suspension set-ups generally used are the 3-point suspension set-up (statically determined) or the 4-point suspension set-up (statically undetermined).

- Any other suspension set-ups (1-, 2-, 5- or more point) are only to be used in special circumstances when detailed engineering has shown that these types of set-ups are required for a specific transport task. Please note that when these types of set-ups are used, only experienced SPMT engineers (level 2 or higher) and operators (level 3 or higher) are allowed to work on the job.

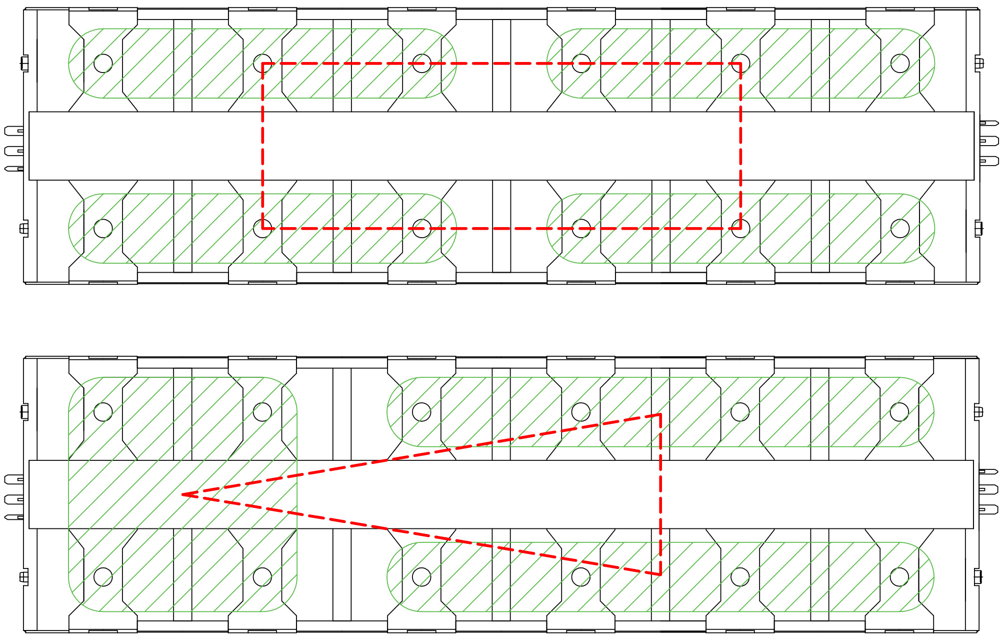


Figure 4: Top view SPMT with three and four point suspension set-up

5.2.1 The stability plane in a 3- or 4-point suspension set-up

A 3-point suspension set-up will give a triangular stability area, while a 4-point suspension set-up will give a rectangular stability area. The advantage of a 3-point suspension set-up is that this set-up is statically determined, but the stability area will be smaller than the stability area of the statically undetermined 4-point suspension set-up. It will always depend on the specific circumstances under which a transport will take place whether it is best to use a 3- or a 4-point suspension set-up.

5.2.2 Assumed stability plane level and stroke height

- As shown in Figure 4, the size and position of the horizontal plane of the stability area is determined by the chosen transporter configuration. The actual vertical location of the stability area (height, elevation) is at the height of the turning point, being the centre of the pendulum axles. By basing all calculations concerning stability on elevation that is lower than the actual elevation of the stability plane, a safety margin is introduced. The ESTA therefore advises to always calculate with an assumed vertical position of the stability plane at ground level, as shown in the figure below.

With respect to the stroke height, the following aspects need to be taken into account;

- In the planning phase a maximum of 70% of the total stroke should be used, leaving 30% for contingencies.
- All calculations should be based on the assumption that the operational stroke is set at mid stroke.

5.3 INPUT FOR ENGINEERING

Different details are required for the engineering of a transport. The minimum information that is always required is described in this section.

