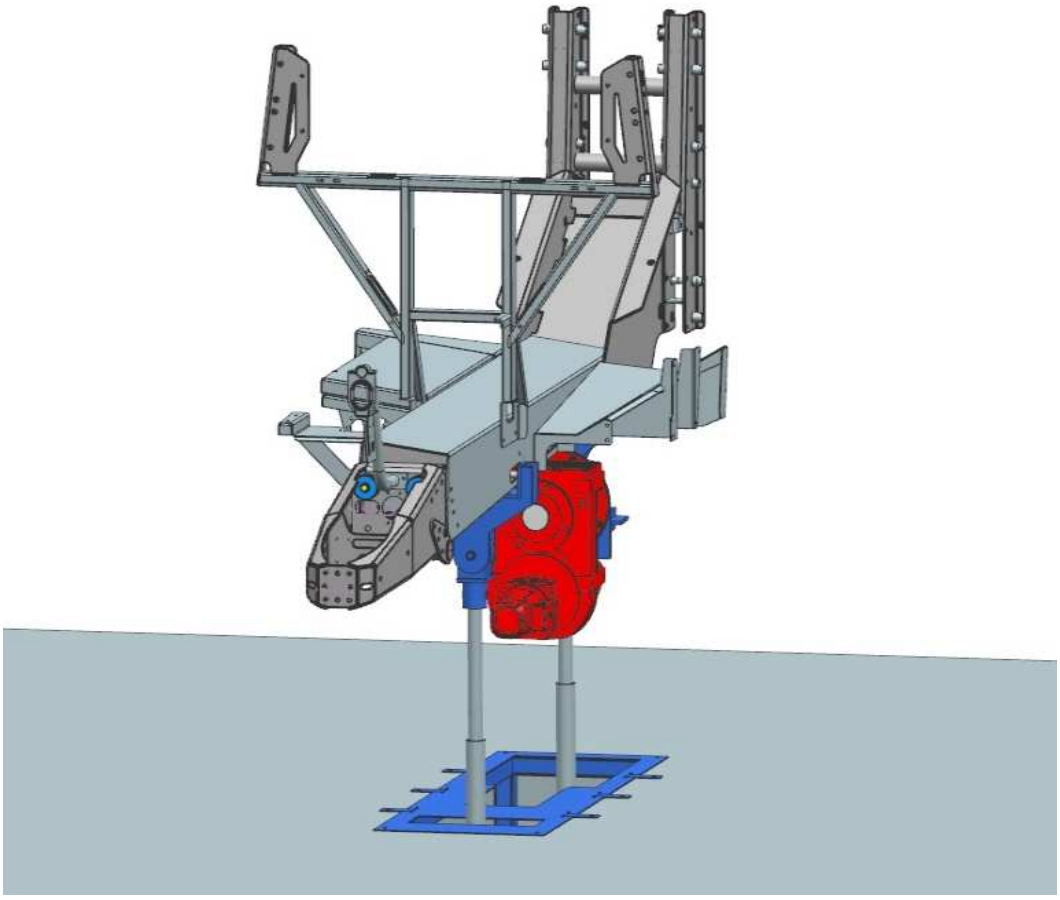
KVERNELAND GROUP NIEUW-VENNEP B.V.

Frame Manipulator

Design of a frame manipulator for the trailed field sprayer assembly line



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kverneland group

DE HAAGSE HOGESCHOOL

Graduation Assignment Mechanical Engineering
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Nieuw-Vennep, December 2014

Foreword

This report was written during the course of my graduation internship at Kverneland Group Nieuw-Vennep, as a mechanical engineering student from The Hague University. In this report the assignment and results are discussed.

This report is intended for:
- Mr. Bastian Kroon; professional coach, Kverneland Group Nieuw-Vennep.
- Mr. Alex Zonneveld; Industrial engineer, Kverneland Group Nieuw-Vennep.
- Mr. W. J. Hijink; graduation coach, The Hague University.
- Mr. D. Hassanpur Golriz; assessor, The Hague University.
- Other interested parties.

I would like to thank the employees of the R&D department and production department of Kverneland Group Nieuw-Vennep for their support during my internship. And finally I want to thank Mr. Bastian Kroon for his guidance and for the opportunity to complete my graduation assignment at Kverneland Group Nieuw-Vennep.

Nieuw-Vennep, 2014

Abstract

Kverneland Group Nieuw-Vennep is an agricultural machinery manufacturer located in the town of Nieuw-Vennep in the Netherlands.
In the spring of 2015 the company will start the production of a new generation of trailed field sprayers and the desire is to assemble these machines as quickly and efficiently as possible. It wants to reach this goal in the first assembly station by tilting the frames sideways so that technicians can have better and more comfortable access to the bottom of the frames.

This design assignment is performed by a full-time mechanical engineering student from The Hague University Delft and is coached by Mr. W. J. Hijink.

The assignment is to design a tool for the trailed field sprayer assembly line that can lift and tilt the frames for the assembly of various frame parts. The necessary steps to achieve a worthy design will be followed in order to achieve a design that complies with the requirements that have been set by Kverneland Group Nieuw-Vennep.
Research will be conducted to explore what solutions are currently available on the market and a prototype build of the new trailed field sprayer will also be witnessed to gain perspective into the situation.
A function analysis of the frame manipulator will be conducted to identify what the frame manipulator must be capable of.
With this information a selection table comprised of solutions for each function will then be used to create various concepts for the frame manipulator. The final concept will be modeled in NX 8.0 and all parts of the frame manipulator will be described and discussed in this report.

In conclusion following a systematic design method where all aspects of the issue have been taken into account and then integrated into a final design has created a functional solution for the situation. Kverneland Group Nieuw-Vennep will evaluate this final design and necessary improvements can be made before having the frame manipulator built.

Table of Contents

Glossary of terms

Actuator	A mechanical device that is used to transmit energy in the form of motion for the operation of another mechanism.
Encoder	Device used to electronically determine the speed and position of an electrical motor
Front arc	Arc installed in the front of a field sprayer to support sprayer booms during transport
Friction coefficient	Dimensionless value used to describe the ratio of the force of friction between two bodies and the force pressing them together
Bobtail bolt	A permanent and vibration resistant fastening system from Alcoa Fastening systems
Jig	Mechanical device designed to hold and locate a component during machining or assembly
Kesselring method	Method used to compare functionality vs feasibility
Morphological analysis	Method used to explore all possible solutions for a complex problem
PTO	Power takeoff, an output shaft that is driven by the motor of a vehicle
R&D	Research & Development
Rear arc	Arc installed on the rear of the field sprayer where the sprayer boom is attached
RPM	Revolutions per minute
Salt spray test	Standard corrosion resistance testing method
Swage	process used to forge lock bolts with dies
Trailed field sprayer	Towed tractor implement for the application of liquid chemicals to crops
Trailer tongue	Part of the trailer that couples a trailer to a tow vehicle
Trestle	A rigid frame used to support a load

List of symbols

Symbol:	Meaning:	Unit:
a	Acceleration	m/s^2
A	Area	m^2
r	radius	m
T	Torque	Nm
g	Gravitational acceleration	m/s^2
E	Young’s modulus	Pa
τ	Shear stress	Pa

1. Introduction

This report was written in the context of a graduation assignment at Kverneland Group Nieuw-Vennep. The purpose of this report is to treat all relevant aspects of the completed graduation assignment at Kverneland Group Nieuw-Vennep.

Kverneland Group Nieuw-Vennep has the desire to assemble the new generation of trailed field sprayers as quickly and efficiently as possible. One of the manners in which they want to achieve this is by using a frame manipulator in the first assembly station to tilt the frames and hereby providing easier access to the bottom of the frame.
The assignment is to design a machine that can tilt the frames for the assembly of the necessary parts, and also position the frames at a height where the technician can perform his tasks in a comfortable manner.

In chapter 2 the background of the company is described and also the description of the assignment. Then in chapter 3 all relevant aspects of the witnessed prototype builds for the design of the frame manipulator are treated. In chapter 4 the function analysis of the frame manipulator, concept creation and final concept selection of the frame manipulator are treated. Chapter 5 describes the design of the various components of the frame manipulator. In chapter 6 a description of the finalized design is provided. Chapter 7 shows the stress analysis that was performed on the main components of the manipulator and followed by an estimate of the cost to have the manipulator built in chapter 8. The bibliography and appendices then follow the conclusions and recommendations.

2. Backgrounds

2.1 Company

Kverneland Group is an international agricultural equipment manufacturer. The group consists of seven manufacturing facilities in Norway, Denmark, Italy, Germany, The Netherlands, Russia and France, with over 20 sales offices and an extensive dealer network. This makes the Kverneland Group one of the largest agricultural equipment manufacturers in the world.

Kverneland Group has a wide range of products for farmers and contractors. The product range consists of: Grass equipment, Crop protection, Soil equipment and Plough equipment. These products are sold under the Kverneland and Vicon brands, in the future these products will also be sold under the Kubota Brand.

The history of the Kverneland Group dates back to 1879. The company started as a small plough manufacturer in the village of Kverneland near Stavanger in Norway. Kverneland has been a family business until it was listed on the Oslo Stock exchange in 1983. As of the mid 90's, the Kverneland Group has grown tremendously through the acquisition of several agricultural equipment manufacturers. In 1998, growth was strongest with the acquisition of Greenland, the company that was responsible for the manufacturing of the world-renowned Vicon brand.
The most recent development at the Kverneland Group is the complete takeover of the company by Kubota in 2012. Kubota is a Japanese manufacturer that through the acquisition of Kverneland Group wants to enter the dry-land farming equipment market.

Kverneland Group Nieuw-Vennep is part of the Kverneland Group. Kverneland Group Nieuw-Vennep is responsible for the development, manufacturing and distribution of high tech crop care equipment. The crop care product range consists of:

- Mounted sprayers
- Trailed sprayers
- Pendulum spreaders
- Disc spreaders

Kverneland Group Nieuw-Vennep currently employs approximately 200 employees, the majority of which is immediate staff. The staff is tasked with the production and assembly of agricultural machinery. The remaining activities involve R&D, Purchasing, Marketing, Logistics, HR and Management.

The factory in Nieuw-Vennep has only been part of the Kverneland Group since 1998; however it does enjoy a long history. In 1910, the company was founded by Hermanus Vissers, with its main activities in trading of seed potatoes, seed and fertilizer as well as contract work in fertilizer spreading, planting potatoes, sowing and mowing.

After the death of Hermanus Vissers in 1933, his sons Herbert and Cor continued with the business. As of 1933, the company began to focus on the repair, fabrication and importation of agricultural machinery. In 1939, the company was divided and Cor continued independently in Hoofddorp and Herbert continued with the existing plant under the name "Vicon" that stands for **VI**ssers **CO**nstructies **N**ieuw-Vennep. In the post war years from 1946 to 1970, the company expanded tremendously with Vicon consisting of 39 employees in 1949 to 1200 employees all over the world in 1970. The period from 1970 to 1985 is also characterized by growth.

Vicon was taken over by the Thyssen Bornemisza Group (TBG) in 1981. What follows is a period of expansion until the agricultural industry collapses late 80's worldwide. This caused different factories of TBG to merge under the name of Greenland.
Vicon BV is then renamed as Greenland Nieuw-Vennep BV and is the specialist in fertilizer spreaders, disc mowers and sprayers for Greenland. In 1998, the Greenland Group is acquired by Kverneland Group. Kverneland Group is then eventually acquired by Kubota in 2012[1]

2.1.1 R&D

The R&D department is tasked with the development of new products for Kverneland Group Nieuw-Vennep.
The R&D department has a staff of approximately twenty engineers and specialists divided in two teams namely spreaders and sprayers.
The R&D department uses Siemens NX 8.0 for CAD/CEA activities. Along with NX, Siemens teamcenter is used as a database for all models and drawings.

The R&D department has its own workshop that is independent of the production line. In this workshop prototypes of future products are built and jigs are also built here for the assembly line.

2.1.2 Trailed field sprayer

A trailed field sprayer is an agricultural machine that is used for spraying crops with liquid fertilizers, herbicides of pesticides. With the use of a tractor the sprayer is towed over the area that must be sprayed. Because of the booms a large area can be sprayed at once. Boom sizes range from 18 to 46 meters
A typical sprayer consists of a main chemical mix tank, a smaller mixing tank, a high-pressure pump and a boom equipped with spraying nozzles.

Figure 1 Trailed field sprayer

2.2 Problem definition

Kverneland Group Nieuw-Vennep will be starting with the production of a new line of trailed field sprayers in the spring of 2015. It is Kverneland's desire to assemble these sprayers as quick and efficiently as possible. In order to achieve this goal new assembly tools are necessary. One of these tools is a frame manipulator.

These new sprayers have a complete new design; the biggest change in comparison with the previous models is the frame.

[1] http://www.werkenbijkverneland.nl

One of the challenges that have emerged with the new frame design is that the new frames are too long for the powder coating line. This issue was resolved by dividing the frames into sections that could fit the powder coating line. After painting the sections they are joined using Bobtail bolts.

Initially, these Bobtail bolt would have been installed in a manner that would have a technician swage the bolt from the side of the frames. But after having performed a salt spray test on these bolts, it became clear that the collar of the Bobtail bolts would corrode because the protective coating on the collar of the Bobtail bolt get damaged in the swaging process.
As a result of that, a decision was made to install the bolts with the collar on the inside of the frame to protect the collar from the environment and also because the head of the Bobtail bolt has a better appearance. More information on the Bobtail bolts can be found in appendix II.

The problem is that the technicians must have access to the bottom of the frame to swage the Bobtail bolts to fasten the frame sections and install the wiring and hoses.
The tool used to fasten the Bobtail bolts in particular, is both heavy and difficult to handle.
This is where the idea for the use of a frame manipulator was conceived.

The idea behind the frame manipulator is to position the frames in such a way that the technician can assemble parts onto the frame in the most ergonomic and comfortable way possible.
This would be achieved by positioning the frame at the appropriate working height and tilting it 90 degrees on its side where technicians will have access to the bottom of the frame without having to lay down on the ground.

2.3 Assignment description

As mentioned before Kverneland Group Nieuw-Vennep will start with the production of a new trailed sprayer model. It is the intention to build approximately 500 machines a year. The assignment is to design a frame manipulator for the new trailed field sprayer assembly line. This frame manipulator must be able to tilt a frame 90 degrees so that technician will be able to assemble parts in a comfortable working position. Because the frame being massive, it will not be possible to tilt the frames manually, for this reason the tilting mechanism must be powered.

It is also important that the frames can be mounted and dismounted from the manipulator as fast as possible, so that the turnaround time can be kept to a minimum and delays in the assembly process be avoided.

Since, there are no tools currently available on the market for this specific application; it will be necessary to begin with researching the different possible solutions, making sketches and creating 3D concepts. By the means of a selection matrix a design will be selected out of the various concepts and will be further developed into a design. Upon approval of the final design, the frame manipulator will be built by the technical department of the Kverneland Group Nieuw-Vennep and integrated into the assembly line.

2.4 Project boundaries

The boundaries of the project must be defined to facilitate the planning of the project. This is important in maintaining focus on key issues. It's also important to stay within these boundaries so that unnecessary research can be avoided.
The project boundaries are as followed:

- A concept report will be made with the various options
- The final concept will be developed and modeled in 3D using Siemens NX 8.0
- Engineering drawings will be made from the final design
- A structural analysis will be made from the 3D model using CAD/CAE software

2.5 Program of requirements and preferences

With all the information provided in the previous paragraphs it's possible to define the program requirements and preferences. The requirements and preferences will consist of fabrication and user requirements

2.5.1 Requirements

Fabrication requirements

- Compact design that will fit within the assembly station
- Powered lifting system
- Powered tilting system
- The manipulator must be able to lift and tilt the weight of the frames
- Modular compatibility for multiple frame sizes

User requirements

- Adjustable work height
- Easy to use
- Frame must be able to be lowered on axle assembly after all the required parts have been installed
- Frame must be able to tilt 90 degrees in both directions

2.5.2 Preferences

Fabrication preferences

- Electrically powered

User preferences

- No hindrance to work around the frame of the manipulator
- Assembled frame must be able to be towed away after being installed on the axle

2.6 Development method

The frame manipulator will be developed in a structured manner. This will be achieved by implementing the methodical development guidelines as prescribed in the book Methodisch Ontwerpen volgens H.H. van den Kroonenberg (F.J. Siers, 2004). This methodical approach to design ensures that every aspect that has a role in the design will be addressed.

This methodical approach is divided in three phases;

- Orientation phase
    - This is the first phase of the project. The goal of this phase is to define the problem, generate a program of requirements and research the problem.
- Concept phase
    - The results from the first phase are used to determine the steps that will be taken in the second phase. The goal of this phase is to explore all possible solutions for all the issues that have been defined in the first phase. The result of this phase is a concept for the solution of the problem, which will be developed further in the next phase.
- Design phase
    - The results of the second phase will be used as the input for the third phase, in which a working method will be engineered for Kverneland Group Nieuw-Vennep. Finally all parts will be detailed and an engineering package will be presented.

3. Research phase

After having performed a market research, it became clear that there is no off the shelf solution available on the market that will meet the requirements of Kverneland Group Nieuw-Vennep BV.

3.1 Prototype build

The new model range of trailed field sprayers consists of three versions namely: a small, medium and large version which will be referred to as model A, B and C respectively.
In September 2014, two “B” model prototypes have been built.

These two prototypes were built as a test to identify problems during the assembly process of the new sprayers, and to identify any issues that need to be addressed before the production of the new models can start. This was a perfect opportunity to witness the assembly of the frames on a purposely-built tilting trestle (fig. 2).

The model-B sprayers where built during this prototype build, as the other versions are still in development. The only differences between the three versions will be the sizes of the tanks and the length of the frames. Other than that, the design of the frames will be similar with the exception of the length and the design of the trailer tongues.
This information will be taken into account for the design of the manipulator.

During the build, the same assembly process that would be followed on the assembly line was used. That transpired in the following working order, noting that only the steps that are important to the functioning of the manipulator will be discussed. A storyboard illustration of the process can be found in appendix III.

- Step 1
    - Mount frame onto trestle
- Step 2
    - Mount front arc & hand tighten corresponding Bobtail bolts
    - Mount rear arc & hand tighten corresponding Bobtail bolts
    - Mount tank support brackets & hand tighten corresponding Bobtail bolts
    - Mount pump support brackets & hand tighten corresponding Bobtail bolts

Figure 2 Frame with forward and rear arc's on the trestle

- Step 3
    - Tilt frame 90 degrees

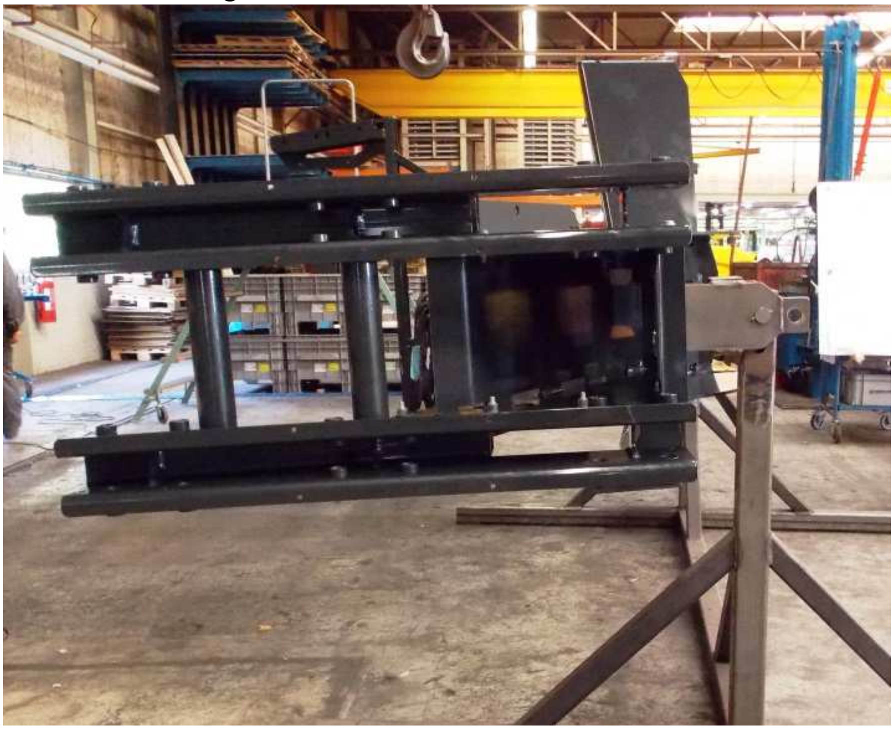


Figure 3 Tilted Frame

- Step 4
    - Swage Bobtail bolts
- Step 5
    - Tilt frame 180 degrees
- Step 6
    - Swage remaining Bobtail bolts
- Step 7
    - Route hoses and cables
    - Install trailer tongue
    - Install trailer jack
    - Install trailer jack hydraulic cylinder (if applicable)
- Step 8
    - Tilt frame 90 degrees into starting position
- Step 9
    - Remove frame from trestle and lower onto the axle assembly

During the test build we have taken advantage of the opportunity to measure the mass of the assembled frames. We also measured the force that is needed to tilt the assembled frame back into the starting vertical position, which will be used to calculate the requirements for the tilting mechanism and lifting mechanism. A scale was used on the overhead crane to make the measurements. The results of these calculations are the following:

The model B frame was measured at three occasions; the first measurement was made before it was mounted to the tilting trestle. The second measurement was made after the frame parts were installed. And the third was made before tilting the assembled frame into the upright position

- Bare frame 345 [kg]

- Assembled frame 780 [kg]
- Tilted frame 280 [kg]

By using the third measurement it is possible to calculate the force that is required to tilt the frame. This was calculated by using the second law of motion. The overhead crane lifted the frame from the tilted position until the cables where tightened and the frame just barely started to tilt. The mass that was being lifted by the overhead crane from the tilted frame was measured using the scale; the reading that was taken from the scale at this point was used to calculate the torque on the axle of the hinges of the tilt trestle;

Formulas:

$$F = m * a$$

$$T = F * r$$

Values:

m = 280 [kg]

a = 9.81$\left[\frac{m}{s^2}\right]$

r = 1,02 [m]

Calculations:

$$F = 280\ [kg] * 9{,}81\ \left[\frac{m}{s^2}\right] = 2746{,}8\ [N]$$

$$T = 2746{,}8\ [N] * 1.02 = 2802\ [Nm]$$

Because of the fact that only the model-B frame design has been finalized and built, we will make an estimate of the mass of the larger frame, the model-C frame.
After having consulted with the designer of the frames (Mr. Reimon Meiland), we have determined that based on the current 3D models that the mass of the B-model can be multiplied with a factor of 2 to make a broad estimate of the mass of the larger C-model. This had been estimated because the design of the C-model has not been finalized at this point.

The mass of the model-B frame has been measured at 345 [kg], the parts that will be installed during the time that the frame is mounted onto the manipulator have a mass of 460 [kg], which will bring the mass to a total of 780 [kg]. The parts that will be installed on the C-model are the same as those being installed on the B-model. The mass of the bare B-model frame is multiplied with a factor of two and then the mass of the frame parts is added to generate the estimate of the mass for the model-C frame;

$$(345\ [kg] * 2) + 460\ [kg] = 1150\ [kg]$$

3.2 Standards

During the research phase, a study was carried out to identify the standards that have a relation to the frame manipulator.
As there is no standard set for the frame manipulator, the following standards will be applied during the design of the frame manipulator.

- NEN-EN 349+A1
    - Safety of machinery – minimum gaps to avoid crushing of parts of the human body.
- NEN-EN-ISO 13857
    - Safety of machinery – safety distances to prevent hazard zones being reached by upper and lower limbs.
        - Used to determine the safe distance between the control panel and the frame manipulator.
- NEN-EN-ISO 12100
    - Safety of machinery – general principles for design – risk assessment and risk reduction.
        - This will be used to assess the safety risks of the frame manipulator so that preventive measures can be implemented

4. Concept phase

4.1 Function analysis

To be able to start creating concepts, a function analysis will be made to expand our insight of the frame manipulator functionality. With this functionality analysis an overview will be made of the main functions, sub-functions and auxiliary functions. Once, the functionality of the frame manipulator is known, smart solutions will become clear to be used in the tool design.

The functions that are essential to the manipulator are: tilting, lifting and clamping.
The most important function for the manipulator is the tilt function, which is the main function of the manipulator. Before a frame can be tilted, there are a series of steps that must be completed, these steps are also known as the sub-functions.

The frame must be fixed or clamped to the manipulator so that the frame can be safely lifted and tilted.

The frames will be delivered to the assembly station on a pallet or cart; from there the frame will be placed on the manipulator using the existing overhead cranes. From here the frame will be lifted to the required working height and tilted into the required position.

In the following table (table 1), the different functions have been categorized and linked with the parts of the manipulator that must fulfill those functions

Main function	Auxiliary function	Part(s)
Tilting field sprayer frames for the installation of parts	Lifting Frame	Lifting mechanism, Actuator
	Manipulator stability	Base frame
	Clamping frame	Frame clamp
	Tilting frame	Tilt mechanism, Actuator

Table 1 Table of functions

As can be seen on above table, each auxiliary function has one or more parts assigned to them. This will be made clearer in the following diagram (diagram 1).

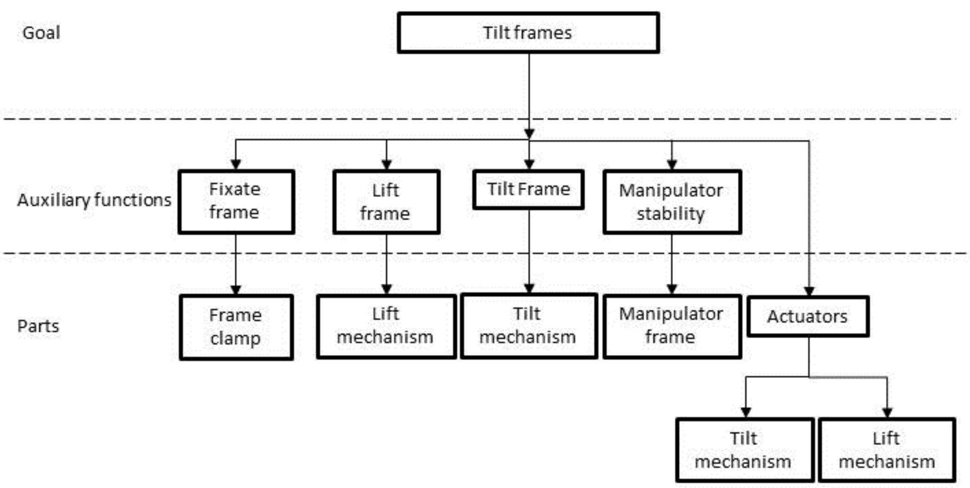


Diagram 1 Function analysis

With this overview it is possible to visualize what parts will be needed for the design of the frame manipulator. In order to create a better picture of which functions each part must comply with, all parts will be individually analyzed.

Manipulator frame:
The frame will provide the base for the manipulator. In this aspect the frame provides stability for the manipulator and also serves as a platform for the lifting mechanism to be mounted on. This frame must be able to absorb the loads from the lifting of the work piece and transfer them to the ground where the manipulator frame will be fixed.

Lifting mechanism:
This part of the manipulator will be responsible for lifting the frame to the desired working height and eventually lowering the frame onto its axle, after all parts have been mounted. The lifting mechanism must be able to absorb and transfer the stresses from the tilting operation to the base frame.

Frame clamp:
The function of the frame clamp is to secure the work piece to the manipulator. The goal is to keep the work piece in its place during lifting, tilting and assembly of parts.

Tilt mechanism:
The function of the tilt mechanism is to tilt the frame piece once it has been mounted onto the manipulator. The frame must be tilted 90 degrees in either direction.

Actuator:
Because of the mass of the frames, it will be impossible to lift and tilt the frames manually. Therefore it will be necessary to use actuators to lift and tilt the frames. Depending on the required movement either linear or rotational actuator may be used. For the lifting mechanism a linear actuator will be needed to complete necessary movement. For the rotary movement of the tilting mechanism it will depend on the method used to complete the tilting operation. And finally, depending of the method used for the clamping of the frame, it might be taken into consideration to use an actuator to clamp the frames onto the manipulator.

4.2 Morphological analysis

A morphological analysis is made at the start of the concept phase. This is done so that all technical solutions can be mapped in order to create concepts. By using this method many combinations can be made in order to create concepts. Of all these concepts only the three most feasible concepts will be evaluated for further development.

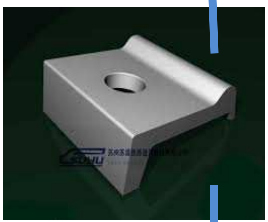
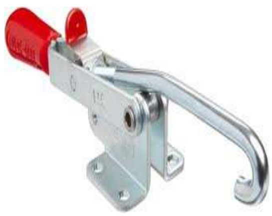
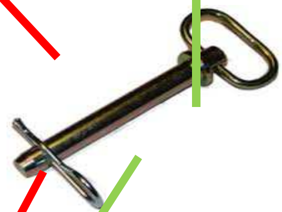
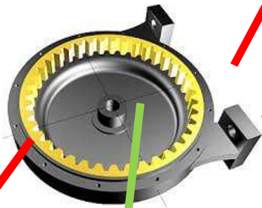
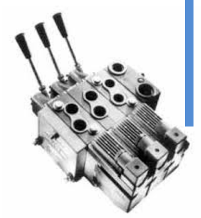
Morphological analysis					
#	Function	Method			
1	Lifting	Lifting table 	Column lift 	Underground cylinder 	Screw jacks 
2	Fixation	Hydraulic clamp 	Plate & bolt 	Manual clamps 	Pin thru frame 
3	Tilting	External axle 	Hinge linear actuator 	Hinge rotational actuator 	
4	Lift actuation	Hydraulics 		Electric 	
5	Tilt actuation	Hydraulics 		Electric 	

Table 2 Morphological analysis

4.3 Concepts

By using a morphological analysis all the different solutions have been categorized. In this chapter the three most likely concepts will be assessed.

Concept 1 (blue line)
This concept is made up of two column lifts, which will be equipped with a tilting mechanism. The tilting mechanism will be actuated using linear actuators. This concept will use hydraulics to power the lifting and tilting mechanisms. The frames will be fixed to the manipulator using plates and bolts.
Advantages:

- Simple construction
- Easy to control

Disadvantages:

- Takes up a lot of floor space of the assembly station
- Technician will be obligated to walk around the structures of the manipulator to work around the frames
- The assembled frame will not be able to be towed away after it has been installed onto its axle

Concept 2 (red line)
The second concept consists of hydraulic cylinders that are housed underground. The tilting mechanism will consist of a hinge attached to an electrical motor.
And finally the frame will be fixed to the manipulator using pins.
Advantages:

- Compact design
- Simple control for the lift mechanism
- Assembled frames can be towed away after being demounted from the manipulator

Disadvantages:

- Hydraulic cylinders could leak
- Cylinders could be damaged after being struck by an object (tools for example)

Concept 3 (green line)
The third concept is almost identical to the second concept, but instead of using hydraulics for the lifting of the frames this concept would use screw jacks
Advantages:

- Compact design
- Safer because of the braked electrical motor used for the jacks

Disadvantages:

- When using multiple jacks the control system will be more complex
- Because of the length of the jacks a deeper hole will have to be made in the floor
- Screw jack could get damaged after being struck by an object
- Slow linear travel

4.4 Concept selection

Using the Kesselring method the three concepts will be compared with each other. The concepts will be assessed using the program of requirements and preferences. Because certain requirements may have a higher importance in comparison with others, weighting factors will be used to give these requirements more influence in the scoring of the concepts.

Requirements	Weighting factor	1	2	3	Ideal
Fabrication requirement					
Compact design	3	3	9	9	**9**
Lifting actuation	1	2	2	3	**3**
Tilting actuation	1	1	3	3	**3**
Modular	3	7	8	8	**9**
Costs	2	6	4	1	**6**
Fabrication preferences					
Electrically powered	1	1	2	3	**3**
Total X		20	28	27	**33**
Total % X		61	85	82	**100**
Users requirements					
Adjustable height	3	9	9	9	**9**
Ease of use	1	2	3	3	**3**
Work speed	3	9	9	6	**9**
Ability to tow completed frame	3	1	9	9	**9**
Maintenance	1	2	1	3	**3**
Manages load	3	9	9	5	**9**
Users preferences					
No obstacles for technicians to move around frames	1	1	3	3	**3**
Total Y		33	43	38	**45**
Total % Y		73	96	84	**100**

Table 3 Concept scoring

The results of the Kesselring method can be seen in the following graph also known as an S-diagram. The graph shows that concepts two and three have scored very close to each other, this is because the concepts are very similar. After having discussed the results with the client, the decision has been made to continue developing the second concept.

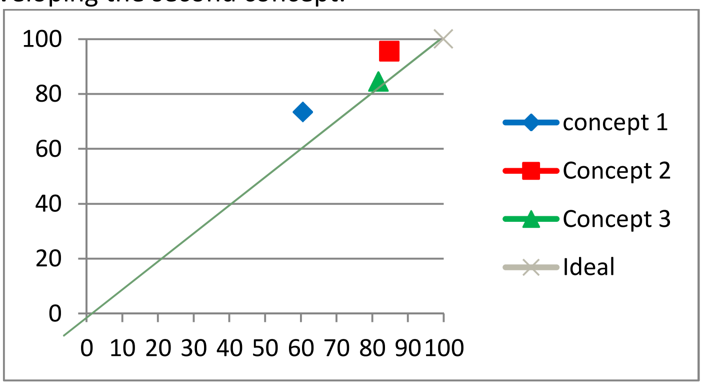


Diagram 2 S-diagram

4.5 3D concept model

A 3D model has been made to create a visual reference to present to the client.
Upon approval of the concept the design phase will start using this model as a reference.

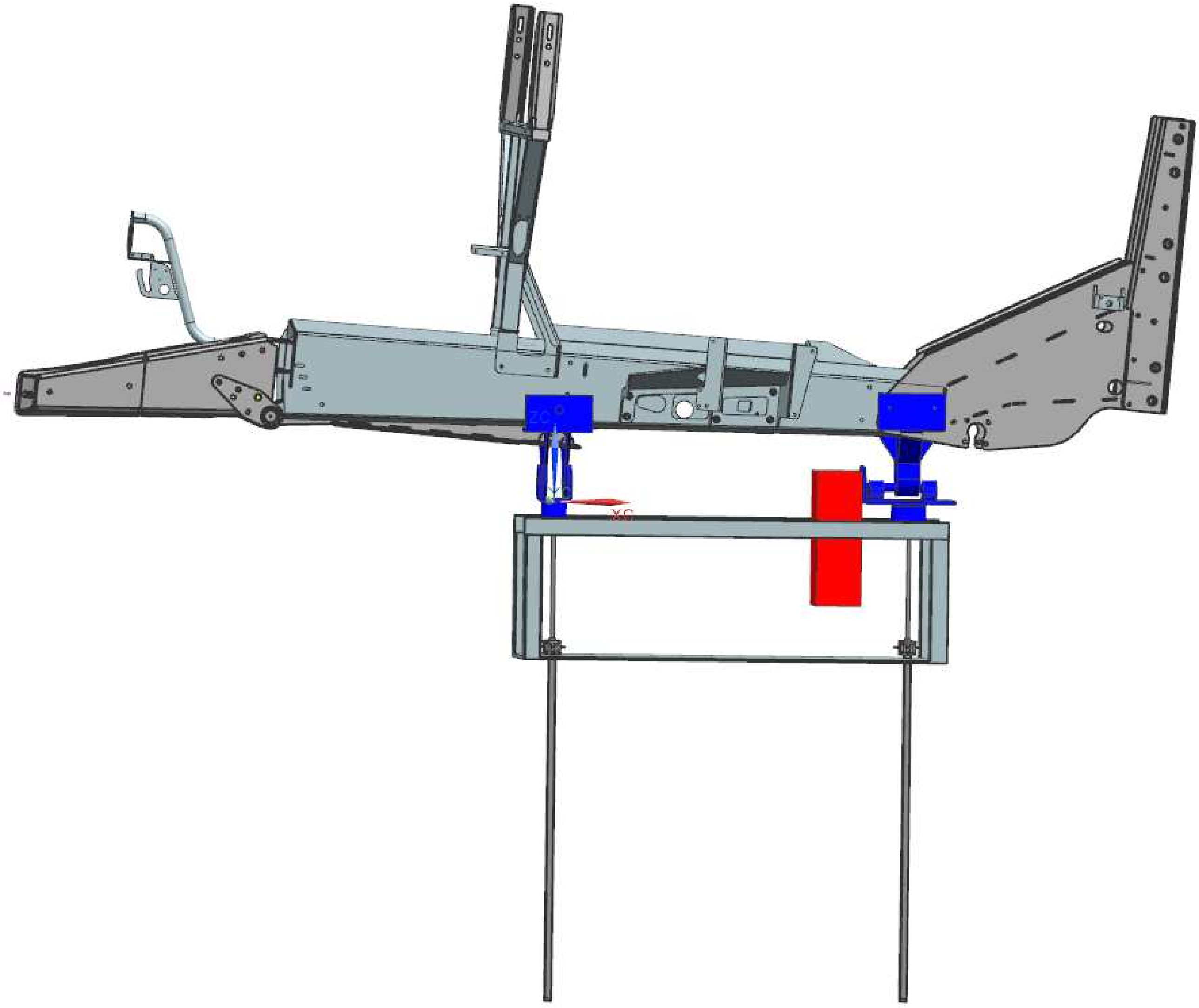


Figure 4 Concept model

5. Design phase

With the approval of the chosen concept, it will now be developed in the design phase. In the design phase all the engineering will take place, which includes 3D modeling and stress analysis.
The final design might deviate from the final concept because of the placement and size of the electrical motor that will be used to power the tilt mechanism, and the stresses that occur as a result of lifting and tilting a frame will also have influence on the final design. All stress calculations will be made using the material properties of S235 steel, as the selected material Kverneland Group Nieuw-Vennep uses for construction of its machines.
Metal components will be powder coated as Kverneland Group Nieuw-Vennep has its own powder coating equipment. RAL5017 is the color that will be used for the manipulator, as this is the color used in the assembly hall for all tools.

5.1 Tilt drive

The tilt drive will use an electrical motor as its power source. In order to be able to choose the right motor for this application we will need to establish the required specifications for the motor. Thanks to the measurements that were made in the prototype build we can calculate the torque that the motor must provide to tilt the frames back into the upright position.

By using the measurements made for the torque that was present on the axle of the hinges of the trestle, we can now specify the torque that the electrical motor must provide to tilt the frames back into the upright position.

At the time of the test build, the force was calculated after deriving the load using a scale. With the readings from the scale it is possible to calculate the force and eventually the torque that is needed to tilt the frame into the upright position. The torque that was calculated in chapter 3.1 will be used to determine the torque that will be required from the gear motor.

With the calculation made in chapter-3, it was made clear that the torque on the axle of the hinges is 2802 [Nm] at the time that the model-B frame was at rest in the tilted position.
As the manipulator must be able to tilt the model-C frame, an estimation will have to be made for the torque that will be required from the gear motor.
At the time the measurement was made on the model-B frame all parts had already been installed which means the calculated torque is what is required to tilt an assembled model-B frame.

Unlike the estimation for the mass of the model-C frame where only the mass of the model-B frame was multiplied, for the estimation of the required torque the result of the torque calculation of the model-B frame will be multiplied with a factor of 2. By using this approach for estimating the torque, it will result in a greater torque than the calculated value actually required. The reasons for this approach are the following:

- To provide a margin for the gear motor as only one gear motor must be able to tilt the frames considering the mass of the model has only been estimated.
- The torque that the gear motor must provide to tilt the frame must be greater than what was measured, as the frame was not being tilted at the time the reading was taken making this a static measurement.

Taking this into consideration the gear motor will be required to deliver:

$$T = 2 * 2802[Nm] = 5604\ [Nm]$$

Another specification that will be important for the safe operation of the manipulator is the speed of the gear motor. After consulting the technician of the assembly line and the client it was decided that the manipulator must be able to tilt a frame with 90 degrees within 15 seconds. This means that a gear motor with a speed of 1-RPM will be needed.

With these specifications, it will now be possible to select a motor that will suit this application. Using the drivegate software from SEW Eurodrive the following gear motor has been selected (see appendix IV for more information): FAF107R77DRE80M4BE05. The selected gear motor has an added Braking feature for safety (see chapter 5.6).

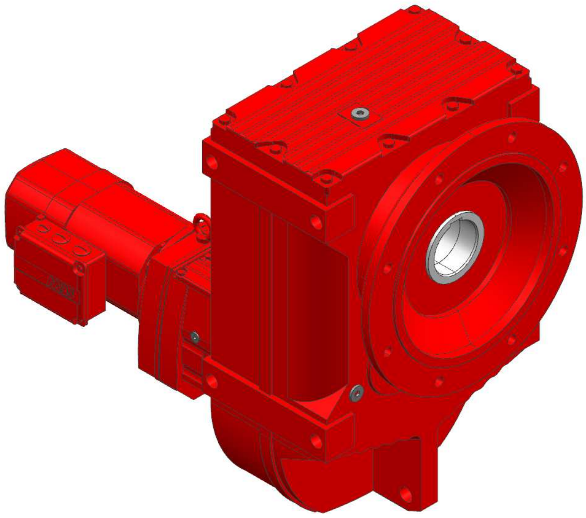


Figure 5 SEW FAF107R77DRE80M4BE05

This gear motor has a hollow shaft; this option was chosen to make the tilt mechanism as compact as possible by avoiding the need for a coupling between the gear motor and the tilt clamp.
The gear motor will be attached to the flange of the tilt clamp frame using bolts.

Because of SEW Eurodrive's drivegate software, all specifications of their products and CAD drawings are made available to designers. Therefore, it was possible to use SEW Eurodrive's CAD model of the gear motor in the development of the frame manipulator. The CAD model was used to mockup the placement of the gear motor in the frame manipulator. By using the CAD model the correct measurements were used to take the sizing and placement of the gear motor into account.

5.2 Lifting mechanism

The lifting mechanism is composed of two hydraulic cylinders. Because of the long stroke of these cylinders and the load that they have to be able to lift, they will have to be custom engineered and built for this specific application. The supplier that Kverneland Group Nieuw-Vennep uses for the hydraulics on their products will provide this service. It is therefore necessary to define the specifications, which the cylinders must comply with for the supplier.

During the test build, we have witnessed that with the assembly of the various parts onto the frames of the sprayer, the center of gravity of the frames had shifted. For this reason each cylinder must be capable of lifting the total mass of the assembled frames. In addition, the mass of the gear motor must also be taken into account for the lifting capacity of the cylinders.

From the specifications of the gear motor can be found that the mass of the gear motor is 277,7[kg]. And as mentioned in chapter-3 the mass of the C-model frame will not be greater than 1150 [kg]. With these details, we can now calculate the force that the cylinders must provide to lift a frame.

Formula:

$$F = m * a$$

Values:

- Mass gear motor :277,7 [kg]
- Mass model C frame :1150 [kg]
- a = g = 9.81$\left[\frac{m}{s^2}\right]$

Calculation:

$$F = (277{,}7[kg] + 1150[kg]) * 9{,}81\ \left[\frac{m}{s^2}\right] = 14005{,}74\ [N]$$

The stroke of the cylinder is defined by the distance from the floor to the elbow of the operator and by the depth that the manipulator must retract into the ground for storage. The elbow height is the height that a work piece must be positioned so that the elbows are bent 90 degrees to achieve an ergonomic working position[2].