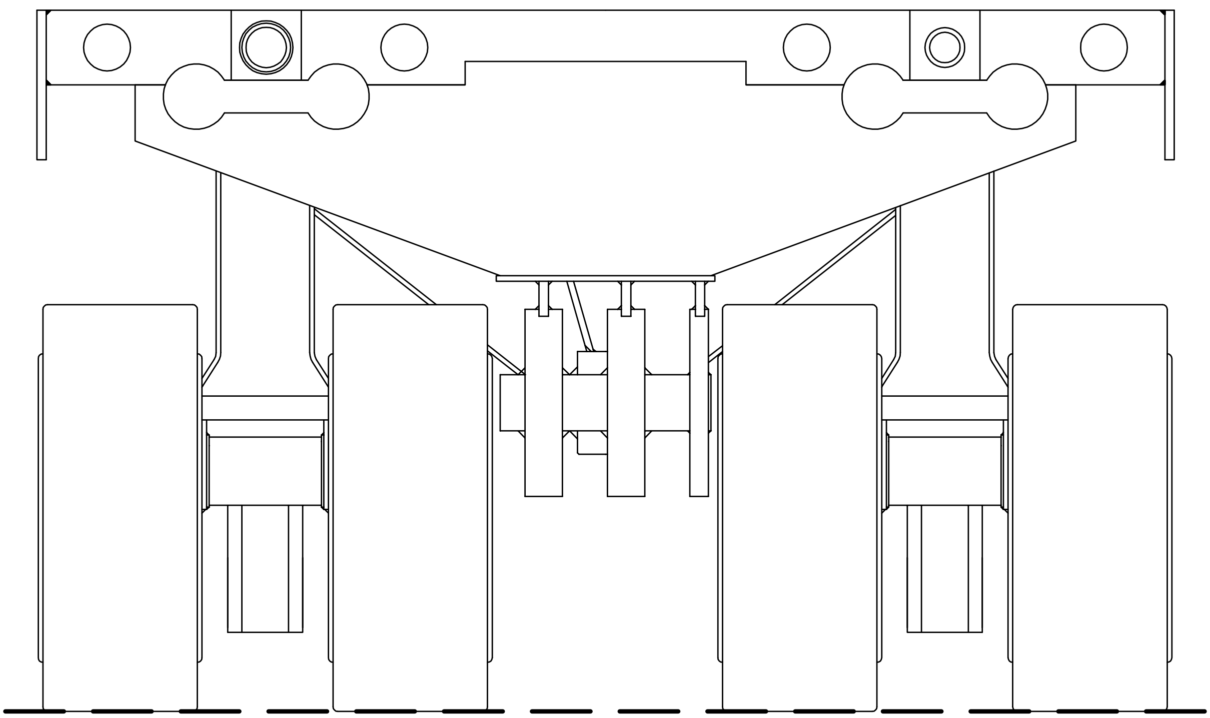


Figure 5: Assumed height of stability area for transporter with pendulum axle (dotted line)

5.3.1 Dimensions, gross weight and COG

As explained in section 3.2 it is the client's responsibility to always correctly inform the operating company of:

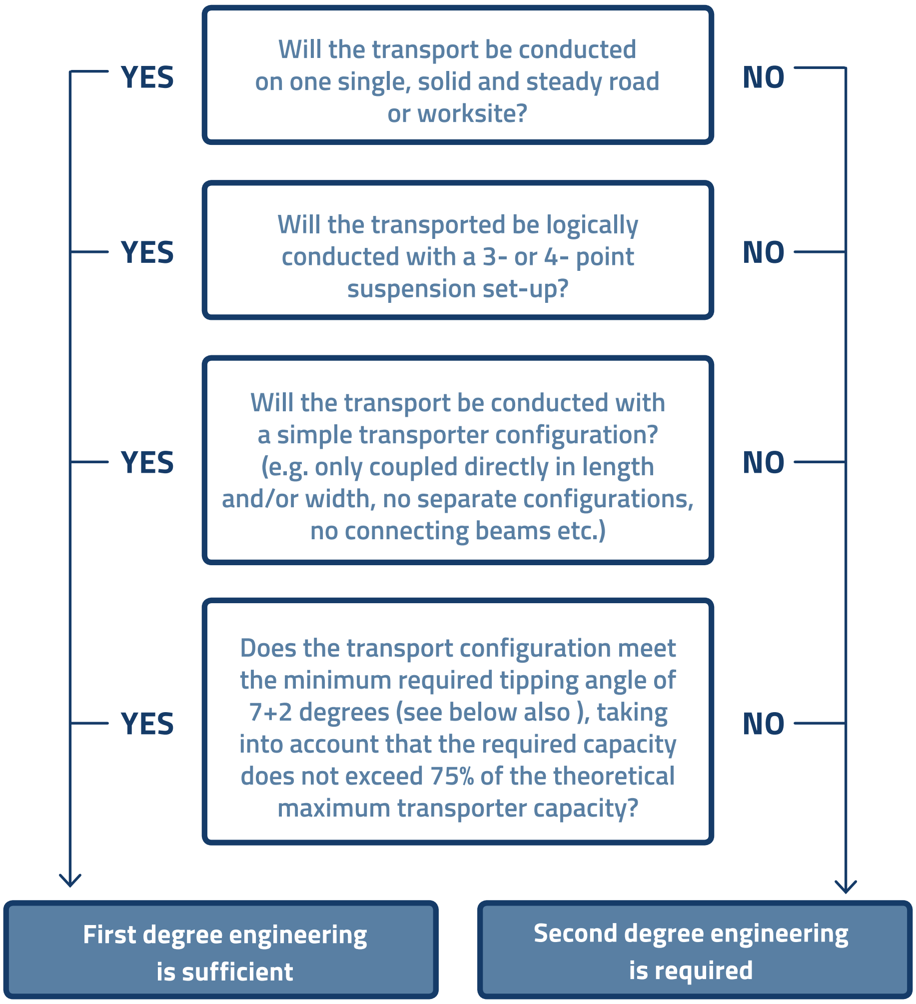
- Gross weight of the load.
- Location of the centre of gravity.
- Dimensions of the load (including packaging if applicable).
- Allowable point loading forces.
- Location of support points.
- Location of lashing and securing points.