This distance has been obtained from the DINED database of the TUDelft; this database contains the human body measurements of the population of The Netherlands. By selecting the 99th percentile, which is the maximum stature in the database, we can obtain a value for the greatest elbow height of the Dutch population. This height is equal to 1232 [mm]; this height was compared to that of the tallest technician working for Kverneland to confirm the data.
The elbow height of the tallest technician was measured at 1200 [mm] what is within range of the 57 [mm] standard deviation of the data.
The cylinders must lower the manipulator 650 [mm] to retract it into the ground. The required stroke is 1200[mm] + 650[mm] = 1850 [mm].

Telescopic cylinders will be used for the lifting mechanism because of the long stroke that will be required. The advantage of using telescopic cylinders instead of traditional cylinders is that it will not be necessary to dig a deep pit in the floor of the assembly line to accommodate a traditional cylinder, as telescopic cylinders are somewhere between 20 and 40% shorter when retracted.

With these specifications the supplier's technical questionnaire (see appendix V) has been filled and has been sent to the supplier along with a sketch with the preferences of the cylinders.

[2] Basisboek ergonomie Voskamp, P. Druk 1

5.3 Tilt clamp

The rear of the frames will be clamped and supported by the tilt clamp. Existing holes in the frames will be used to lock the frames onto the tilt clamp using two pins.
The pins have a 30 [mm] diameter; this dimension was used based on the shear and compressive strain analyses, which can be found in the appendix VI.

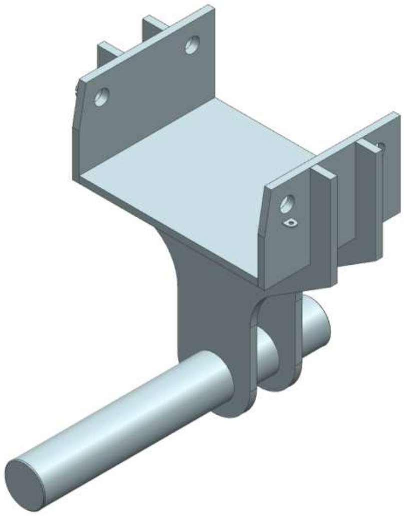


Figure 6 Tilt clamp

The clamp is composed of a saddle that supports the frames, hinge plates and an axle that connects into the gear motor. The axle of the gear motor has a diameter of 95 [mm] and for this reason the axle of the tilt clamp has been made of this same dimension, this was done to avoid using additional couplings between the clamp and gear motor as mentioned before.

5.3.1 Saddle

The saddle is constructed using three plates, one bottom and two side plates. The side plates have been chamfered in de forward facing top corner. This was done to avoid interference with the tank support plates that will be installed on the frame.

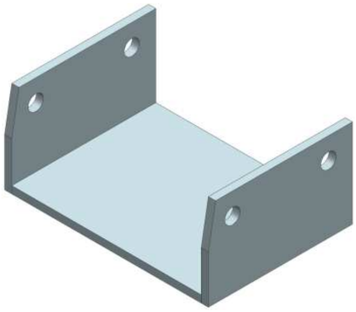


Figure 7 Saddle

5.3.2 Hinge plate

The hinge plates have been designed to provide extra support to the saddle by the means of reinforcement tabs. By incorporating the reinforcement tabs into the hinge plates it will be possible to keep the distance between the gear motor and the clamp as short as possible.
Other advantages include:

- Load of the frame is closer to the gear motor
- Tilt clamp will be smaller

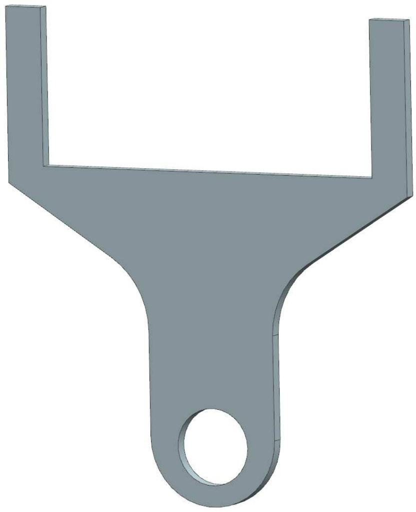


Figure 8 Hinge plate

5.3.3 Clamping pin

As mentioned before in paragraph 5.3 the frames will be locked into the clamps by using pins.
This method was chosen for multiple reasons; one reason is that the holes in the frames where the pins must pass thru will not always perfectly align with the pin holes of the clamps. The ability to manually insert the pins will allow the technician to work the pin into place without damaging the paint finish of the frame.
Another reason for using this method is for the operator to perform a conscious step during the process of mounting the frames onto the manipulator and visually confirm that the pins have been correctly installed. The downside to using this method is that the operator will have to place the pins and walk around to secure the pins from falling out during tilting with clips for example. In order to save time by avoiding the need to walk around and place clips, a spring-loaded pin will be used in combination with a locking mechanism (fig. 9)

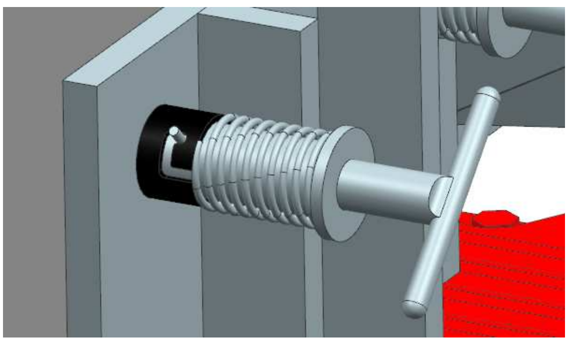


Figure 9 Spring loaded pin in locked position

5.3.4 Mounting frame tilt clamp

The tilt clamp and gear motor will be assembled on a mounting frame. The mounting frame has a flange on one side to attach the gear motor to, and a base plate where a bearing housing will be mounted to support the opposite end of the tilt clamp.
The mounting frame will then be mounted on the hydraulic cylinder.
The location of the bolt holes of the bearing housing and the flange of the gear motor determined the positioning of the reinforcement plates under the mounting frame. The bearing housing that has been selected for the mounting frame is manufactured by SKF, the specifications can be found in appendix VII.

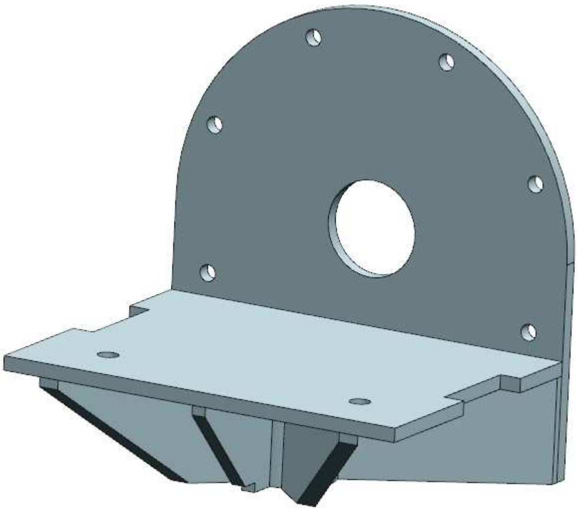


Figure 10 Mounting frame

5.4 Support clamp

The support clamp is the clamp that will be used on the forward facing end of the frame. Because of the limited space between the two lifting cylinders, this clamp will not be actuated.
The sprayer frames have been designed with a three degree slope and for this reason the support clamp will have this same slope built in the clamp to adequately support the frame. Another key factor is that because of the sloping design of the frame, the support clamp will be lower than the tilt clamp. This height difference will be incorporated in the hinge plates of the support clamp.

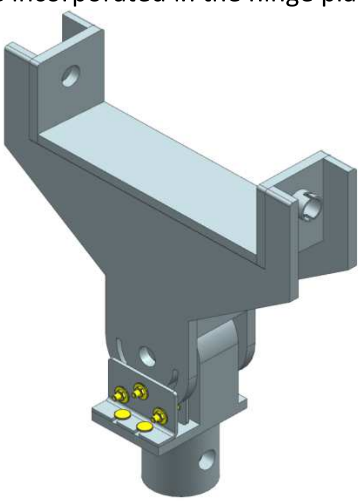


Figure 11 Isometric view of the support clamp assembly

5.4.1 Hinge plate

The height difference between the support clamp and the tilt clamp has been incorporated into the hinge plates of the support clamp. These plates have been designed with the same idea of incorporating the reinforcement tabs in the plates.
The shaft for the support clamp will not have the same size as the shaft of the hinges on the tilt clamp. This was done for two reasons; the first one is because the diameter used in the tilt clamp is not necessary, as the support clamp is not actuated. The second reason is that since the support clamp is not actuated a solution will have to be developed so that the clamp will not fall once a frame has been demounted from the manipulator. The solution for this problem will be treated in the next paragraph.

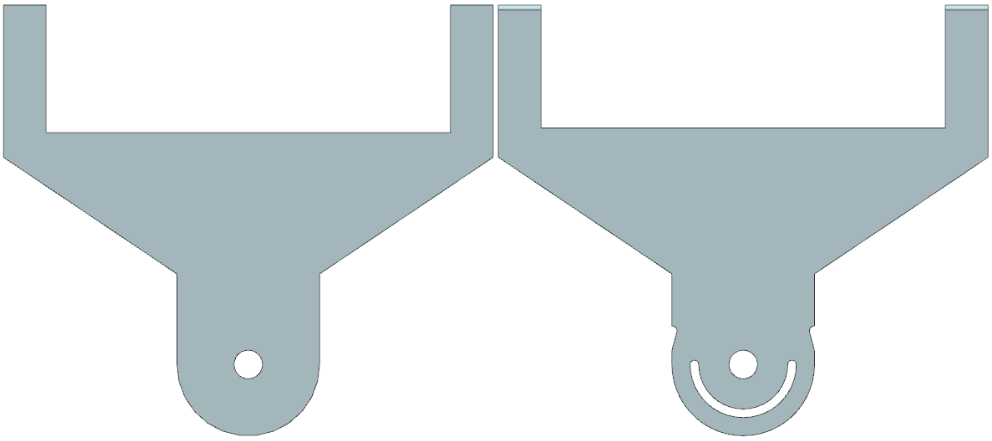


Figure 12 Support clamp hinge plates

5.5 Clamp brake

As mentioned in the previous paragraph, the support clamp will need a system to keep it in the upright position when frames are being loaded and unloaded. A locking or braking system will be developed to keep the support clamp in the starting position.

Two solutions have been considered for this situation. The first solution is to use a pin on the support clamp to lock it in place. With this concept the technicians must place the pin before removing a frame from the manipulator. The downside to this concept is that if the technician should forget to place the pin, the clamp would tip over to one of the tilt positions, as it would not be held in place.
The advantages of this system are:

- The clamp will be securely locked in place
- Simple construction

The disadvantages are:

- Extra step for technicians to complete
- Technicians forgetting to remove the pin could damage the support clamp.

The second solution is a braking mechanism. This mechanism would be mounted on the clevis of the support clamp. Here brake pads will be used to apply pressure to the hinge plate.
The idea behind this solution is that the braking mechanism would provide sufficient resistance to keep the clamp in place, but still allowing it to turn during the tilting operations.
The advantages of this solution are:

- Technicians will not have to engage it, so it is one step less for them to perform
- Brake pads can be easily adjusted after the pads have worn out
- No risk of damage to the support clamp as a result of the operator forgetting to disengage

The disadvantages are:
- Brake pads will wear out and require replacement.
- The braking system will take up more space than the locking pin solution

After having discussed these two solutions with the client, is was decided to use a braking system on the support clamp.
The reason for this choice is that technicians will not have to perform an extra step while using the manipulator.

As mentioned before the clamp brake will be mounted onto the clevis of the support clamp. Here two brake pads will be used to apply pressure to the hinge plate of the clamp.
Because of the low friction coefficient between two metal parts (typically between $\mu s = 0.5$ & $\mu s = 0.8$), another material will be used to increase the friction coefficient. Because of the higher friction coefficient between rubber and metal (approx. $\mu s = 1.2$)[3], rubber will be used as the braking material. As the brake pads will wear from the use of the manipulator, they can be readjusted using bolts. Once the rubber pads have been worn-out the rubber plates can be easily replaced by removing the old plates and securing new plates with rivets.

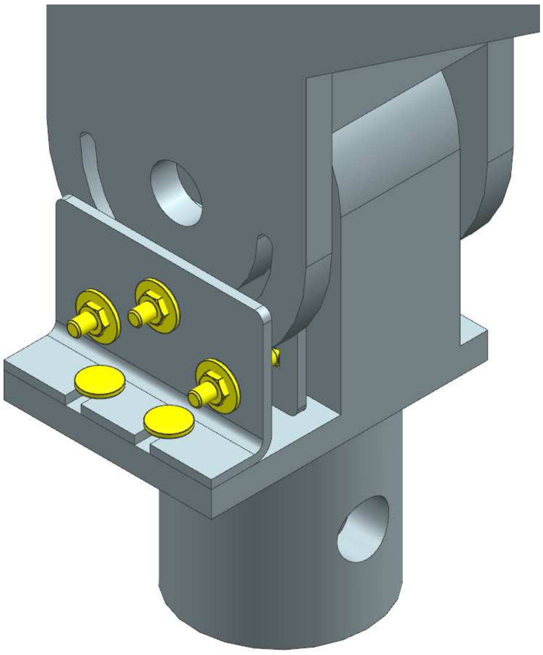


Figure 13 Clevis with clamp brake

3 http://www.werktuigbouw.nl/abc/cof.htm#mu_materialen

5.6 Base frame

The base frame is the mounting platform for the lifting cylinders and also where the frame manipulator will be stored when it is retracted and not in use.
The dimensions of the base frame are defined by the size and placement of the various parts of the frame manipulator, as these must be able to lower into the base frame.

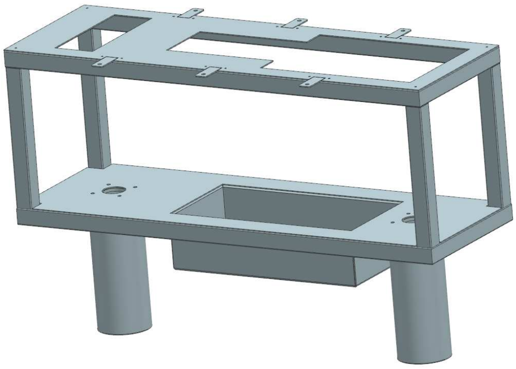


Figure 14 Base frame

The base frame will be inserted in a pit in the floor of the assembly station. The lifting cylinders will be installed within the shafts on the bottom of the frame, the flange of the cylinders will be fastened and rested on the bottom plate of the frame. This way it will not be necessary to dig a deep pit for the base frame. Because of the way the gear motor is attached to the mounting frame and lift cylinder, the bottom plate of the base frame will prevent the manipulator from completely lowering into the base frame. This issue was solved by making a recess in the bottom plate for the gear motor to recess into. The base frame will be secured to the ground to prevent movement of the entire manipulator.

5.6.1 Cylinder placement

The placement of the cylinders was determined by selecting a distance in which all three frames can be clamped on the frame manipulator without obstructing assembly of parts.
After the analysis of the 3D models of the three sprayer frames, it became apparent that a distance of 1590 [mm] between the three frames would work. At this distance the model-A frame would fit on the manipulator and the B & C model frames can be assembled, the only issue would be that the jack of the B & C model frames will have to be installed in the extended position. Also with this setup the center of gravity of the frames are set between the lifting cylinders.
At this distance all three frames can be clamped into the manipulator and not have interference from the clamps with the assembly of the frame parts at the time that the frames are on the manipulator.

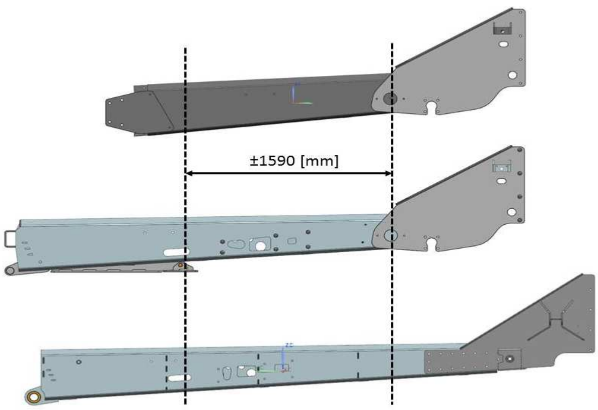


Figure 15 Model A, B & C frames

5.7 Safety

Safety of the operator is the first priority; therefore safety features have been incorporated in to the design of the frame manipulator.
The possible hazards of the manipulator must first be identified so that the necessary precautions can be determined.

The possible hazards are:

- The operator is struck by the manipulator and gets injured.
- The operator gets pinched or crusher by a hinge
- The operator forgets to place the frame pins and the frame falls out of the clamps
- The electrical power for the gear motor fails during tilting and the manipulator could continue to tilt uncontrolled

5.7.1 Control panel

The manipulator will be operated from a control panel. There are two precautions that will be made, to ensure the operator will not be at risk of being injured during the operation of the manipulator.
The first precaution is that the control panel is placed outside of the danger zone of the manipulator.
The second precaution is the use of a two-hand control system; this will be implemented so that the control panel can be placed as close to the manipulator as possible.
A two-hand control device requires the simultaneous use of both hands of the operator to operate the manipulator[4]. This will prevent the operator from reaching the danger zone with any body part during the time that the manipulator is being operated.

Figure 16 Two-hand control

The exact location of the control panel will be determined later as the client is yet unsure of the exact setup for the station where the manipulator will be used.

5.7.2 Emergency stop

An emergency stop switch also known as an emergency kill switch will be placed on the control panel. This switch will be used in case of an emergency to cut off all power to the manipulator, in order to stop the manipulator from working.

[4] http://www.michigan.gov/documents/dleg/twohand_292567_7.pdf

5.7.3 Pin sensor

Proximity sensors are often used in industrial automation applications to detect metal objects; this is achieved by using an inductive loop.

Figure 17 Example of a proximity sensor

By taking into account that technicians could forget to place the frame locking pins or decide not to place one pin to save time, proximity sensors will be used as a safety measure to prevent this from happening.

As the pins that will be used to hold the frames on the clamps will be made of steel, these sensors will be capable to detect them once they have been placed. Once the sensors have detected the presence of the pins, a signal will be sent to the control box to confirm that all pins have been placed and that the frame can be tilted.

5.7.4 Tilting

Tilting the frames presents two risks. The first risk is that due to an electrical failure during the process of tilting, a frame could continue to tilt uncontrolled and fall into the tilted position causing damage and bringing the operator at risk of injury.
The second risk is that the operator fails to pay attention during the tilting operation and fails to stop tilting at 90 degrees, and hereby causing damage to the gear motor and or the frame manipulator itself.

The precautions that will be taken to avoid these situations are the following.
The gear motor will be equipped with a motor brake and an encoder. The motor brake is an option for the gear motor from SEW Eurodrive and is integrated in the motor. The motor brake engages as soon as there is no electrical power being supplied to the motor. This is convenient as the gear motor will be locked in that current position and hereby effectively locking the tilt mechanism in place.
An encoder is also another option for the gear motor from SEW Eurodrive. The encoder will be used to electronically determine the position of the tilt mechanism. It will be possible to set limits for the gear motor to avoid tilting the frames past the tilted positions. It has the added benefit that it can be used to confirm that the manipulator is in its resting position

6. Final design

With the design of the frame manipulator completed a rendering has been made of the design.
A human model has been inserted into the rendering to visualize the use of the manipulator.
In the following image (see figure 18) the frame manipulator can be seen in the upright position where all parts are preassembled.

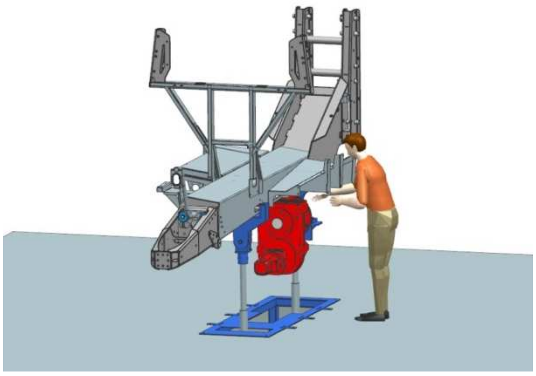


Figure 18 Frame manipulator in upright position

The following render (see figure 19) shows the manipulator in the tilted position at which point the Bobtail bolts will be fastened. The gear motor has been positioned between the lifting cylinders; this was done in this manner so that technicians can take advantage of the lifting cylinders to be able to lower the frames on to the axle assembly once all the parts have been mounted and fastened on to the frame. There are disadvantages to the position of the gear motor, which are the following;

- Because of the size of the gear motor the technician will have to reach with the swaging tool so that four of the Bobtail bolts can be swaged.
- Parts and tools can fall into the large opening the base frame where the gear motor must retract into.

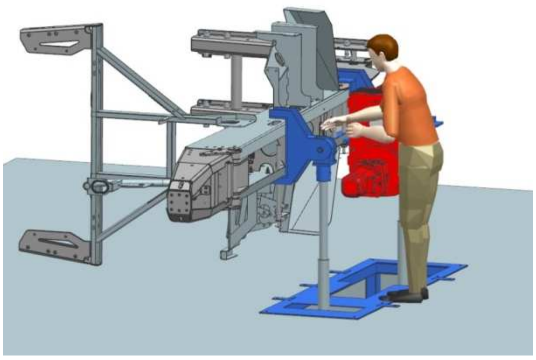


Figure 19 Frame manipulator in the tilted position

As the hydraulic cylinder supplier had not responded to the engineering request for the hydraulic lifting cylinders as the time this report was being written, it was not possible to finalize the design of the base frame as the correct measurements of the cylinder will be needed for the positioning of the fastening holes and the access hole for the cylinder on the bottom of the base frame.
A parts list with corresponding materials can be found in appendix IX. Engineering drawings of the finalized parts can be found in the appendix X.