Without this information it is not possible to perform any accurate engineering. If this information is not known, it is the client's responsibility to determine the correct information.

5.3.2 Work environment/route

Clear and accurate information concerning the work environment and the route over which the transport will travel is required for the engineering process. More information can be found in section 6.1.1. From the perspective of engineering the most important factors are:

- Inclines and/or declines in the route.
- Road camber.
- Allowable ground bearing pressures.



5.4 ENGINEERING

This section describes how to determine whether first or second degree engineering is required, followed by the basic guidelines that need to be taken into account at the respective levels of engineering.

5.4.1 Required degree of engineering

The required degree of engineering can be determined on the basis of the following flow chart. It will be clear that for any complex operation second degree engineering will be required.

5.4.2 First degree engineering and restrictions

In case of first degree engineering, the following **minimum calculations** should be performed:

- Verification that the intended transporter configuration has sufficient capacity for the intended transport.
- Verification that the intended transporter configuration provides sufficient stability by means of static stability calculations.

If first degree engineering is applied, the following **restrictions** need to be taken into account:

- The maximum transporter capacity for calculation purposes should be set at 75% of the theoretical maximum capacity as indicated by the manufacturer.
- All road cambers or inclinations along the transport route should be increased by 2 degrees, so a minimum of 2 degrees camber and/or inclination must always be taken into account.
- The minimum tipping angle that is acceptable with first degree engineering is 7 + 2 = 9 degrees, where the additional 2 degrees is to be taken into account as a safety margin.
- Lashing and securing requirements must be thought through.

5.4.3 Second degree engineering and restrictions

In case of second degree engineering, the following **additional calculations** compared to first degree engineering must be performed:

- Dynamic forces such as wind, inertia and slopes must be taken into consideration.
- Deflection and/or deformation of the transporter configuration must be taken into consideration.
- Effects and requirements with regard to lashing and securing must be thought through.

If second degree engineering is applied, the following **restrictions** must be taken into account:

- The maximum transporter capacity for calculation purposes should be set at 90% of the theoretical maximum capacity as indicated by the manufacturer.
- All road cambers or inclinations along the transport route should be increased by 2 degrees, so a minimum of 2 degrees camber and/or inclination must always be taken into account.
- The minimum tipping angle that is acceptable with second degree engineering is 5 + 2 = 7 degrees, where the additional 2 degrees is to be taken into account as a safety margin. After careful consideration, the aforementioned minimum tipping angle may be deviated from if with engineering and work preparation documentation it can be proven that a lower tipping angle can be deemed acceptable for a specific transport.

5.5 CENTRE OF GRAVITY

For the purpose of this best practice guide the centres of gravity of the transporter and the load are not considered to be combined. The centres of gravity can be combined if required, provided that adequate measures are taken, showing that the combination of centres of gravity does not introduce additional risk.

6. PREPARATION OF A TRANSPORT

Not engineering only…

But in addition to engineering, or even as part of engineering, other preparations have to be taken care of before a transport can take place in a safe way. These preparations will be further explained in this section.

6.1 WORK ENVIRONMENT

Certain preparations have to be completed with respect to the work environment before a transport can be executed.

6.1.1 Route survey

For every transport a route survey has to be conducted and appropriately documented. This can range from a site inspection assessing the route conditions for a transport that will only travel a short distance, to a complete route survey covering public roads for several kilometres.

- It is the primary responsibility of the operating company to ensure that a route survey is carried out.
- With respect to the part(s) of the route that travel on the client's site, it is the primary responsibility of the client to provide adequate route survey information to the operating company.

During the route survey the following aspects have to be checked at the very least:

- If a route survey shows that certain fixed objects might be on a critical path of the transporter or the load, it is advised to execute a test transport with a test-load or to perform a swept-path analysis in a drawing in order to ensure the final transport can be safely executed.
- It has to be assessed whether any objects or obstacles will be in the way of the transporter or the load. For example, on public roads one has to consider that street furniture, curbs, trees, or power lines may be in the way of the transporter and/or the load. In an industrial environment one has to consider the presence of objects like pipelines, machinery or air ducts that may be in the way of the transporter and/or the load.
- It has to be assessed whether there are any inclines or declines on the route. If there are, then the angles of these inclines and/or declines need to be measured accurately.
- Depending on the ground surface on which the transport will be conducted, not only the longitudinal inclines or declines have to be assessed, but the road camber (transverse inclines or declines of a road) has to be measured as well.
- It has to be assessed what the (maximum) ground-bearing pressures and permissible axle load of the surfaces over which the transport will travel are. When the transport is going to take place on a client's site or in an industrial environment, it is the client's responsibility to make sure this information is available.
- With respect to ground bearing pressures, extra care has to be taken when the transport is going to travel over bridges (or bridge-like constructions). Also the possible presence of pipelines and culverts under the ground/road surface that can locally reduce the ground bearing pressure has to be taken into account.
- Where applicable, extreme environmental conditions and temperatures need to be assessed and taken into account.

6.1.2 Preparation of the work environment

In certain situations the work environment has to be prepared before a transport can take place. The exact preparations that are required will in general be concluded from the route survey and the engineering process. Depending on contractual agreements, it will be the responsibility of the client or the operating company to ensure that the preparations that are required are carried out.

Possible preparations are;

- Removal of street furniture and/or other objects that will or may be in the way of the transporter and the load.
- Levelling of ground surfaces on/over which the transport will travel.
- Reinforcement of structures and/or parts of the surfaces over which the transporter will travel.
- Before the transport takes place, all activities that take place in the environment through which the transport will travel, or are in close proximity to the transport, must be stopped in order to prevent potential situations that might require the transport to make an emergency stop or could lead to dangerous situations.
- The environment through which the transport will travel, or areas in close proximity to the transport, should be cleared of all persons that are not directly involved with the transport.

6.2 DOCUMENTS AND PROCEDURES

Certain documents and procedures have to be prepared/put in place before a transport may be executed.

6.2.1 Risk assessment

- If deemed necessary a risk assessment may be carried out before a transport. Such risk assessment should at least assess which risks there are in direct relation to:

- All persons directly involved with the transport.
- All persons that will or may be present in close proximity to the transport.
- The load, the transporter and all objects/items that are in close proximity to the transport.
- The (work) environment through which the transport will travel/in which the transport will take place.

No transport is without risk. Risks deemed unacceptable are to be mitigated by appropriate precautions until they are deemed acceptable by all parties involved.

6.2.2 Method statement

If deemed necessary a method statement may be created for a transport. Such method statement could include, but is not necessarily limited to:

- How the transporter(s) will be (de)mobilised.
- Which route the transport will travel.
- How the load will be loaded on/unloaded from the transporter.
- Which transporter configuration and suspension set-up will be used.
- Who will be responsible for the transport and how the different tasks related to the transport will be divided.
- Which Health, Safety and Environmental procedures will apply.
- Any situation-specific measures required for the transport to be executed safely.

6.2.3 Toolbox talk

Before the actual transport takes place, a toolbox talk will be held with all persons that are directly involved with the transport. The toolbox talk will also have to be documented appropriately. A toolbox talk could include, but is not necessarily limited to discussing:

- Which route the transport will travel.
- How the load will be loaded on/unloaded from the transporter.
- Which transporter configuration and suspension set-up will be used.
- Who will be responsible for the transport and how the different tasks related to the transport will be divided.
- Which Health, Safety and Environmental procedures will apply.
- Any situation-specific measures required for the transport to be executed safely.
- All general and situation-specific risks of the transport.
- Any questions?

6.2.4 Contingency plan

If deemed necessary a contingency plan may be created for a transport. The contingency plan provides fall-back scenarios in case of unforeseen events.

6.2.5 Communication plan

If deemed necessary a communication plan may be created for a transport. A communication plan describes the responsibilities of the various persons involved, in combination with the lines of communication agreed upon.

6.2.6 Permits

Depending on where the transport will take place and through which area the transport will travel, various permits may be required. Describing the various permits that may be required is outside the scope of the Best Practice Guide.

7. THE TRANSPORT

Taking care of the preparations and engineering don't get the load from A to B…

But the actual transport does, meaning that no matter how good the preparations and engineering have been, it all comes together when the transport actually takes place.

7.1 THE OPERATORS

In the end it is the operating team who actually execute the transport. This means the safety of any transport is directly in the hands of this team. The following guidelines enable the team to safely execute a transport.

7.1.1 General

In general one can distinguish between the roles of supervisor, operator and banksmen within the operating team. The exact number of people involved depends on the type of transport: one person can have multiple roles (for example the supervisor may be the operator), while at the same time more than one person may be present in a certain role (for example multiple banksmen).

7.1.2 Communication

- For communication between operators preferably 2-way radios should be used.
- Where 2-way radios are not allowed, it is advised to use a whistle to draw attention and to communicate through pre-defined hand signals.
- Before the execution of a transport, clear agreements should be made between supervisor, operator and banksmen concerning the terminology that will be used during the transport.
  - Different hydraulic suspension groups should be named logically and in such a way that during the transport they can be referred to without the risk of confusion.
  - The different directions in which the transporter can drive should be referred to with unambiguous and fixed terminology.

7.1.3 Personal protective equipment

All personal protective equipment that has to be worn in the specific work environment/location at which the transport takes place has to be worn, but all operators and any other persons that will be in the direct vicinity of the transport need to wear at least:

- Hard hat
- Safety shoes
- High-visibility jacket (where necessary on site)
- Gloves (where necessary on site); the operator who is in control of the hand-held control of the transport should not be hindered by gloves.
- Safety glasses (where appropriate)

7.1.4 Training

Nobody should be allowed to transport a load without being adequately trained. For more information on training schemes see section 4.

7.2 FINAL CHECKS

Before actually executing the transport, various final checks have to be made. To guide the operating company with these final checks, check-lists are provided in the appendices of this Best Practice Guide. General descriptions of the final checks will be given below.

7.2.1 Information

Before a transport is executed, it must be checked whether all the persons involved are fully aware of all the information required. See also section 6.2.3 on toolbox talks.