7. Stress analysis

A stress analysis has been performed using CAD software; the results of the analysis will be used to determine if the components are able to handle the stresses. With the results from this analysis the necessary changes will be made so that the manipulator will be able to cope with the stresses.

For this stress analysis the clamps of the frame manipulator will be analyzed independently as each clamp must be able to carry the complete load of the frame. With the data from these analyses, enhancements will be made to the clamps

In the following images the results from the stress analyses for the tilt clamp can be seen. The first picture (fig. 20) shows the clamp being loaded in the upright position; the second image (fig. 21) shows the clamp being loaded in the tilted position. In both situations the material does not deform under stress as the occurring stresses are under the yielding point of S235.

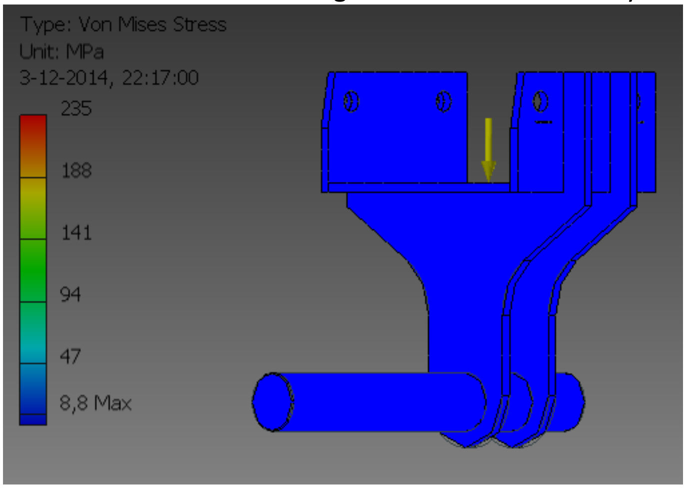


Figure 20 Tilt clamp loaded in upright position

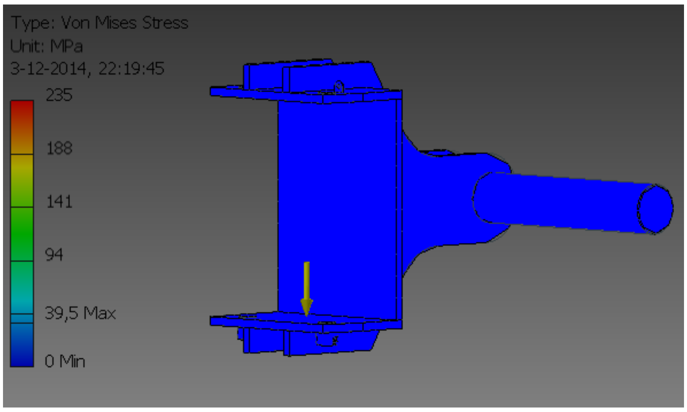


Figure 21 Tilt clamp loaded in the tilted position

In the following images the stress analysis of the support clamp can be seen. In the first image the clamp has been loaded in the upright position, just as with the tilt clamp the stress in the support clamp is not sufficient to deform the material as the occurring stresses are well under the yielding point of S235.

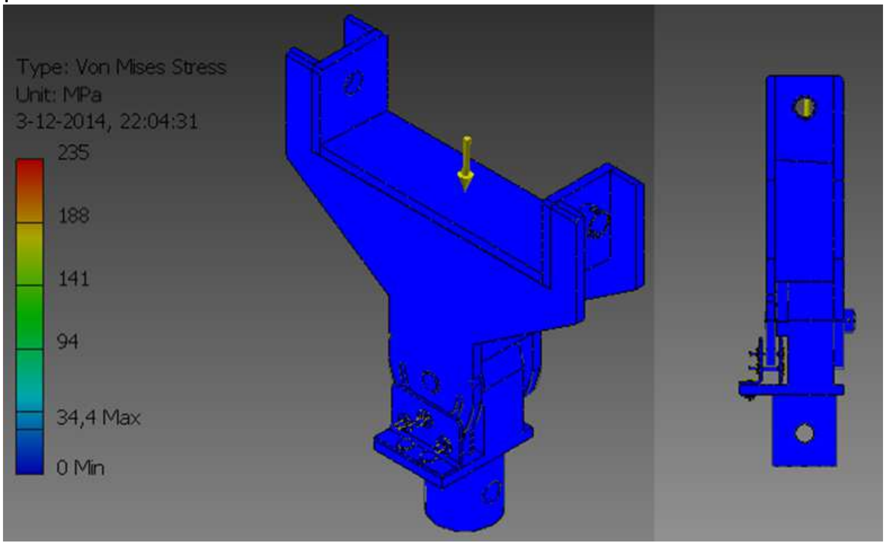


Figure 22 Support clamp loaded in the upright position

However in the tilted position a greater stress can be observed, this is caused by the intentional contact between the end position limit plate of the support clamp and the clevis of the cylinder. This stress is not sufficient to cause permanent deformation to the material.

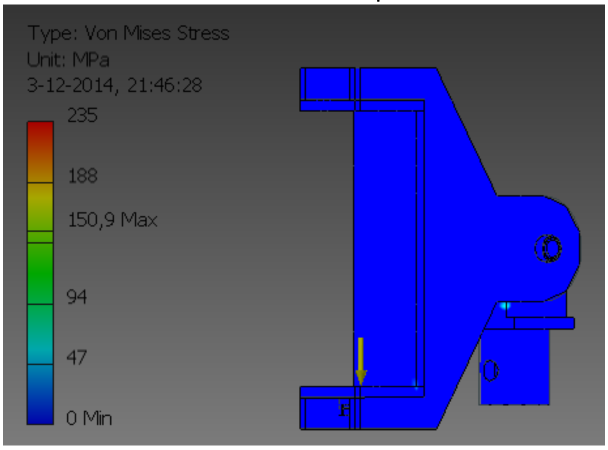


Figure 23 Support clamp loaded in the tilted position

8. Cost estimate

The cost estimate of the frame manipulator will be based on gross material prices of Kverneland's suppliers. The prices of the components that will be purchased from a supplier have been obtained from the suppliers catalog for this cost calculation. The remaining costs will be estimated.

Kverneland Group Nieuw-Vennep has its own inventory of materials and also has the necessary equipment to build the frame manipulator; therefore we will use the company's calculation models to estimate the machining costs. An example of the calculation model for the laser can be found in appendix VIII.

Material	€ 2.489,23
Laser cutting	€ 11,50
Bending	€ 15,00
Welding	€ 540,00
Powder coating	€ 10,00
Gear motor	€ 1.100,00
Lift cylinders	€ 5.000,00
Bearing housing	€ 500,00
Fasteners	€ 40,82
Assembly	€ 480,00
Total	€ 10.186,55

Table 4 Cost breakdown

The total costs for the parts, materials and machining is € 10.186,55.
The costs for the installation, electrical systems and hydraulics systems have not been included in this estimation.

9. Conclusion

In this graduation assignment research was conducted for the design of a frame manipulator for the assembly line of the new generation trailed field sprayers of the Kverneland Group Nieuw-Vennep. The purpose of this assignment was to develop a method that technicians can use to assemble parts on to the frames of the sprayers quickly and efficiently by tilting the frames.

By witnessing the test build of two prototypes of the new field sprayers a lot of useful information was gathered and insight was gained into the situation. During the test builds feedback from the technicians assembling the prototypes was also received. This information proved to be useful during the development of the frame manipulator.

Because the frame manipulator needs to handle all three models of the new sprayers and only the middle size model-b sprayer design being finalized, the parameters for the handling of the larger model have been estimated.

With all this information a function analysis has been carried out to identify all the functions that the frame manipulator must fulfill. Solutions for these functions were listed in the morphological analysis, which was then used to generate various concepts. Here the best concept was selected and developed into the final concept.

With the final concept a method has been successfully developed where technicians can assemble the frames in a quick and efficient manner. This concept for the frame manipulator provides the best solutions for the requirements of Kverneland Group Nieuw-Vennep.
The benefits of this concept are:

- It provides the user the ability to lift and position the frame at the correct working height.
- It provides a comfortable working position to the technician using it.
- It allows the technician to benefit from the lifting system to be able to lower the frames onto its axle assembly.

10. Recommendation

After having reviewed the final concept of the frame manipulator I have a couple of recommendations for improvements.

Tilt mechanism

This concept uses a large gear motor to tilt the frames into position. The positioning is not ideal for the user, as he will have to reach over the gear motor to be able to swage the corresponding Bobtail bolts in that section of the frame.

One solution to this issue is to use a helical hydraulic rotary actuator instead of the gear motor. This type of actuator with the same capacity as the selected gear motor has a much smaller size. This will then provide the benefit of a more compact tilting mechanism.

Lifting mechanism

Due to the applied torque on the top of the cylinders resulting from the tilting operation the seals of the hydraulic cylinder can wear faster than expected. An option that should be considered to prevent this from happening is a guide system to provide additional support for the cylinders during tilting.

11. Bibliography

11.1 Literature

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11.2 Links

Company history and information

http://www.werkenbijkvernelandgroup.nl

Material coefficient of friction

http://www.werktuigbouw.nl/abc/cof.htm#mu_materialen

Two hand control information

http://www.michigan.gov/documents/dleg/twohand_292567_7.pdf

Inductive sensor information

http://en.wikipedia.org/wiki/Inductive_sensor

Gear motor supplier

http://www.sew-eurodrive.nl

Alcoa bobtail bolt information

http://www.alcoa.com/fastening_systems_and_rings/commercial/catalog/pdf/huck/en/af1033_bobtail_tech_flyer_white.pdf

12. Appendix

Appendix I Reflectie

De reflectie is opgezet om de voortgang tijdens de afstudeerstage te rapporteren.

Voor dit afstudeer opdracht lag de nadruk op de rollen van onderzoeker en ontwerper. Met de ingevulde competentie tabel kan men zien welke competenties verbeterd zijn in vergelijking met het begin van de opdracht.

Competentietabel

	Taakrollen	Onderzoeker	Ontwerper	Adviseur
Competentieset werktuigbouw & hbo algemeen				
nr.	Competenties werktuigbouwkunde			
1	Project management uitvoeren (organiseren, plannen, uitvoeren, verslag opstellen	3	3	3
2	Een onderzoeksopdracht uitvoeren	3	3	3
3	Het kunnen opstellen van productdefinitie, pva en pve voor een duurzaam product of proces	3	3	3
4	Het realiseren van een functioneel duurzaam product of voortbrengingsproces	3	3	4
5	Het realiseren van een detailontwerp voor een duurzaam product of voortbrengingsproces		3	3
6	Het realiseren van een prototype/model van een duurzaam product of voortbrengingsproces		4	4
7	Het voorbereiden van een voortbrengingsproces		3	3
8	Het produceren van een duurzaam product		3	3
9	Het beheren of onderhouden van een product of proces	3	3	3
nr.	Algemene hbo competenties			
10	Kritisch handelen (analytisch en probleem oplossend vermogen en het onderbouwen van keuzen, oordeelsvorming)	3	4	4
11	Systematisch een probleem aanpakken (creatieve, plan- en projectmatige werkhouding)	4	3	3
12	Samenwerken (sociaal communicatieve vaardigheden)	3	3	4
13	Persoonlijke en professionele ontwikkeling	4	3	4
14	Zelfverantwoordelijk werken	4	4	4
15	Kunnen functioneren in een internationale en/of multiculturele context	3	3	3

Deze competenties waren bij Kverneland goed te verbeteren. Door de zelfstandige uitvoering van de opdracht heb ik de competentie van zelfverantwoordelijk werken kunnen verbeteren. De competenties voor het realiseren van een model van een prototype/model van een duurzaam product of voortbrengingsproces heb ik ook kunnen verbeteren met het realiseren van het ontwerp van de frame manipulator. De competentie kritisch handelen heb ik verbeterd door een systematisch aanpak te gebruiken om het ontwerp te kunnen realiseren door het probleem goed te analyseren en slimme keuzen te maken voor de oplossingen.
De competentie persoonlijke en professionele ontwikkeling is aanbod gekomen bij het leren werken met een CAD programma waarmee ik niet bekend was.

Appendix II Bobtail bolts

ANATOMY OF THE HUCK BOBTAIL®

HUCK®

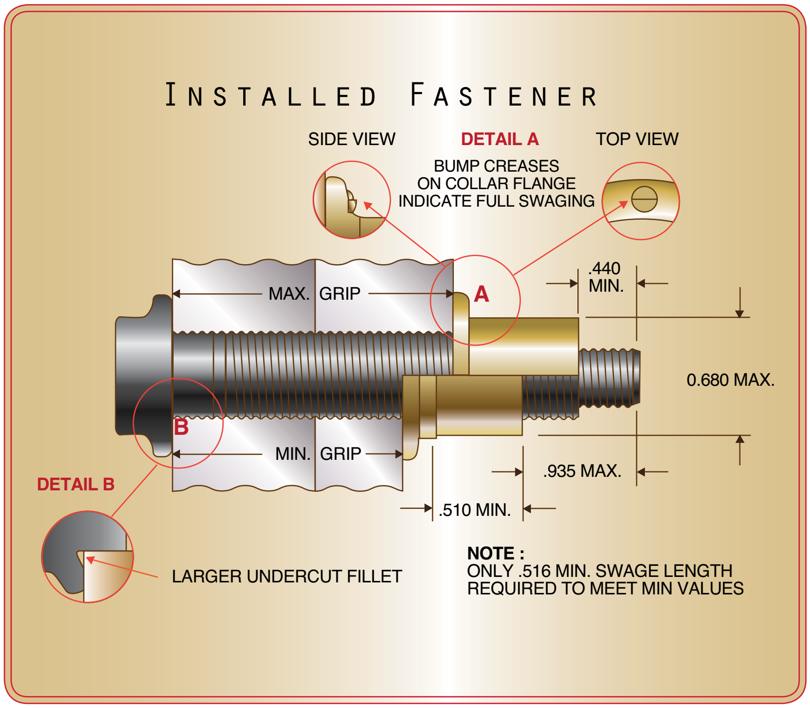
Alcoa Fastening Systems

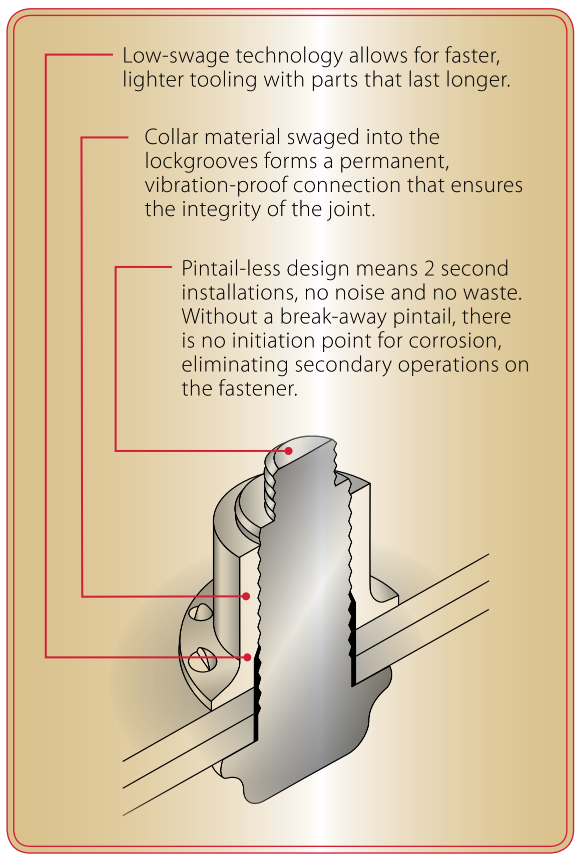
ALCOA

An engineer's-eye view of what makes a BOBTAIL® superior in strength and vibration resistance.

The Huck BOBTAIL® lockbolt is Huck-engineered to deliver superior strength and reliability. Offering 5 to 10 times the fatigue strength of conventional nuts and bolts, the BOBTAIL is preferred for heavy-duty applications where ultimate vibration resistance is critical. Its shallow thread and large root radius increase fatigue strength. And full metal-to-metal contact between the collar wall and the bolt threads eliminates the gap that you find with ordinary nuts and bolts; the kind of gap that can lead to loosening under vibration intensive conditions. In addition, the Huck BOBTAIL is fast and easy-to-install with light, ergonomic tooling, ensuring efficiency on the manufacturing floor.

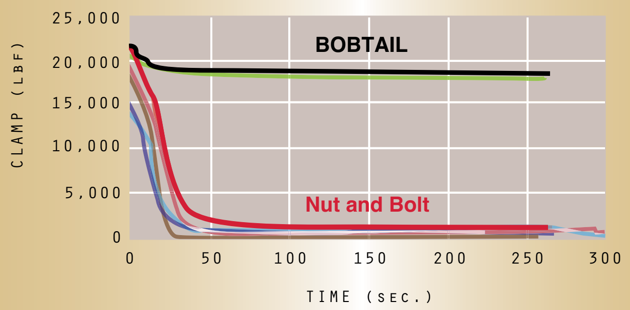
The detailed specifications charts and images in this flyer illustrate BOBTAIL performance in more detail, as compared to nuts and bolts.





Transverse Vibration Comparison

14mm class 10.9



TRANSVERSE VIBRATION COMPARISON

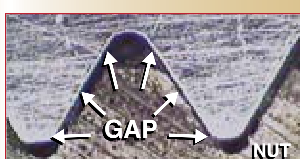
This chart shows that once vibration begins, clamp load quickly decays with conventional nuts and bolts, while it holds constant with the BOBTAIL.

Gap Elimination Schematic

LOCKBOLT

The swaged collar forms over the lock thread, and eliminates the gap.

STD. BOLT

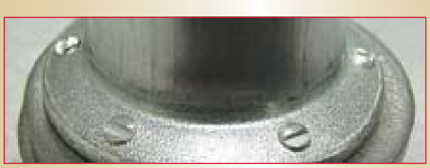


Regular nuts and bolts have gap, which allows for loosening by vibration.

GAP ELIMINATION SCHEMATIC

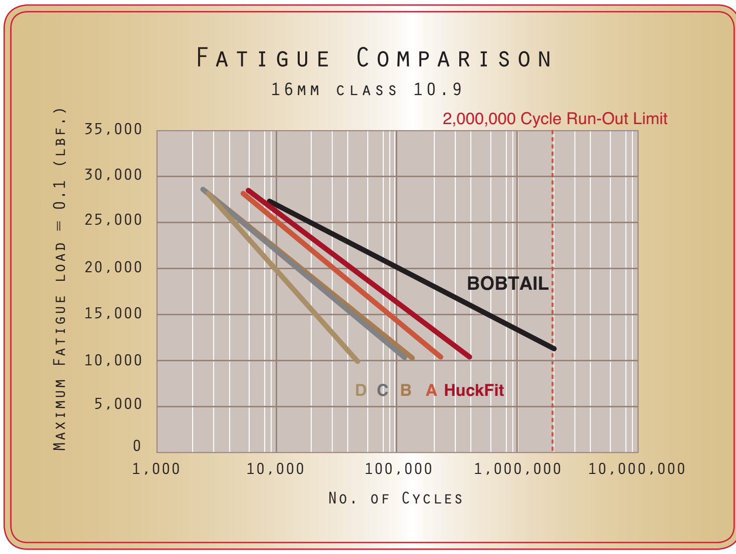
The photos illustrate the gap that occurs in the design of nuts and bolts. It's this gap condition which promotes loosening in conventional threaded fasteners. The BOBTAIL design practically eliminates gaps. Huck engineers have made this possible by ensuring full metal-to-metal contact between the swaged on collar and the lockbolt, providing vibration resistance even in the most severe environments.

Collar Design



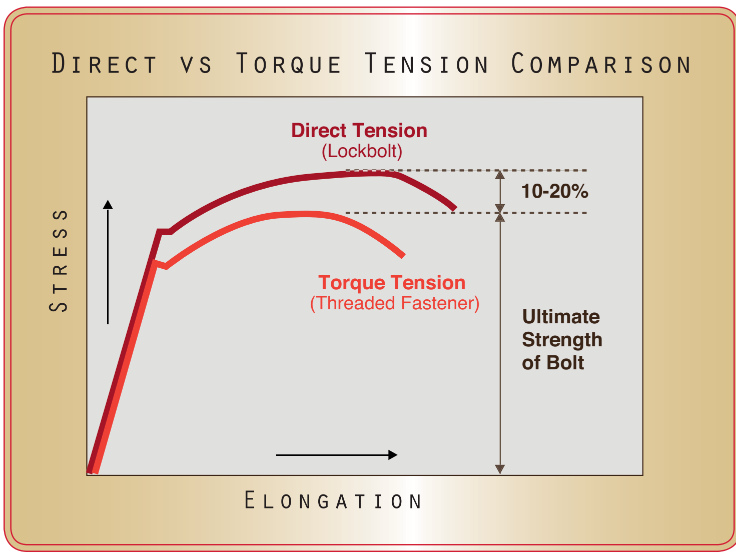
COLLAR DESIGN

The bump crease in the collar flange -- a proprietary HUCK design -- indicates the BOBTAIL has been fully swaged on. A quick visual inspection is all that is required to ensure complete installation.



FATIGUE COMPARISON

This chart illustrates the number of cycles required for a variety of nut and bolt types to reach fatigue under vibratory conditions. Notice the BOBTAIL reaches a 2,000,000 cycle run-out limit before fatigue.



DIRECT TENSION / YIELD STRENGTH

Because Huck BOBTAIL lockbolts are not subjected to torsion during installation, they can safely be taken to higher preload values than conventional bolts. BOBTAIL installation is under direct tension only, while conventional bolts are under a combination of tension and torsion during installation.

Conventional bolts develop torsional forces from friction and geometric factors between the mating threads, resulting in a reduction of yield and tensile strength of 10% to 20%. The torque-tension relationship is shown in the chart to the left.