7.2.2 Pre-use checklist

Before a transport is executed, it is the operating company's responsibility to ensure that all aspects as mentioned on the pre-use checklists are covered. An example of a pre-use checklist is given in the appendices. The pre-use checklists cover:

- Equipment.
- Operations.
- Work area.

7.2.3 Weather conditions

- It is recommended that prior to each transport careful consideration is given to weather forecasts.

- Both before and during the transport the maximum allowable wind speeds, as specified either by the client or during the engineering process, need to be observed. If these wind speeds are exceeded the transport should not be executed. If the transport has already started, the safest way to proceed must be carefully considered.

- When weather conditions such as rain, fog or snow can be expected to restrict the visibility of the operators the transport should not be executed. It is the operating company's responsibility to ensure that a transport is not executed if weather conditions could jeopardize the safety of the transport.

- No transport should be executed in weather conditions that could lead to a slippery road, ground surface or icy conditions in the working environment, unless the transporter configuration has been specifically adapted for this and these conditions have been taken into account during the engineering of the transport.

- The maximum and minimum working temperatures of the equipment, as indicated by the equipment manufacturer, should always be taken into account. These temperatures may be exceeded only if specific measures have been taken in consultation with the equipment manufacturer.

7.3 BRINGING A LOAD ONTO/DISCHARGING A LOAD FROM THE TRANSPORTER

The following guidelines have to be taken into account when loading/unloading an SPMT.

7.3.1 Bringing an SPMT underneath a load

- When a load is placed on an SPMT by bringing the SPMT under a load, it is advised that once the transporter is in place under the load, the height of the transporter is increased in increments (step-by-step).

- When a load is unloaded from the SPMT by lowering the load on supports, it is advised that once the load is in place over the supports, the height of the transport is decreased in increments (step-by-step).

7.3.2 Loading a load with a crane

- When placing a load onto an SPMT with a crane, it is advised to have the suspension set to a 4-point suspensions set-up. If a 3-point suspension set-up is required for the transport the 4-point suspension should be set before loading and be changed into a 3-point suspension set-up once loading is finished and before the transport proceeds.

7.4 MOVING THE TRANSPORTER

While moving the transporter (and load) the following guidelines have to be taken into account.

7.4.1 Driving

- The preferable driving direction is always the by design intended forwards direction. In general this direction can be recognised by the position of the 'knee' of the transporter, as shown in Figure 6.

7.4.2 Driving Stroke

- Unless otherwise defined from an engineering perspective, it is advised that whenever possible a transport is always conducted with the transporter at mid-stroke height (50% of the maximum stroke) in order to maximise the upward and downward correction possibilities.

7.4.3 Driving Levelling

- The transporter deck has to be kept in a horizontal position in the transverse direction at all times, unless the transporter configuration has been specifically adapted for a different position and this has been taken into account during the engineering of the transport.

- In order to ensure that the deck remains horizontal, at least one spirit level should be placed within the direct line of sight of the operating team, so they can check at all times whether the deck is horizontal in the transverse direction.

7.4.4 Abrupt movements

- Abrupt movements must be avoided at all times.

- In order to reduce the chance that abrupt movements such as emergency stops will be required all activities, other than the transport, in the environment in which the transport will take place should be stopped at the time of the transport and all persons, other than those directly involved with the transport, should leave the area.