For more information, visit
alcoafasteners.com/bobtail

HUCK®

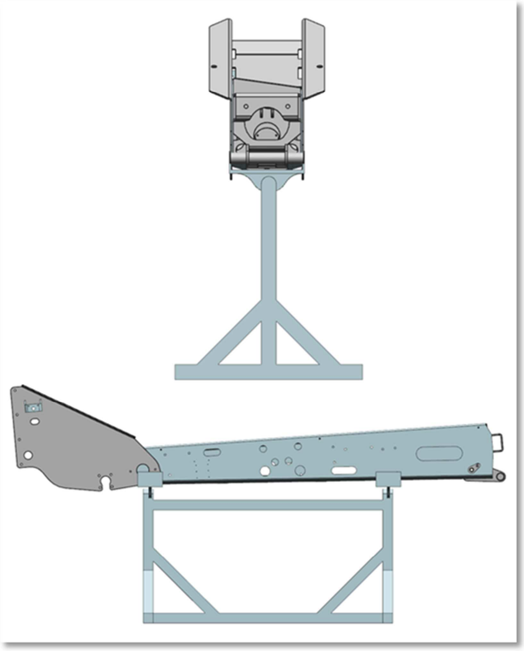
Alcoa Fastening Systems

ALCOA

AF1033 04/09

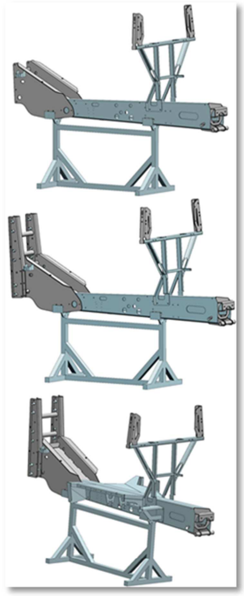
Appendix III Test build storyboard

Step 1



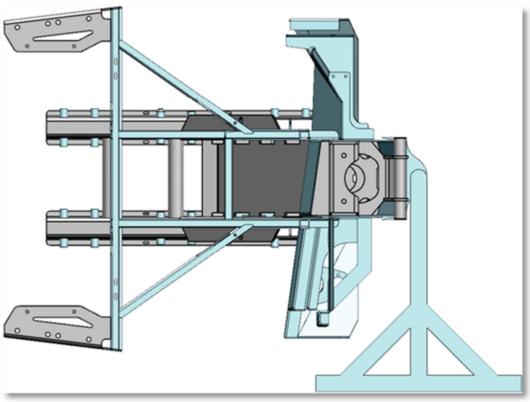
- Mount frame on trestle

Step 2



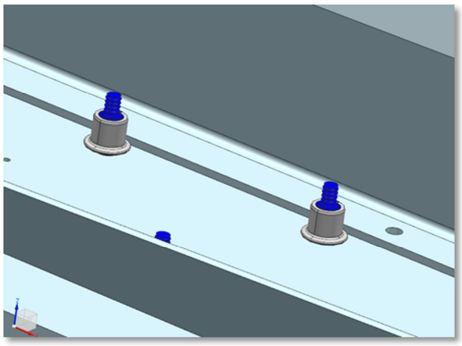
- Mount front arc
- Mount rear arc
- Mount tank brackets
- Hand tighten bobtail bolts

Step 3



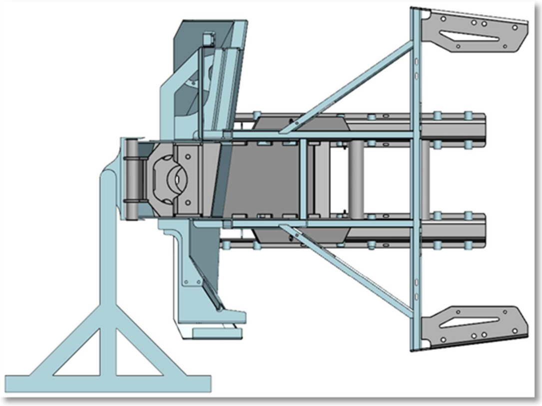
- Tilt 90 degrees

Step 4



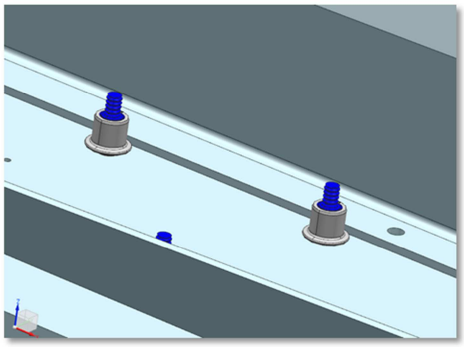
- Swage bobtail bolts

Step 5



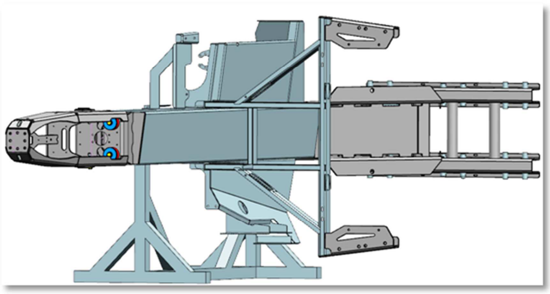
- Tilt 180 degrees

Step 6



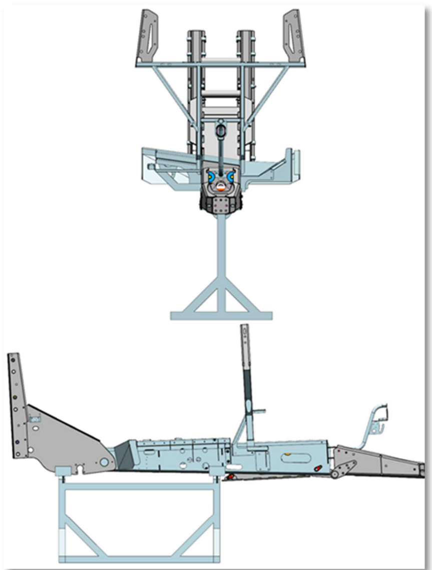
- Swage remaining bobtail bolts

Step 7



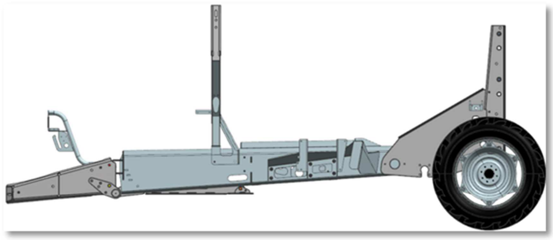
- Route hoses and cables
- Install trailer tongue
- Install trailer jack
- Install trailer jack hydraulic cylinder (if applicable)

Step 8



- Tilt 90 degrees to starting position

Step 9



- Remove frame from trestle and lower onto the axle assembly

Appendix IV Gear motor specs

Product information

AC gearmotor

FAF107R77DRE80M4BE05

Rated motor speed	[1/min]	: 1435
Output speed	[1/min]	: 1,1
Overall gear ratio		: 1263,00
Output torque	[Nm]	: 5690
Service factor SEW-FB		: 1,40
input mounting position/IM		: M3
Position of connector/terminal box	[°]	: 0
Cable entry/connector position		: X
Hollow shaft	[mm]	: 90
Permitted output overhung load with n=1400	[N]	: 65000
Lubricant quantity 1st gear unit	[Liter]	: 19,5
Lubricant quantity 2nd gear unit	[Liter]	: 1,2
Flange diameter	[mm]	: 450
Motor power	[kW]	: 0,75
Duration factor		: S1-100%
Efficiency class		: IE2
Efficiency (50/75/100% Pn)	[%]	: 79,2 / 81,3 / 81
CE mark		: Yes
Motor voltage	[V]	: 230/400
Wiring diagram		: R13
Frequency	[Hz]	: 50
Rated current	[A]	: 2,9 / 1,68
Cos Phi		: 0,79
Thermal class		: 155(F)
Motor protection type		: IP55
Design requirement		: IEC
Net weight	[Kg]	: 277,7
Braking torque	[Nm]	: 5
Brake voltage	[V]	: 230

Additional feature and Options:
BE05- SEW - disk brake
BG - Simple rectifier
Enclosure IP 55 - brake motor
Thermal classification 155(F)

The technical data are subject to a final technical inspection.
This inspection is made upon the creation of a quotation/an offer.
You can find the exact net weight on the order confirmation. For technical reasons, the real weight may differ from this information.
Created on: 2014-10-03 09:55:59 / Richard Maduro / Haagse hogeschool
DC Version 2.15 SP1

Page 1 from 1

Appendix V Büter technical questionnaire

BÜTER® Technical questionnaire

QM- FORMULAR

Customer:		Date:	22-10-2014
Customer article number:	VNRAM-0012	Name:	R Maduro
Büter article number:			

Operating conditions:

Operating times	continuous ☐	partial ☐
Number of cycles: 3 per day	No. of operating days: 230 per year	Life time: 15 year
Maximum stroke speed:	Rectracting: 62 mm/s	Extending: 62 mm/s
Forces when extending: 1400 daN		
Forces when retracting: 1400 daN		
Maximum operating pressure: 200 bar	Test pressure: bar	
Stroke limitation when extending :	Outside the cylinder ☐	Inside the cylinder ☒
Stroke limitation when retracting:	Outside the cylinder ☒	Inside the cylinder ☐
Impact loads during operation (accelaration of the piston rod by external loads)	When retracting ☐ / When extending ☐	no ☒
Radial forces or loads	yes ☒	no ☐
Vibrations of the piston rod under load (damping cylinder):	yes ☐	no ☒
Overpressure (peak pressure > 300 bar):	yes ☐	no ☒
Operation until final position	yes ☒	no ☐
Further remarks : Production tool		

Environmental conditions:

Branch:	Surrounding temperature:	Temperature range of the hydraulic oil:
Intended purpose/ operation: Lifting operation		
Physical: ☐ Dust ☐ Sea air ☐ Stone chipping ☐ Mud ☐ Splicing		
Chemical:	yes ☐	no ☒
Operating position:	Piston rod retracted ☐	Piston rod extended ☒
Transport position:	Piston rod retracted ☐	Piston rod extended ☐
Rest position:	Piston rod retracted ☒	Piston rod extended ☐
Special demands on the piston rod:		

Safety criteria:

Stopping by static loads :	yes ☐	no ☐	Required safety factor:
Stopping by dynamic loads :	yes ☐	no ☐	
Bend/break rise:	yes ☒	no ☐	
Rise of personal injury:	yes ☒	no ☐	

Special demands:

Paint coating of the cylinder housing:	primed ☒	yes ☐	Colour: RAL 5017	Layer thickness: (Standard ca. 50μm)
	painted ☒	yes ☐	Coulour: RAL 5017	Layer thickness: (Standard ca. 80μm)
Applied oil viscosity:				
Special seal types :				
Connections:	Fixed pipe ☒	hose ☐		

The cylinders are delivered with a retracted piston rod and closed connections!

	Datum	Name	Stand	Datei
Erstellt	18.01.11	L. Rüther	18.01.11	Fo_TechnischerFragebogenEN.docx
Geprüft	18.01.11	R. Graaf	a	Seite 1 von 1

Appendix VI Shear and compressive strain analysis

The following analyses have been made to confirm if the selected diameter will be sufficient for the locking pins of the frame manipulator.

Effective shear stress

$$\tau = \frac{F}{A}$$

$$\tau = shear\ stress$$
$$F = applied\ force\ [N] = 11281{,}5\ [N]$$
$$A = stressed\ material\ diameter == 1/4\pi 30^2$$

$$\tau = \frac{11281{,}5}{1/4\pi 30^2} = 15{,}9\ \left[\frac{N}{mm^2}\right]$$

Maximum allowable shear stress

$$\overline{\tau} = 0{,}5 * ReH$$
$$ReH = \ elastic\ limit/\ yieldpoint\ \left[\frac{N}{mm^2}\right]$$
$$\tau = \ shear\ stress$$

The pins will be made from S235 steel, which has a yield point of 235 $\left[\frac{N}{mm^2}\right]$

$$\overline{\tau} = 0{,}5 * 235 = 117{,}7\ \left[\frac{N}{mm^2}\right]$$

The effective shear stress is compared to the maximum allowable shear stress to verify the pins will be able to withstand the stress that will be applied to them.

$$\overline{\tau} \geq \tau$$
$$117{,}7 \geq 15{,}9$$

The shear stress in this situation is smaller than the maximum allowable shear stress, thus the chosen diameter can be used for the pins.

Compressive strain

The compressive strain is also calculated to verify the pins can withstand the stress and not deform under stress. The minimum required safety factor for the pins is a factor 5.

$$\tau_{compst} = \frac{F}{A_{proj}}$$

$$A_{proj} = 15 * 30 = 450\ [mm^2]$$

$$\tau_{compst} = \frac{11281{,}5}{450} = 25{,}07\ \left[\frac{N}{mm^2}\right]$$

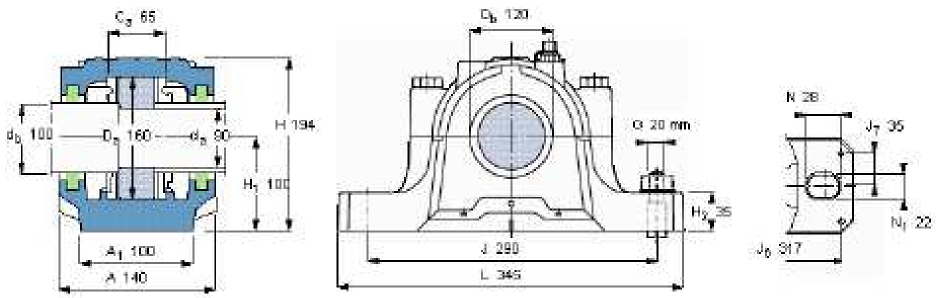
$$V_{pen} = \frac{235}{25{,}07} = 9{,}37$$

Appendix VII SKF bearing housing specifications

SKF

Split plummer block housings, SNL series for bearings with a cylindrical bore, with standard seals

Shaft		Appropriate bearings (basic designation) Self-aligning ball bearings		Spherical roller bearings		CARB bearing	Designat Housing
da	db						
mm		-					
90	100	1218	2218	22218	23218	C 2218	SNL 218



Order designations
Housing only SNL 218
Seals

TSN 218 L	TSN 218 A	2 x TSN 218 S	2 x TSN 218 ND	End cover ASNH 218

Appropriate SKF bearings and accessories

Bearing	Lock nut	Locking device	Locating rings
1218	KM 18	MB 18	2 x FRB 17,5/160
2218	KM 18	MB 18	2 x FRB 12,5/160
22218 E	KM 18	MB 18	2 x FRB 12,5/160
23218 CC/W33	KM 18	MB 18	2 x FRB 6,25/160
C 2218	KMFE 18	-	2 x FRB 12,5/160

Cap bolts

Size [mm]	M 16x90
Rec. tightening torque [Nm]	150

Max permissible load

$F_{120°}$	170
$F_{150°}$	100
$F_{180°}$	85

Appropriate attachment bolts

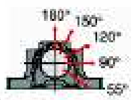
Size [mm]	20
Rec. tightening torque [Nm]	385

Dowel dimensions

Diameter (max)	8
Centre distance J_6	317
Centre distance J_7	35

Breaking loads, housing [kN]

$P_{0°}$	430
$P_{55°}$	550
$P_{90°}$	340
$P_{120°}$	250
$P_{150°}$	215
$P_{180°}$	275
P_a	180



The limit for $P_{0°}$ applies only when the housing is not supported over its entire base area

Grease quantities [kg]

Initial fill	0,43
Regreasing	0,04

Appendix VIII Laser cutting time calculation

The following worksheet is used in Excel to calculate how much time the laser needs to cut a part Using NX 8.0 the cutting contours are calculated and inserted in to the following Excel sheet.

VNRAM-0059				
1390	Contour			
0	Contour			
0	Gat			
1390	Length	0,84	Length/speed	
		0,03	Overspring	
		0,028571	1/amount from plate	
		0,90	**1,081**	time*factor kaputt

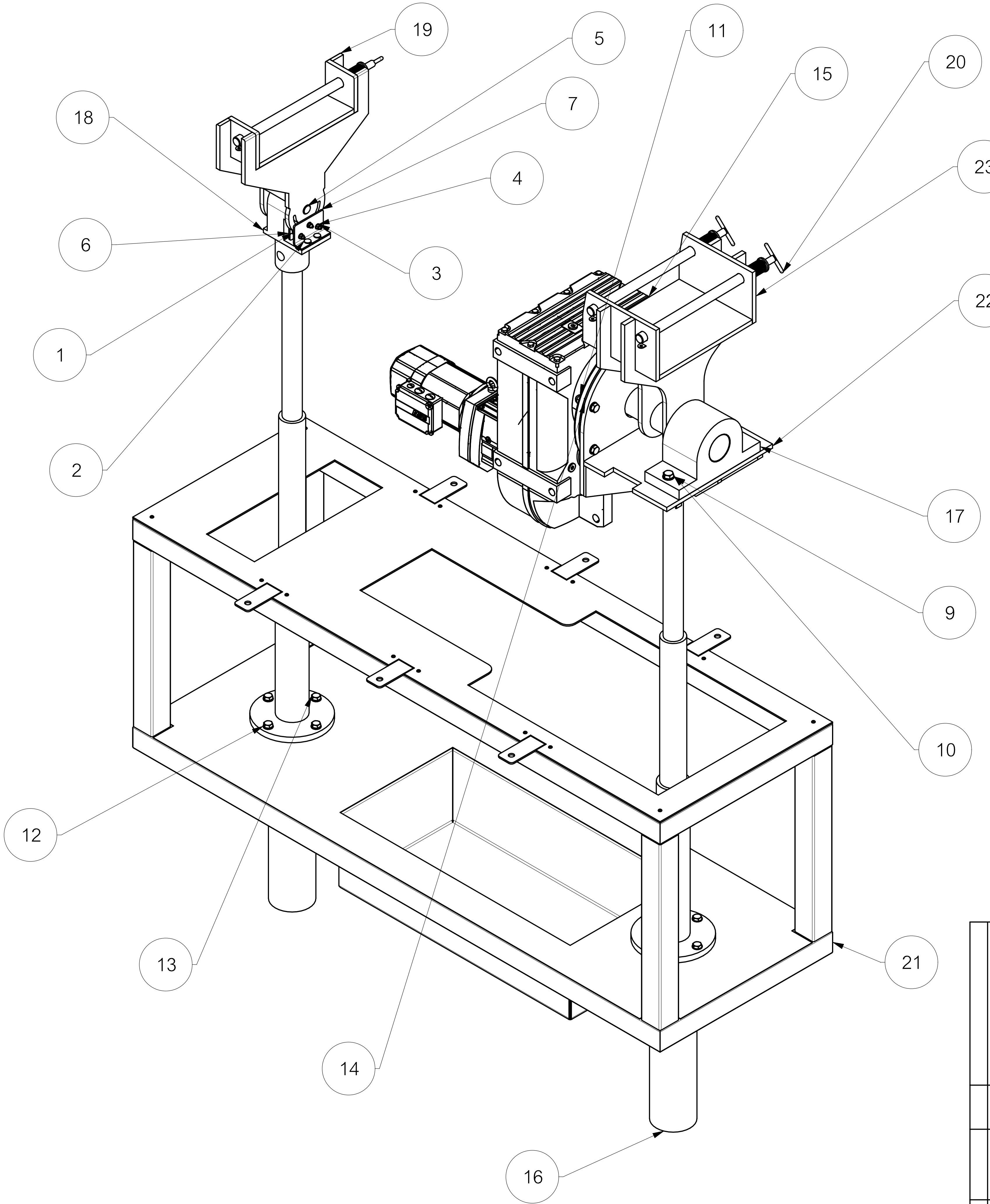
After this calculation has been repeated for each part the required time can be summed up so that the costs of the laser can be calculated.