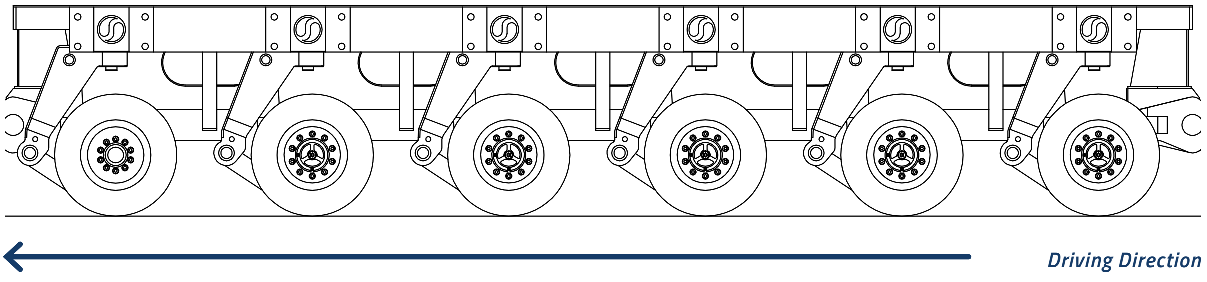
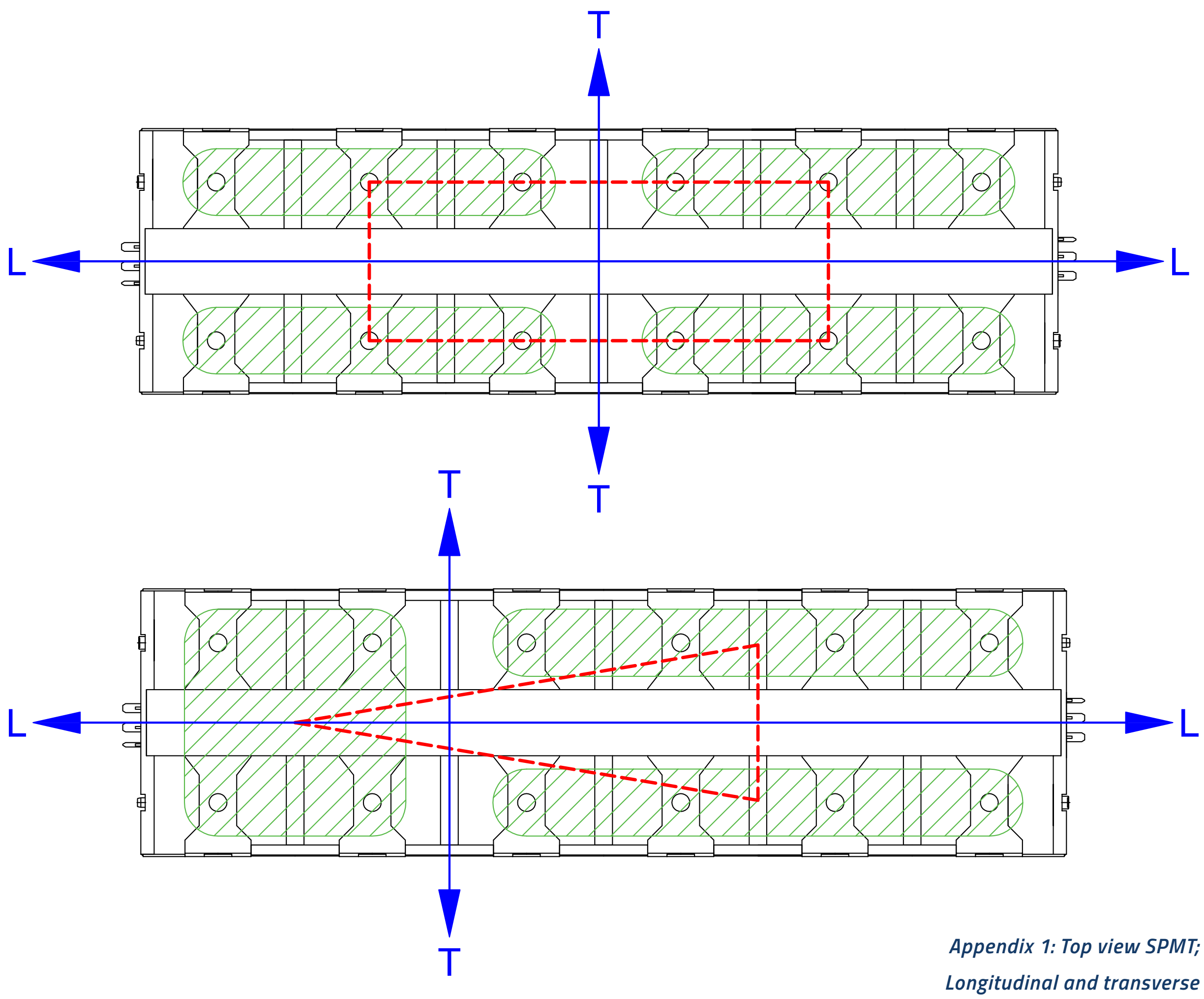


Figure 6: Preferred/Forwards driving direction

APPENDICES

APPENDIX 1: TOP VIEW SPMT; LONGITUDINAL AND TRANSVERSE STABILITY (EXAMPLE)



Appendix 1: Top view SPMT; Longitudinal and transverse stability (example)

APPENDIX 2: RESPONSIBILITY MATRIX

The table below shows the basic way tasks and responsibilities must be divided. When required, this set-up can be (contractually) deviated from by mutual agreement.

Responsibility/task	SPMT Manufacturer	Operating company	Client
EQUIPMENT			
Design	**Primary**	Secondary (input)	Tertiary (input)
Maintenance	Secondary (instruct)	**Primary**	-
Documentation and information (including engineering data)	**Primary**	-	-
THE LOAD			
Design to be transportable	-	Secondary (input)	**Primary**
Documentation and information about load properties	-	-	**Primary**
ENGINEERING			
Information about load properties	-	-	**Primary**
Information about route situation	-	**Primary** (off site)	**Primary** (on site)
Defining threshold engineering values	-	**Primary**	Secondary (input)
Perform adequate engineering	-	**Primary**	-
PREPARATION			
Route survey	-	**Primary** (off site)	**Primary** (on site)
Civil works, removal of street furniture, etc.	-	**Primary** (off site)	**Primary** (on site)
Permits	-	**Primary (mutual agreement)**	
Risk assessment	-	**Primary**	Secondary (input)
Method statement	-	**Primary**	Secondary (input)
Toolbox talk	-	**Primary**	Secondary (input)
OPERATION			
Personnel	-	**Primary**	-
Communication	-	**Primary**	-
Performing final checks	-	**Primary**	Secondary (verification)
Monitoring weather conditions	-	**Primary**	-
TRAINING			
Basic SPMT operating course	**Primary**	Secondary	-
Competence based operator assessment	-	**Primary**	-

APPENDIX 3: CHECKLISTS

On the following pages a number of checklists can be found.