Appendix IX Parts List

NX Part number	Description	Qty.	Material
VNRAM-0053	Support clamp clevis	1	S235
VNRAM-0055	Frame manipulator assembly	-	-
VNRAM-0059	Tilt clamp base plate	1	S235 15mm sheet metal
VNRAM-0060	Tilt clamp side plates	2	S235 15mm sheet metal
VNRAM-0063	Tilt clamp hinge plates	2	S235 15mm sheet metal
VNRAM-0064	Tilt clamp assembly	-	-
VNRAM-0065	Tilt clamp shaft	1	S235 90mm round
VNRAM-0067	Support clamp base plate	1	S235 15mm sheet metal
VNRAM-0068	Support clamp side plate 1	1	S235 15mm sheet metal
VNRAM-0069	Support clamp plain hinge plate	1	S235 15mm sheet metal
VNRAM-0070	Support clamp braked hinge plate	1	S235 15mm sheet metal
VNRAM-0072	Support clamp assembly	-	-
VNRAM-0073	Support clamp side plate 2	1	S235 15mm sheet metal
VNRAM-0074	Gear motor mounting flange	1	S235 15mm sheet metal
VNRAM-0075	Mounting frame base plate	1	S235 15mm sheet metal
VNRAM-0076	Mounting frame assembly	-	-
VNRAM-0077	Mounting frame diagonal flange reinforcement	2	S235 15mm sheet metal
VNRAM-0079	Mounting frame diagonal reinforcement 1	1	S235 15mm sheet metal
VNRAM-0080	Mounting frame diagonal reinforcement 2	1	S235 15mm sheet metal
VNRAM-0081	Mounting frame housing reinforcement	1	S235 15mm sheet metal
VNRAM-0082	Mounting frame perpendicular reinforcement	1	S235 15mm sheet metal
VNRAM-0083	Support clamp end position limit plate	2	S235 15mm sheet metal
VNRAM-0084	Clamp brake supported plate	1	S235 5mm sheet metal
VNRAM-0085	Clamp brake secondary plate	1	S235 5mm sheet metal
VNRAM-0087	Inductive sensor holder	3	S235 1mm sheet metal
VNRAM-0088	Pin lock	3	S235 34mm round
VNRAM-0092	Gear motor box	1	S235 1mm sheet metal
VNRAM-0095	Base frame beam long	4	S275 80*80*5 square tubing
VNRAM-0096	Base frame beam short	4	S275 80*80*5 square tubing
VNRAM-0097	Base frame pillars	4	S275 80*80*5 square tubing
VNRAM-0098	Cylinder base	2	S235 15mm sheet metal
VNRAM-0099	Base frame floor plate	1	S235 1mm sheet metal
VNRAM-0100	Base frame securing plates	6	S235 5mm sheet metal
VNRAM-0101	Base frame cover plate	1	S235 5mm sheet metal
VNRAM-0102	Base frame assembly	-	-
VNRAM-0104	Gear motor flange spacer	1	S235 5mm sheet metal
VNRAM-0105	Support clamp hinge pin	3	S235 30mm Round

KVG Part number	Description	Qty.	Material
KG01069900	Lock nut M8	5	Stainless steel
KG01263900	SS washer M8	5	Stainless steel
KG00652900	Carriage bolt M8*30	2	Stainless steel
KG00653200	Carriage bolt M8*50	3	Stainless steel
KG00750700	Tapping screw 5,5*19	16	Stainless steel
KG00362362	Hex bolt M16 *70	16	Steel
KG01267762	Washer M16	32	Steel
KG01072662	Lock nut M16	16	Steel
KG00365162	Hex Bolt M18 * 100	2	Steel
VN30597900	Hex nut M18	2	Steel
KG01267862	Washer M18	4	Steel

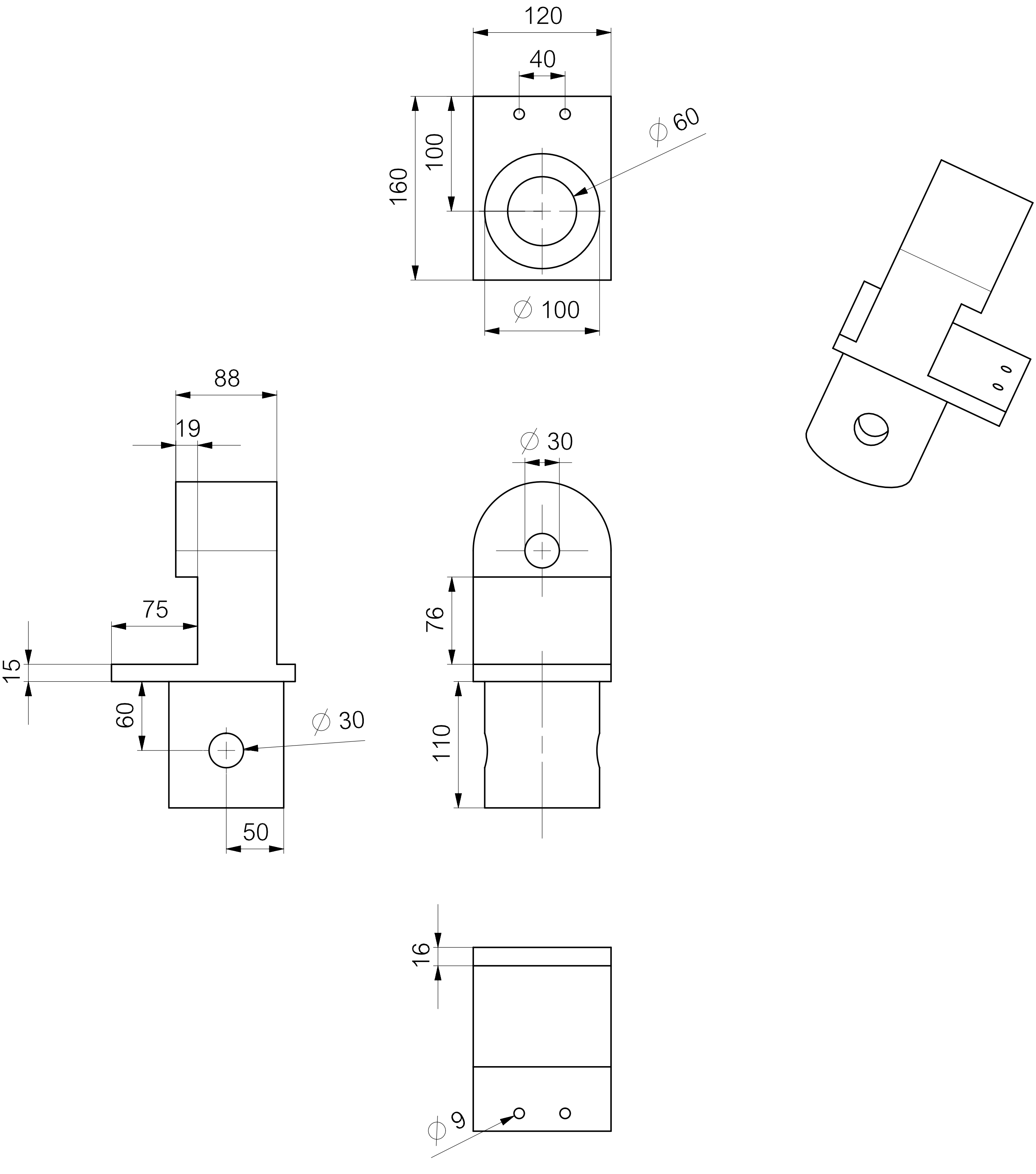
Appendix X Engineering drawings



Pos.	Number	Qt.	Item name
23	VNRAM-0064	1	Tilt clamp assembly
22	VNRAM-0076	1	Mounting frame assembly
21	VNRAM-0102	1	Base frame assembly
20	VNRAM-0089	3	Frame locking pin
19	VNRAM-0072	1	Support clamp assembly
18	VNRAM-0053	1	Support clamp clevis
17	VNRAM-0049	1	SKF bearing housing mockup
16	VNRAM-0012	2	Hydraulic cylinder
15	VNRAM-0086	1	SEW Gear motor
14	VNRAM-0104	1	Gear motor flange spacer
13	KG00362362	16	HEX. BOLT M16X70 8.8
12	KG01267762	32	WASHER M16
11	KG01072662	16	LOCK NUT M16 8
10	KG00365162	2	HEX. BOLT M18X100 8.8
9	KG01267862	4	WASHER M18
8	VN30597900	2	LOCK NUT M18 8
7	VNRAM-0084	1	Clamp brake supported plate
6	VNRAM-0085	1	Clamp brake secondary plate
5	VNRAM-0105	1	Support clamp hinge pin
4	KG01069900	5	LOCK NUT M8 A2
3	KG01263900	5	WASHER M8 A2
2	KG00652900	2	CARRIAGE BOLT M8X30 A2
1	KG00653200	3	CARRIAGE BOLT M8X50 A2

Description of Change | Person | Date | RvMo

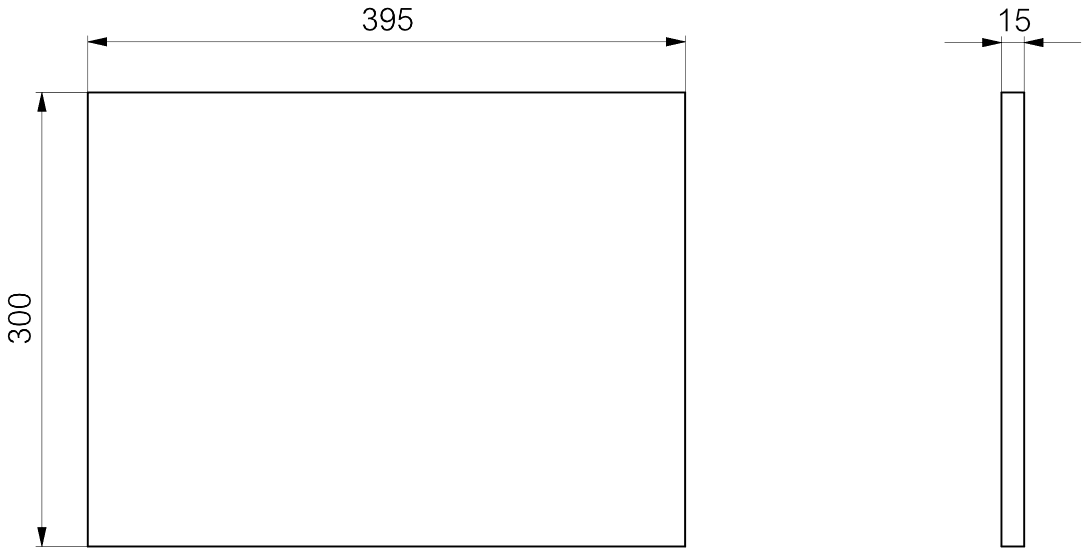
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 15-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department:	
Tolerance: ISO 2768-1-Coarse		Item name: Frame manipulator assembly -		
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0055	Revision: 01
Scale:			VNRAM-005586=RAL7021 VNRAM-005584=RAL1003 VNRAM-005593=DELTATONE	VNRAM-005594=RAL3000 VNRAM-005588=RAL6016 VNRAM-0055 / VNRAM-0055 VNRAM-0055 VNRAM-0055
Reference: -				
Units in mm	Proj	NX A3	Replacement for: -	NX drafting version: 01.001 / State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 40	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	
Tolerance ISO 2768-1-Coarse		Item name: Support clamp clevis -		
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0053	Revision 01
Scale:				
Reference: -			VNRAM-005386=RAL7021 VNRAM-005384=RAL1003 VNRAM-005393=DELTATONE	VNRAM-005394=RAL3000 VNRAM-005388=RAL6016 VNRAM-0053 · VNRAM-0053 VNRAM-0053 VNRAM-0053
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001 · State: Wip

Description of Change · Person · Date · RvMo



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance: ISO 2768-1-Coarse

Item name: Tilt Clamp base plate

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

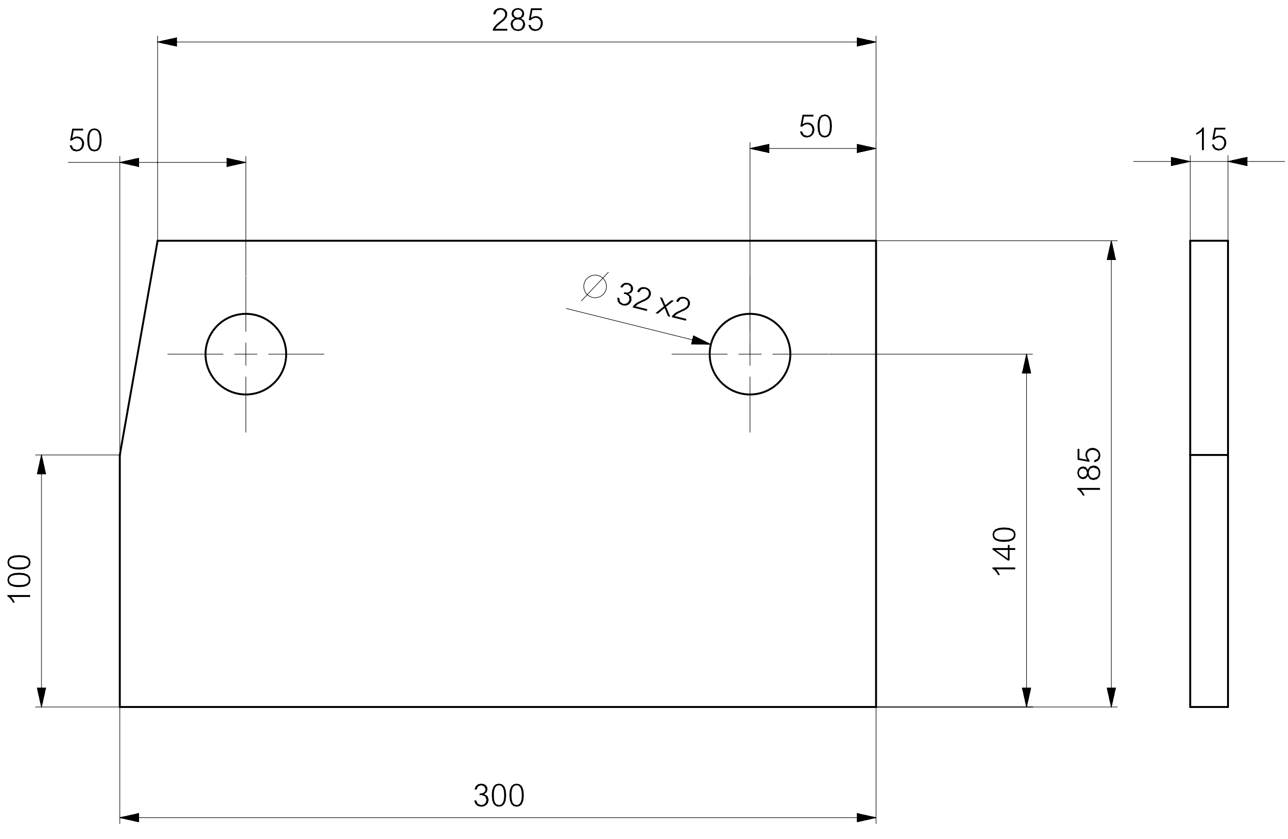
Item number: VNRAM-0059

Revision: 01

VNRAM-005986=RAL7021 VNRAM-005994=RAL3000 VNRAM-0059
VNRAM-005984=RAL1003 VNRAM-005988=RAL6016 VNRAM-0059
VNRAM-005993=DELTATONE VNRAM-0059 VNRAM-0059

Description of Change | Person | Date | RvMo

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer:	Drafter:	Date 1. creation:	Project:	Treatment/Other:
gr_rma	gr_rma	08-Dec-2014	-	-

Approved by:	Approval date:	Weight:	Responsible department:
	00-Jan-0	Kg	C

Tolerance
ISO 2768-1-Coarse

Item name:
Tilt clamp side plates
-

Surface roughness:
ISO 1302

Scale:

Reference:
-

Legal owner:
kverneland group

Item number:
VNRAM-0060

Revision
01

VNRAM-006086=RAL7021
VNRAM-006084=RAL1003
VNRAM-006093=DELTATONE
VNRAM-006094=RAL3000
VNRAM-006088=RAL6016
VNRAM-0060
VNRAM-0060
VNRAM-0060
VNRAM-0060

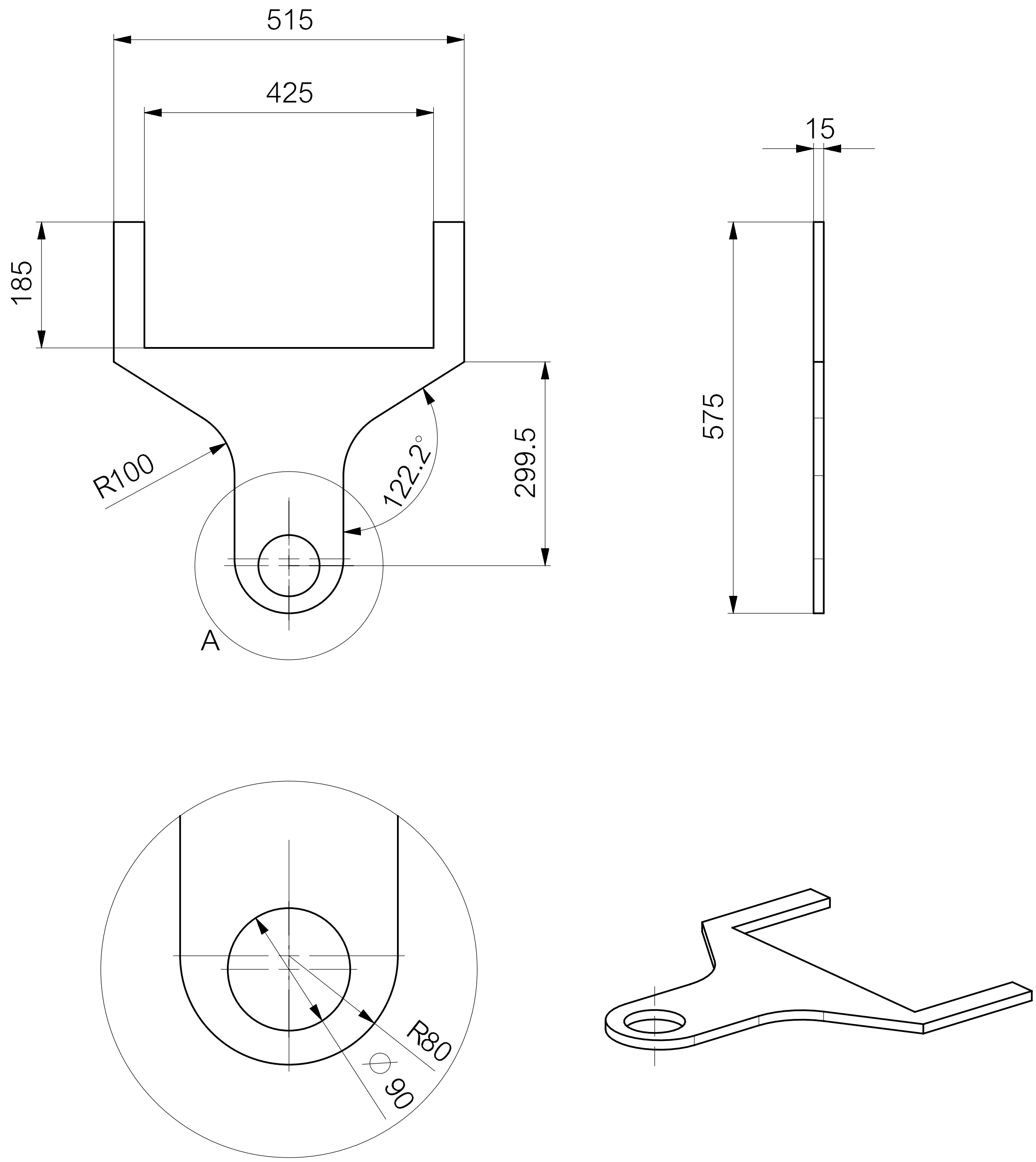
Units in mm | Proj | NX A4v

Replacement for:
-

NX drafting version:
01.001

State:
Wip

Description of Change | Person | Date | RvMo



DETAIL A
SCALE 1:5

S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: ©	

Tolerance: ISO 2768-1-Coarse

Item name: Tilt clamp hinge plates
-

Surface roughness: ISO 1302

Legal owner: kverneland group

Item number: VNRAM-0063

Revision: 01

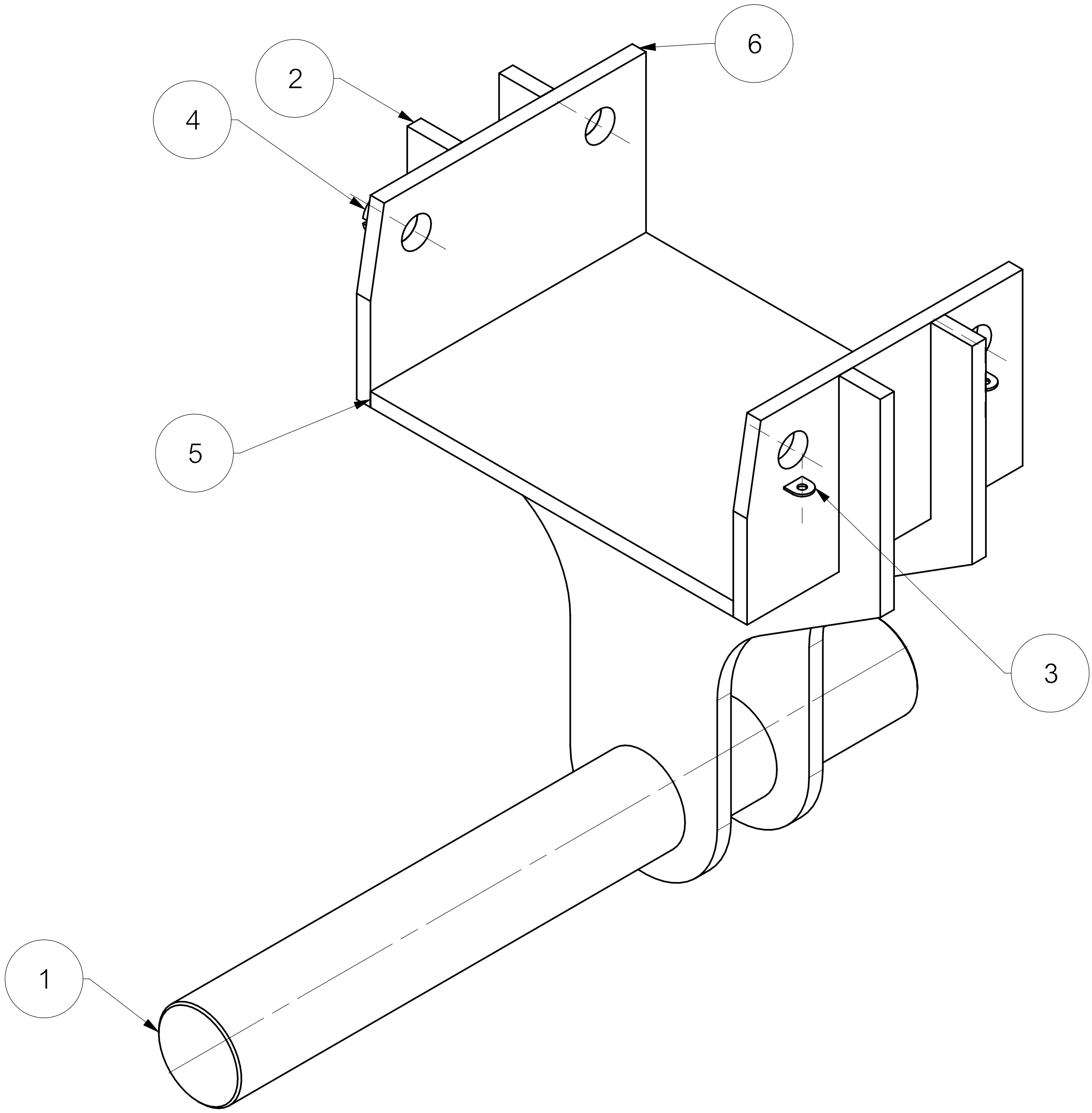
Scale:

Reference: -

VNRAM-006386=RAL7021
VNRAM-006384=RAL1003
VNRAM-006393=DELTATONE
VNRAM-006394=RAL3000
VNRAM-006388=RAL6016
VNRAM-0063
VNRAM-0063
VNRAM-0063
VNRAM-0063

Description of Change | Person | Date | RvMo

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip



Pos.	Number	Qt.	Item name
6	VNRAM-0060	2	Tilt clamp side plates
5	VNRAM-0059	1	Tilt clamp base plate
4	VNRAM-0088	2	Pin lock
3	VNRAM-0087	2	Inductive sensor holder
2	VNRAM-0063	2	Tilt clamp hinge plates
1	VNRAM-0065	1	Tilt clamp shaft

Description of Change

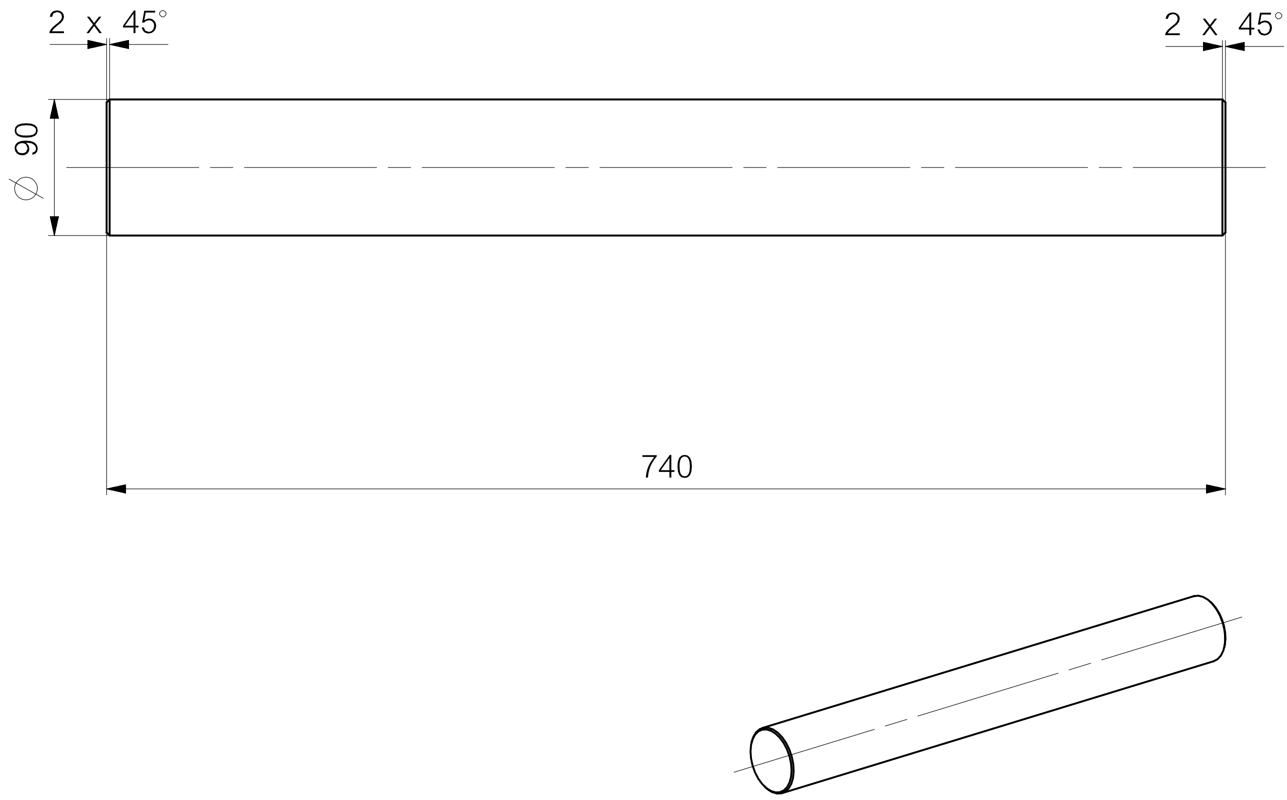
Person

Date

RvMo

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 12-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	
Tolerance ISO 2768-1-Coarse		Item name: Tilt clamp assembly -		
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-064	Revision 01
Scale:				
Reference: -			VNRAM-06486=RAL7021 VNRAM-06484=RAL1003 VNRAM-06493=DELTATONE VNRAM-06494=RAL3000 VNRAM-06488=RAL6016 VNRAM-064 VNRAM-064 VNRAM-064 VNRAM-064	
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001 State: Wip

WIP



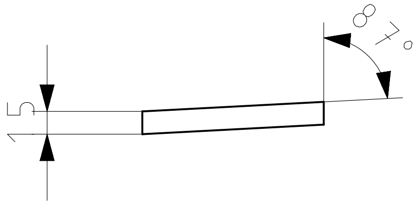
S235JRC+C/SH/ Mat.nr.:10122	EN 10277-2	Rd. 90h9		EN 10278
Material	Norm	Dimension		Norm
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	
Tolerance: ISO 2768-1-Coarse	Item name: Tilt clamp shaft -			
Surface roughness: ISO 1302	Legal owner: kverneland group	Item number: VNRAM-0065		Revision: 01
Scale:				
Reference: -		VNRAM-006586=RAL7021 VNRAM-006584=RAL1003 VNRAM-006593=DELTATONE	VNRAM-006594=RAL3000 VNRAM-006588=RAL6016 VNRAM-0065	VNRAM-0065 VNRAM-0065 VNRAM-0065
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001
				State: Wip

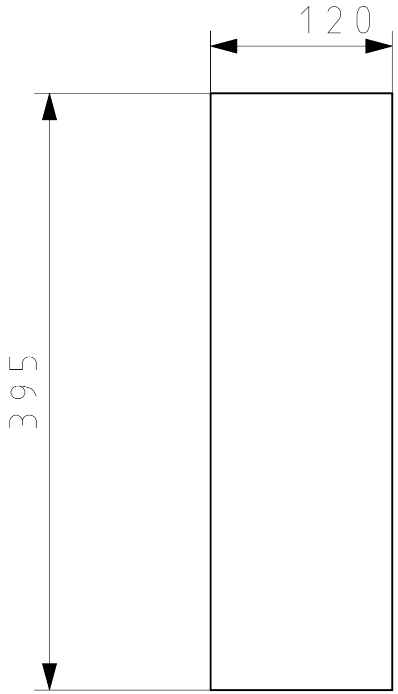
Description of Change

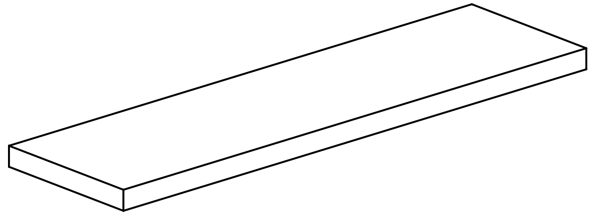
Person

Date

RvMo







S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: x.xx Kg	Responsible department: C	

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp baseplate
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0067

Revision: 01

VNRAM-006786=RAL7021	VNRAM-006794=RAL3000	VNRAM-0067
VNRAM-006784=RAL1003	VNRAM-006788=RAL6016	VNRAM-0067
VNRAM-006793=DELTATONE	VNRAM-0067	VNRAM-0067

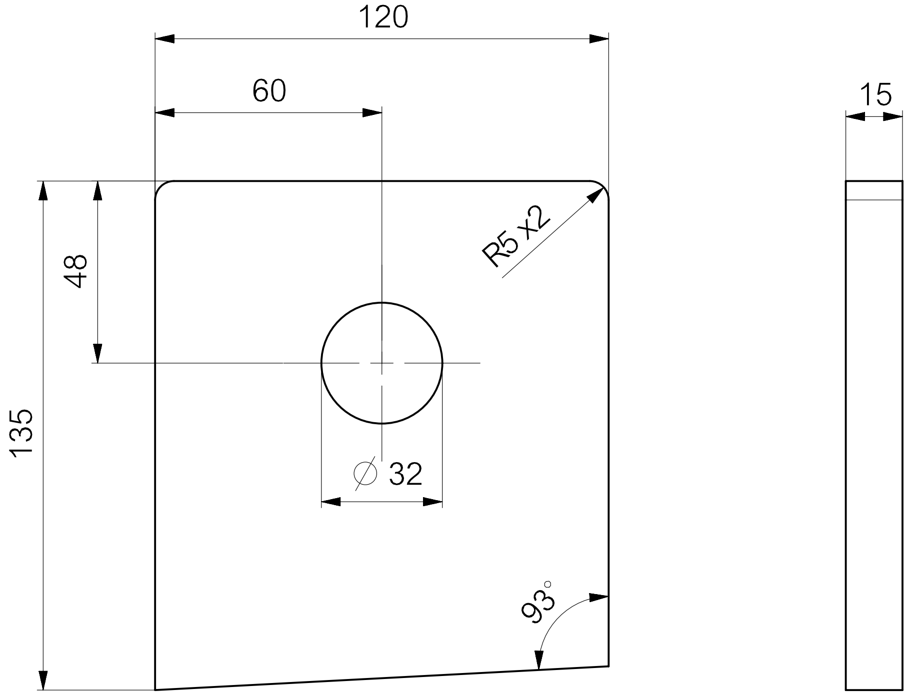
Units in mm | Proj | NX A4

Replacement for: -

NX drafting version: 01.001

State: Wip

Description of Change | Person | Date | RvMo



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 12-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: ©	

Description of Change | Person | Date | RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp side plate 1 -

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-068

Revision: 01

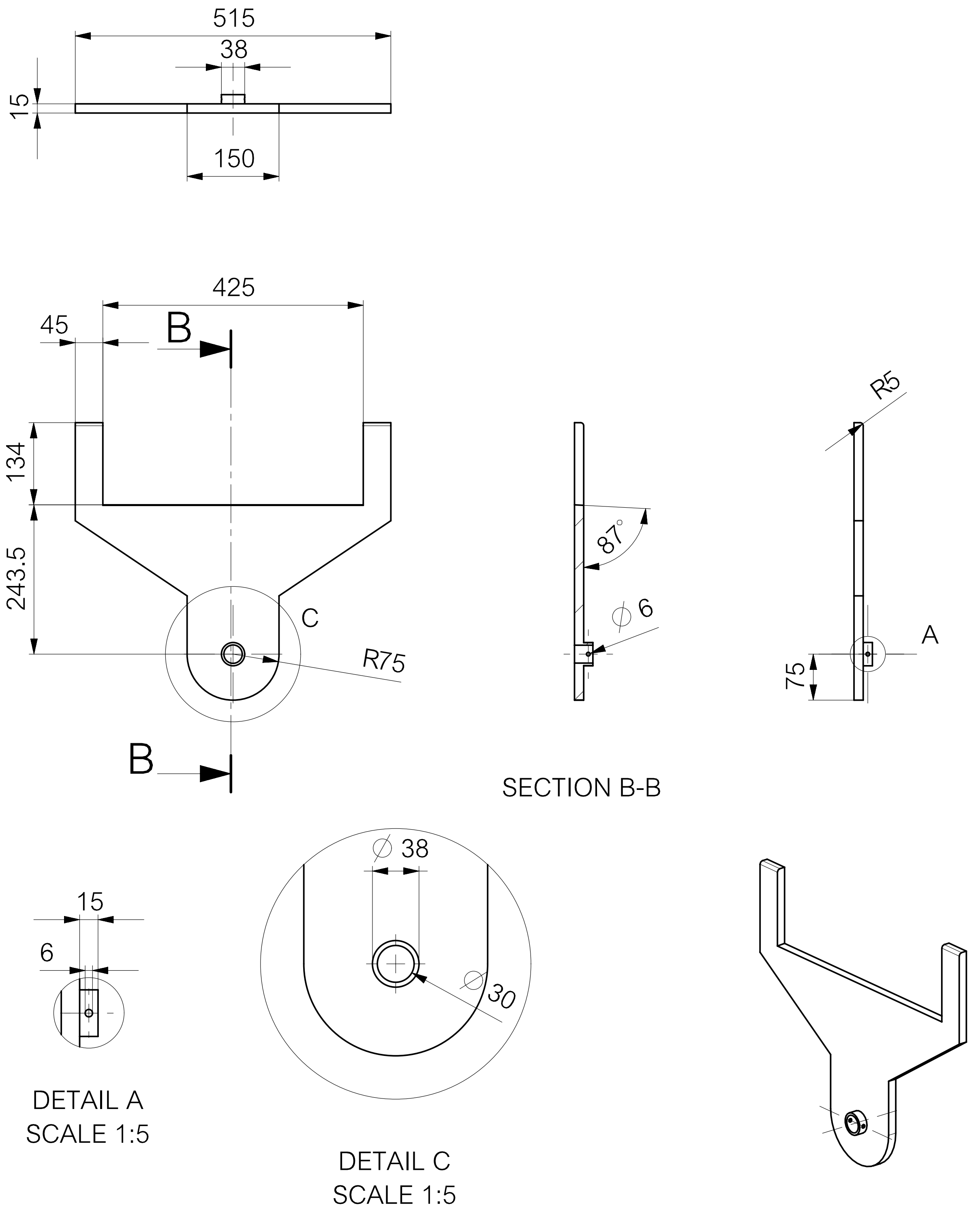
VNRAM-06886=RAL7021 VNRAM-06894=RAL3000 VNRAM-068
VNRAM-06884=RAL1003 VNRAM-06888=RAL6016 VNRAM-068
VNRAM-06893=DELTATONE VNRAM-068 VNRAM-068

Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Description of Change

Designer: gr_rma | Drafter: gr_rma | Date 1. creation: 08-Dec-2014 | Project: - | Treatment/Other: -

Approved by: | Approval date: 00-Jan-0 | Weight: Kg | Responsible department: C

Tolerance: ISO 2768-1-Coarse | Item name: Support clamp plain hinge -

Person

Surface roughness: ISO 1302 | Legal owner: kverneland group | Item number: VNRAM-0069 | Revision 01

Date

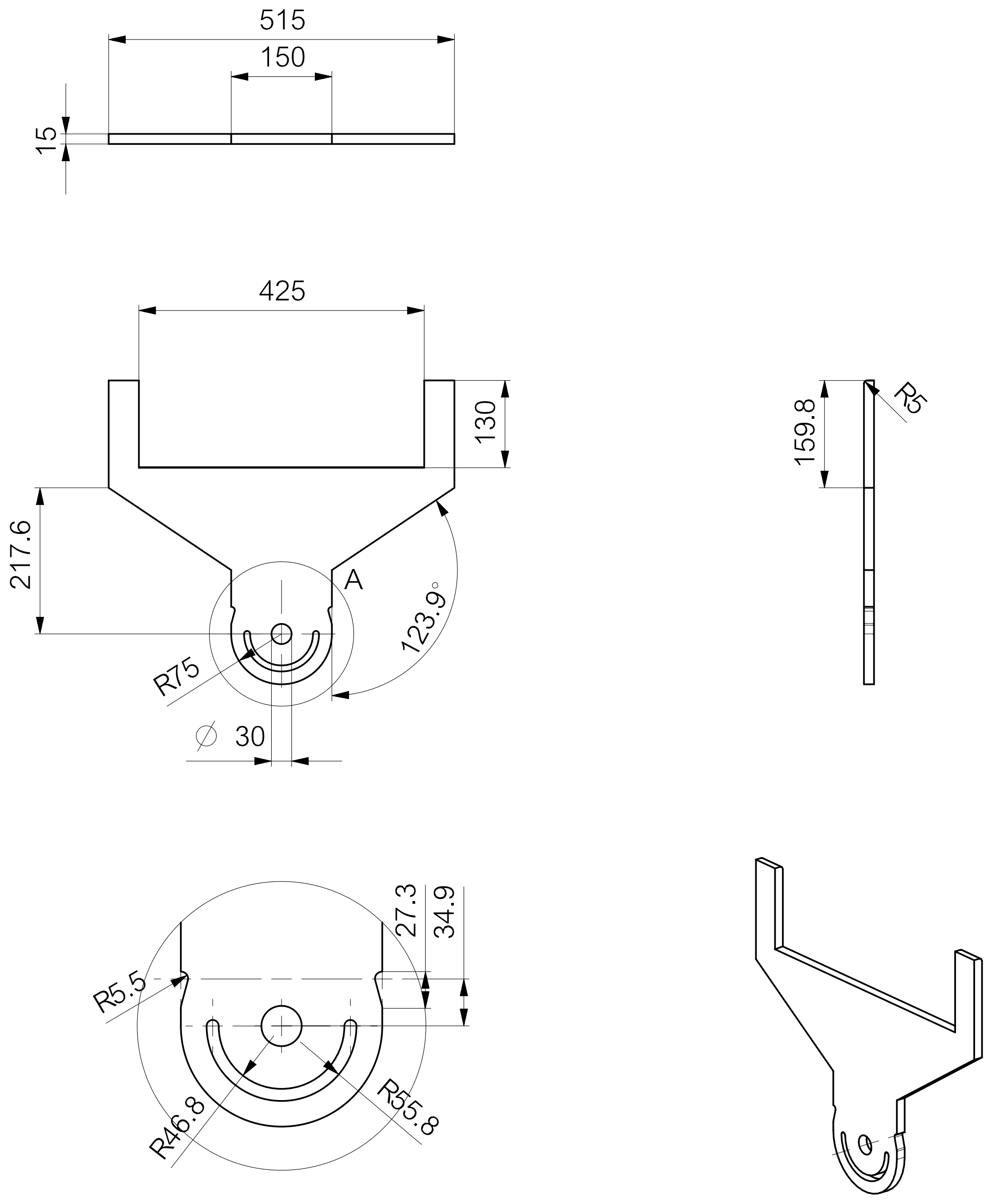
Scale:

Reference: -

VNRAM-006986=RAL7021 VNRAM-006994=RAL3000 VNRAM-0069
VNRAM-006984=RAL1003 VNRAM-006988=RAL6016 VNRAM-0069
VNRAM-006993=DELTATONE VNRAM-0069 VNRAM-0069

RvMo

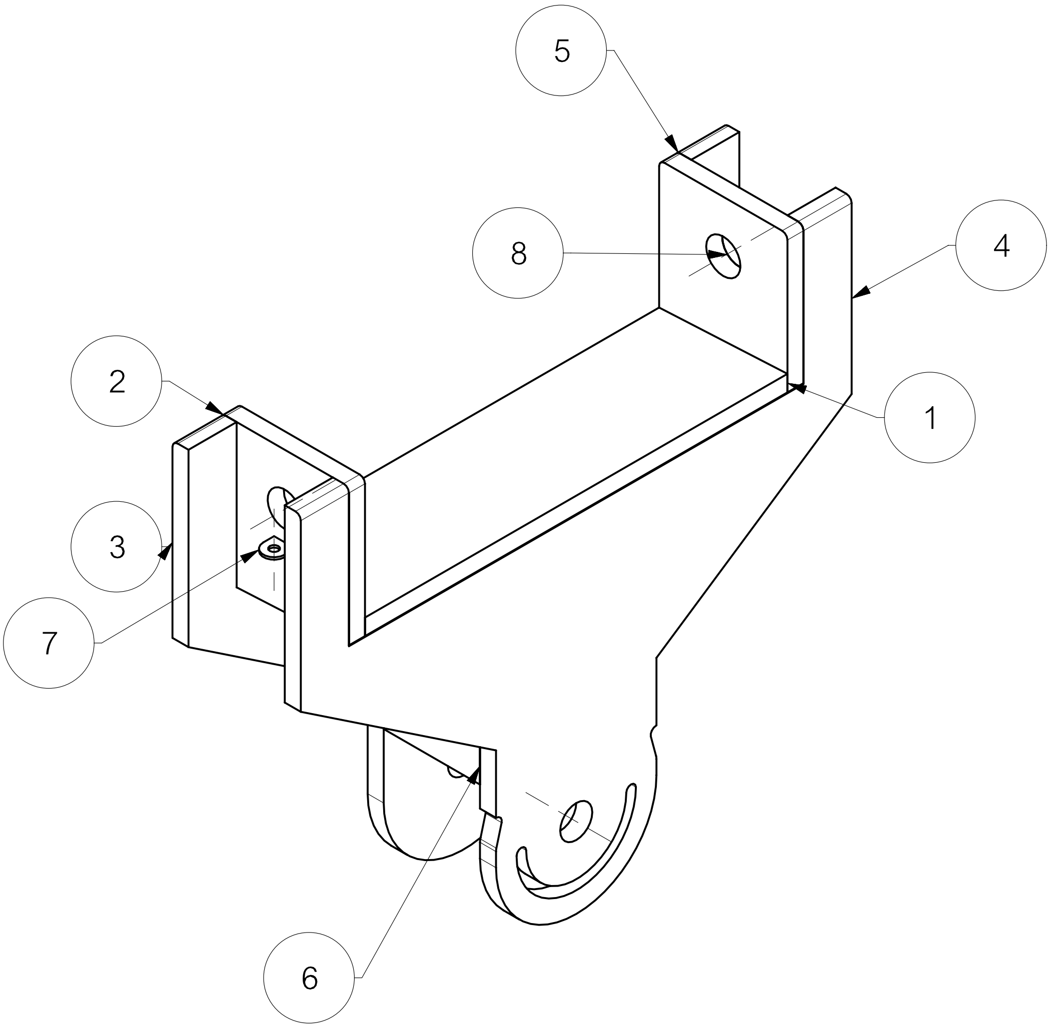
Units in mm | Proj | NX A4v | Replacement for: - | NX drafting version: 01.001 | State: Wip