- Checklist A: Route survey checklist
- Checklist B: Engineering checklist
- Checklist C: Pre-mobilisation equipment checklist
- Checklist D: Pre-operations checklist

CHECKLIST A: ROUTE SURVEY CHECKLIST

Relates to: Route survey
To be checked by: Operating company
When to be checked: Upon completion of route survey

Check/component	Yes	No	N.A.	Remarks/values
OFF-SITE				
General route inspection performed				
Bridges on route (if yes, note maximum capacity)				
Culverts on route (if yes, note maximum capacity)				
Overhead powerlines on route (if yes, note location and height)				
Note gradients and cambers on route				
(Site) Specific attention points				
Swept-path analysis to be performed				
Swept-path analysis performed (note date)				

OFF-SITE				
Test transport to be performed				
Test transport performed (note date)				
Lowest permissible axle pressure on route (note value and location)				

ON-SITE				
General route inspection performed				
Bridges on route (if yes, note maximum capacity)				
Culverts on route (if yes, note maximum capacity)				
Overhead power lines on route (if yes, note location and height)				
Note gradients and cambers on route				
(Site) Specific attention points				
Swept-path analysis to be performed				
Swept-path analysis performed (note date)				
Test transport to be performed				
Test transport performed (note date)				
Lowest permissible axle pressure on route (note value and location)				

Date and time of check: ....-.......................................- 20........... / .... : ....

Performed by: ....

Signature: ....

Checklist B: Engineering checklist

Relates to: Engineering of the transport
To be checked by: Operating company
When to be checked: Upon completion of engineering

Check/component	Ok	Not ok	N.A.	Remarks/values
THRESHOLD VALUES				
Total payload (note value)				
Longitudinal tilt (note value)				
Transverse tilt (note value)				
ENGINEERING RESULTS				
Maximum payload capacity of the transporter set-up				
Stability angle longitudinal direction (note value, ok if > longitudinal tilt)				
Stability angle transverse direction (note value, ok if > transverse tilt)				
Strength of additional components				
Deflection				
Dynamic forces taken into account				
Gradient forces (note max.)				
Acc./deceleration (note max.)				
Centrifugal forces (note max.)				
Wind force (note max.)				
ON-SITE				
Transport configuration and set-up as determined during engineering				
Maximum payload (note value)				
Maximum transporter speed (note value)				
Maximum wind speed (note value)				
Maximum longitudinal tilt (note value)				
Maximum transverse tilt (note value)				

Date and time of check: ....-..- 20........... / .... : ....

Performed by: ....

Signature: ....

CHECKLIST C: PRE-MOBILISATION EQUIPMENT CHECKLIST

Relates to: Equipment
To be checked by: Operating company
When to be checked: Before mobilisation of equipment

Check/component	Ok	Not ok	N.A.	Remarks/values
TRANSPORTER				
Checked transporter (note ID)				
General condition (visual)				
Hydraulics (visual, leakage)				
Tyres (visual, pressure)				
Connector bolts (visual)				
Protection plates (visual)				

Check/component	Ok	Not ok	N.A.	Remarks/values
POWER PACK(S)				
Checked power/power packs (note ID)				
General condition (visual)				
Fuel level (note level, ok if sufficient)				
Engine oil level				
Clean air filter				
Hydraulics (visual, leakage)				
Hydraulic oil level driving system (note level, ok if sufficient)				
Hydraulic oil level lifting system (note level, ok if sufficient)				

Check/component	Ok	Not ok	N.A.	Remarks/values
SPARE PARTS AND AUXILIARY EQUIPMENT				
Checked spare parts and auxiliary equipment (note ID)				
General condition (visual)				
Hydraulic hoses (check number and condition)				
Control boxes (check number and condition)				
Condition of auxiliary equipment (visual)				

Date and time of check: ....-.......................................- 20............ / .... : ....

Performed by: ....

Signature: ....

CHECKLIST D: PRE-OPERATIONS CHECKLIST

Relates to: Operations
To be checked by: Operating company
When to be checked: Before start of operations

Check/component	Ok	Not ok	N.A.	Remarks/values
SUPPORTING CHECKLIST				
Route survey checklist available and complete				
Engineering checklist available and complete				
Pre-mobilisation checklist available and complete				
WORK AREA				
Work area clear from obstacles				
Work area clear from non-authorised persons				
LOAD AND LOAD SUPPORTS				
General condition (visual)				
Centre of gravity location identified				
Load support condition (visual)				
TRANSPORTER AND POWER PACK				
General condition (visual)				
Sufficient fuel				
Suspension set-up as per engineering				
Suspension set-up cross-check (to be performed by 2nd auditor!)				Cross-check performed by:
Steering coordination system set				
COMMUNICATION, RESPONSIBILITIES, INSTRUCTIONS				
Lines of communication are clear				
Responsibilities of various persons are clear				
Toolbox talk performed				
Weather conditions within acceptable limits				

Date and time of check: ....-..- 20........... / .... : ....

Performed by: ....

Signature: ....

APPENDIX 4: COMPETENCE ASSESSMENT FORM FOR OPERATORS

Part I: From level 0 to level 3

Operating company: ....

Operator name: ....

Started as operator: ....-..- 20........... / .... : ....

Assigned mentor: ....

Criteria	Ok	Signed by	Date	Remarks
CRITERIA TO GO FROM LEVEL 0 TO LEVEL 1				
Operator has followed manufacturer's training (or equivalent).				
Fulfilled all entry criteria for level 1				
CRITERIA TO GO FROM LEVEL 1 TO LEVEL 2				
Operator has frequently practiced basic skills on the job during a period of at least 3 months, during which the operator has observed at least 10 different jobs and has worked actively with SPMTs.				
Operator has learned to recognise various suspension set-ups.				
Operator has learned the settings of various coordinate systems.				
Operator has learned how to assemble and disassemble various standard transporter configurations.				
Operator has learned to recognise (potentially) dangerous situations.				
Operator fully understands the main working principles of a SPMT.				
Operator fully understands the lines of communication, various responsibilities and different tasks.				
Operator fully understands the concepts of static payload design capacity, centre of gravity and stability area and has been introduced to the concepts of (spine beam) deflection, tyre deflection, stability angle and overload angle.				
Fulfilled all entry criteria for level 2				
CRITERIA TO GO FROM LEVEL 2 TO LEVEL 3				
Operator has been working as a level 2 operator for at least 3 months, during which operator has worked actively with SPMTs.				
Operator has learned to set the required suspension set-up and is now fully qualified to do so.				
Operator has learned to set the required coordinate system and is now fully qualified to do so.				
Operator has learned to assemble and disassemble different standard transporter configurations and is now fully qualified to do so.				
Operator has learned to carry out pre-operation checks, understand their significance and is now fully qualified to conduct pre-operations checks.				
Operator is now fully capable of recognising (potentially) dangerous situations and can take appropriate action.				
Operator fully understands the concepts of static payload design capacity, centre of gravity and stability area, (spine beam) deflection, tyre deflection, stability angle and overload angle. Operator understands their mutual relation.				
Fulfilled all entry criteria for level 3				

Part 2: From level 3 to level 5

Operating company: ....

Operator name: ....

Started as operator: ....-...- 20........... / .... : ....

Assigned mentor: ....

Criteria	Ok	Signed by	Date	Remarks
CRITERIA TO GO FROM LEVEL 3 TO LEVEL 4				
Operator has been working as a level 3 operator for at least 6 months, during which operator has worked actively with SPMTs.				
Operator has learned to set complex suspension set-ups and coordinate systems and is now fully qualified to do so.				
Operator has learned to assemble and disassemble different complex transporter configurations and is now fully qualified to do so.				
Operator is capable of taking the lead in standard jobs, is well aware of all the responsibilities and is able to supervise and clearly instruct colleagues.				
Operator fully understands the theoretical concepts behind the SPMT and is able to clearly explain these as well as their mutual relation.				
Fulfilled all entry criteria for level 4				

CRITERIA TO GO FROM LEVEL 4 TO LEVEL 5				
Operator has been working as a level 4 operator for at least 12 months, during which the operator has worked actively with SPMTs.				
Operator is capable of taking the lead in complex jobs, is well aware of the various responsibilities and is fully qualified to supervise and clearly instruct colleagues.				
Operator fully understands how to work safely with an SPMT and is able to instruct colleagues likewise.				
Fulfilled all entry criteria for level 5				

APPENDIX 5: COMPETENCE ASSESSMENT FORM FOR ENGINEERS

Part I: From level 0 to level 3

Operating company: ....

Operator name: ....

Started as operator: ....-...- 20........... / .... : ....

Assigned mentor: ....-...- 20........... / .... : ....

Criteria	Ok	Signed by	Date	Remarks
CRITERIA TO GO FROM LEVEL 0 TO LEVEL 1				
Engineer has had appropriate training.				
Fulfilled all entry criteria for level 1				

CRITERIA TO GO FROM LEVEL 1 TO LEVEL 2				
Engineer has been working as a level 1 engineer for at least 1 year, during which the engineer has worked actively on SPMT transport engineering.				
Engineer has visited at least 5 different SPMT transports for which he/she did the engineering in the work field.				
Engineer has learned about the engineering framework as described in the ESTA Best Practice Guide and is qualified to perform all required calculations.				
Engineer has learned about dynamic forces and is able to take these into account during engineering.				
Fulfilled all entry criteria for level 2				

CRITERIA TO GO FROM LEVEL 2 TO LEVEL 3				
Engineer has been working as a level 2 engineer for at least 1 year, during which the engineer has worked actively on SPMT transport engineering.				
Engineer has visited at least 5 different SPMT transports for which he/she carried out the engineering in the work field.				
Engineer can independently implement the engineering framework as described in the ESTA Best Practice Guide, including taking into account dynamic forces.				
Fulfilled all entry criteria for level 3				