DETAIL A
SCALE 1:5

S235JR/ Mat.nr.:10038		EN 10051	Pl. 15		EN 10025-2
Material		Norm	Dimension		Norm
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 08-Dec-2014	Project: -	Treatment/Other: -	
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ		
Tolerance ISO 2768-1-Coarse		Item name: Support clamp braked hinge plate -			
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0070		Revision 01
Scale:			VNRAM-007086=RAL7021 VNRAM-007084=RAL1003 VNRAM-007093=DELTATONE	VNRAM-007094=RAL3000 VNRAM-007088=RAL6016 VNRAM-0070	VNRAM-0070 VNRAM-0070 VNRAM-0070
Reference: -					
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip

Description of Change
Person
Date
RvMo



Pos.	Number	Qt.	Item name
8	VNRAM-0088	1	Pin lock
7	VNRAM-0087	1	Inductive sensor holder
6	VNRAM-0083	2	Support clamp en position limit plate
5	VNRAM-0073	1	Support clamp side plate 2
4	VNRAM-0070	1	Support clamp braked hinge plate
3	VNRAM-0069	1	Support clamp plain hinge plate
2	VNRAM-0068	1	Support clamp side plate 1
1	VNRAM-0067	1	Support clamp base plate

Material	Norm	Dimension	Norm
-	-	-	∅

Description of Change | Person | Date | RvMo

Designer:	Drafter:	Date 1. creation:	Project:	Treatment/Other:
gr_rma	gr_rma	11-Dec-2014	-	-

Approved by:	Approval date:	Weight:	Responsible department:
	00-Jan-0	Kg	C

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp assembly
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0072

Revision: 01

VNRAM-007286=RAL7021 VNRAM-007294=RAL3000 VNRAM-0072
VNRAM-007284=RAL1003 VNRAM-007288=RAL6016 VNRAM-0072
VNRAM-007293=DELTATONE VNRAM-0072 VNRAM-0072

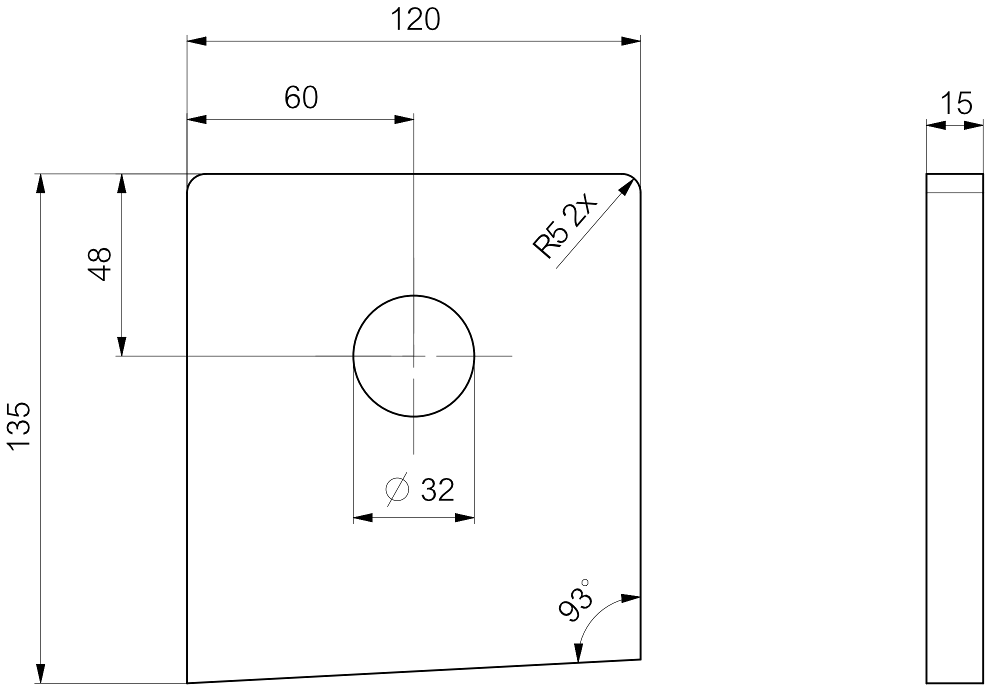
Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip

W P



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Description of Change

Person

Date

RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp side plate 2

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0073

Revision: 01

VNRAM-007386=RAL7021
VNRAM-007384=RAL1003
VNRAM-007393=DELTATONE

VNRAM-007394=RAL3000
VNRAM-007388=RAL6016
VNRAM-0073

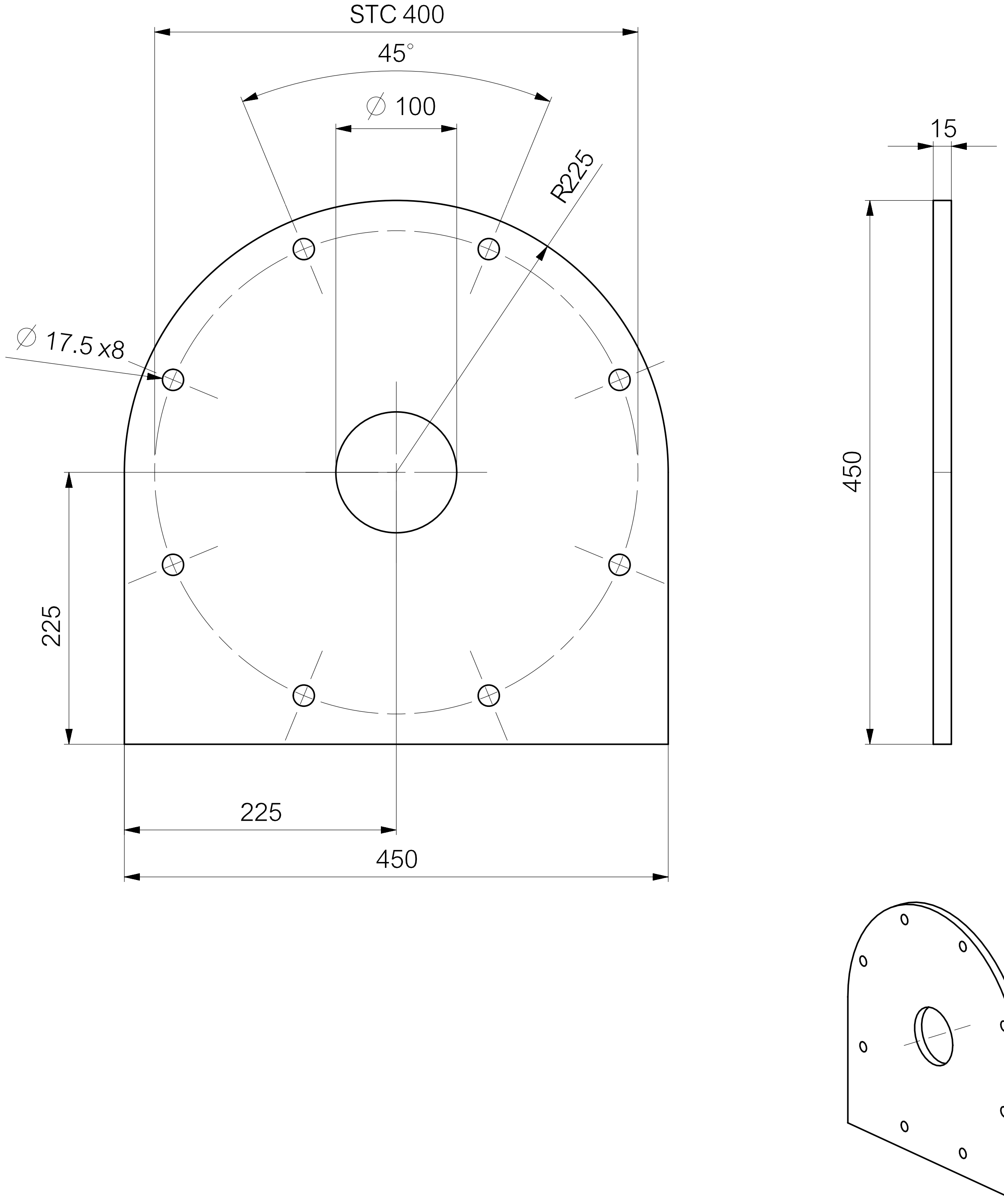
VNRAM-0073
VNRAM-0073
VNRAM-0073

Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Description of Change

Tolerance: ISO 2768-1-Coarse

Item name: VNRAM-0074_D

-

Person

Surface roughness: ISO 1302

Legal owner: kverneland group

Item number: VNRAM-0074

Revision: 01

Date

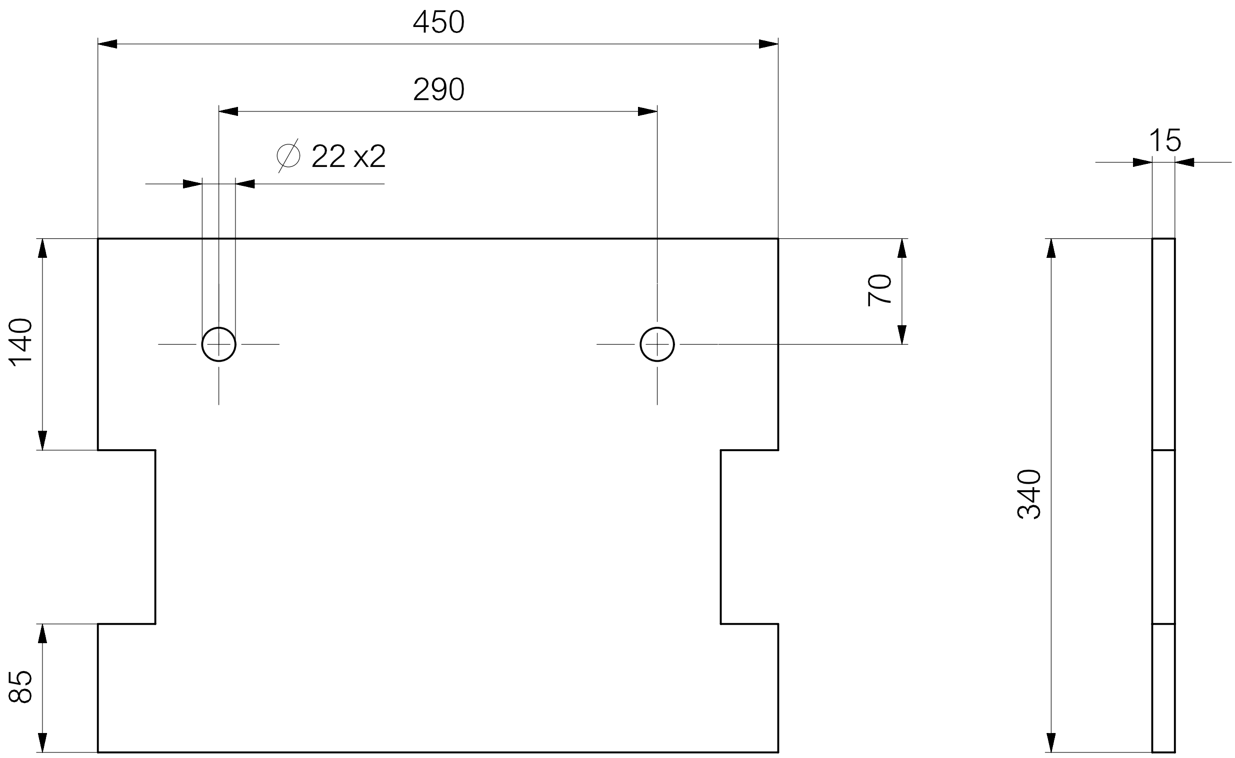
Scale:

Reference: -

VNRAM-007486=RAL7021
VNRAM-007484=RAL1003
VNRAM-007493=DELTATONE
VNRAM-007494=RAL3000
VNRAM-007488=RAL6016
VNRAM-0074
VNRAM-0074
VNRAM-0074
VNRAM-0074

RvMo

Units in mm | Proj | NX A4v | Replacement for: - | NX drafting version: 01.001 | State: Wip



S235JR/ Mat.nr.:10038 | EN 10051 | Pl. 15 | EN 10025-2
Material | Norm | Dimension | Norm

Description of Change

Designer: gr_rma
Drafter: gr_rma
Date 1. creation: 09-Dec-2014
Project: -
Treatment/Other: -

Approved by:
Approval date: 00-Jan-0
Weight: Kg
Responsible department: C

Tolerance
ISO 2768-1-Coarse

Item name:
Mounting frame base plate
-

Person

Surface roughness:
ISO 1302

Legal owner:
kverneland group

Item number:
VNRAM-0075

Revision
01

Date

Scale:

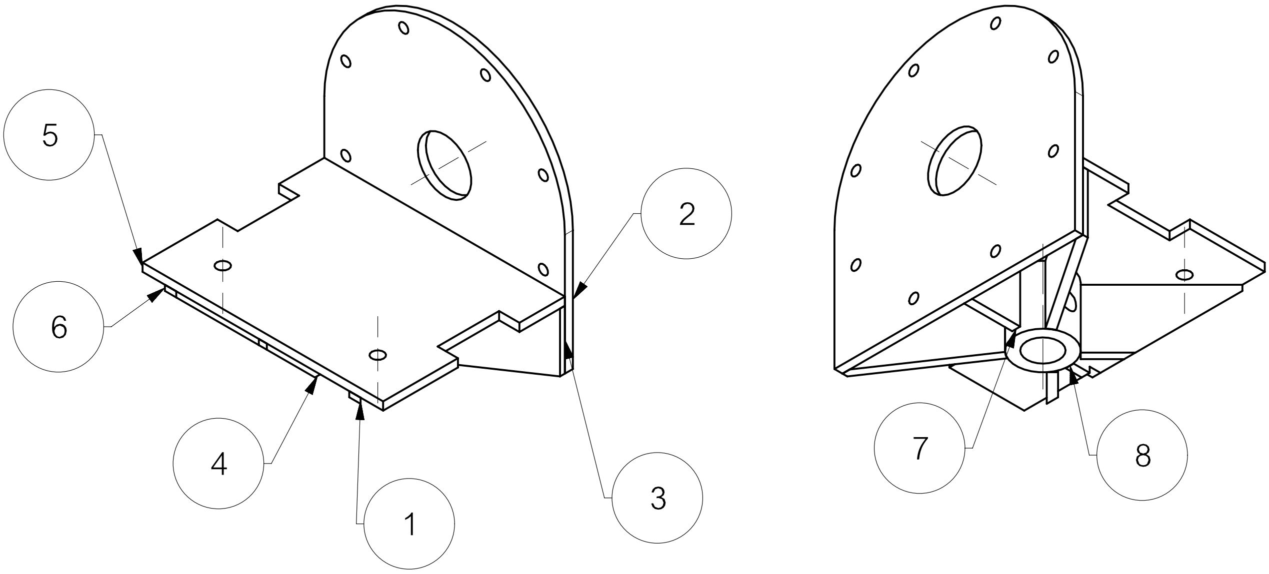
Reference:
-

VNRAM-007586=RAL7021 VNRAM-007594=RAL3000 VNRAM-0075
VNRAM-007584=RAL1003 VNRAM-007588=RAL6016 VNRAM-0075
VNRAM-007593=DELTATONE VNRAM-0075 VNRAM-0075

RvMo

Units in mm | Proj | NX A4v

Replacement for: -
NX drafting version: 01.001
State: Wip



Pos.	Number	Qt.	Item name
8	VNRAM-0078	1	Cylinder coupler
7	VNRAM-0082	1	Mounting frame perpendicular reinforcement
6	VNRAM-0080	1	Mounting frame diagonal reinforcement 2
5	VNRAM-0075	1	Mounting frame base plate
4	VNRAM-0081	1	Mounting frame housing reinforcement
3	VNRAM-0077	2	Mounting frame diagonal flange reinforcement
2	VNRAM-0074	1	Gear motor mounting flange
1	VNRAM-0079	1	Mounting frame diagonal reinforcement 1

Description of Change | Person | Date | RvMo

Designer: gr_rma
Drafter: gr_rma
Date 1. creation: 12-Dec-2014
Project: -
Treatment/Other: -

Approved by:
Approval date: 00-Jan-0
Weight: Kg
Responsible department: Ⓒ

Tolerance: ISO 2768-1-Coarse
Item name: Mounting frame assembly
-

Surface roughness: ISO 1302
Scale:
Reference: -

Legal owner: kverneland group

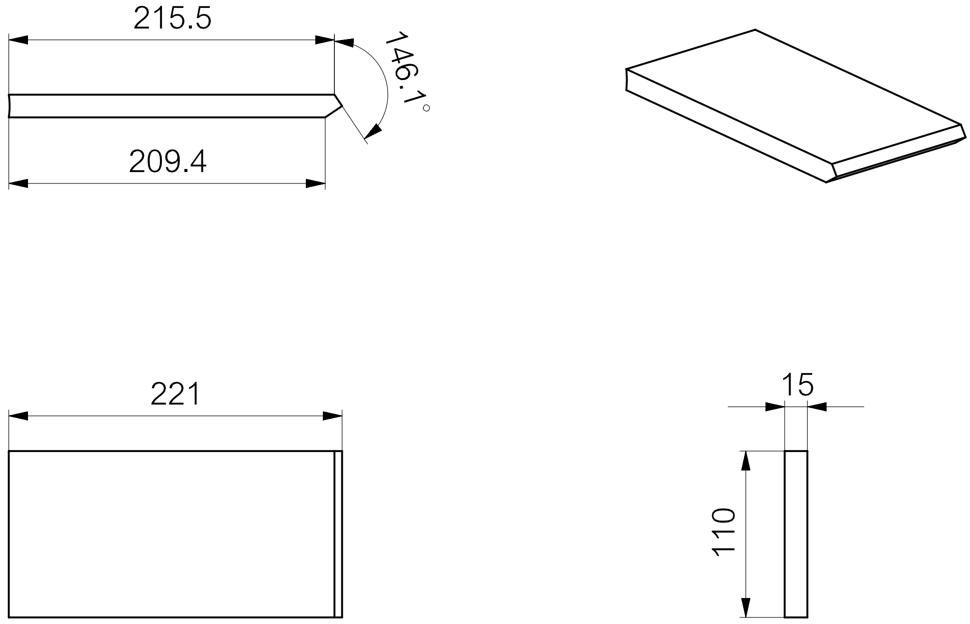
Item number: VNRAM-076
Revision: 01

VNRAM-07686=RAL7021
VNRAM-07684=RAL1003
VNRAM-07693=DELTATONE
VNRAM-07694=RAL3000
VNRAM-07688=RAL6016
VNRAM-076
VNRAM-076
VNRAM-076
VNRAM-076

Units in mm | Proj | NX A4v

Replacement for: -
NX drafting version: 01.001
State: Wip

WIP



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Description of Change

Person

Date

RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Mounting frame diagonal flange reinforce

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0077

Revision: 01

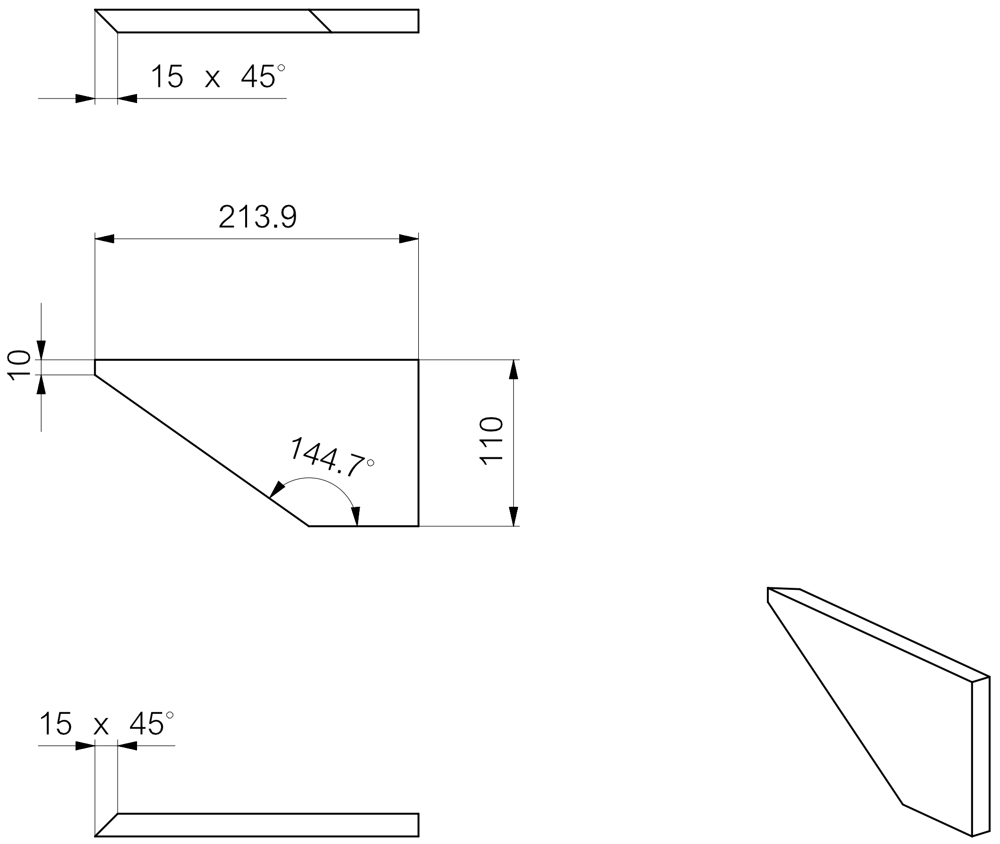
VNRAM-007786=RAL7021	VNRAM-007794=RAL3000	VNRAM-0077
VNRAM-007784=RAL1003	VNRAM-007788=RAL6016	VNRAM-0077
VNRAM-007793=DELTATONE	VNRAM-0077	VNRAM-0077

Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: ©	

Description of Change | Person | Date | RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Mounting frame diagonal reinforcement 1 -

Surface roughness: ISO 1302

Scale:

Reference: -

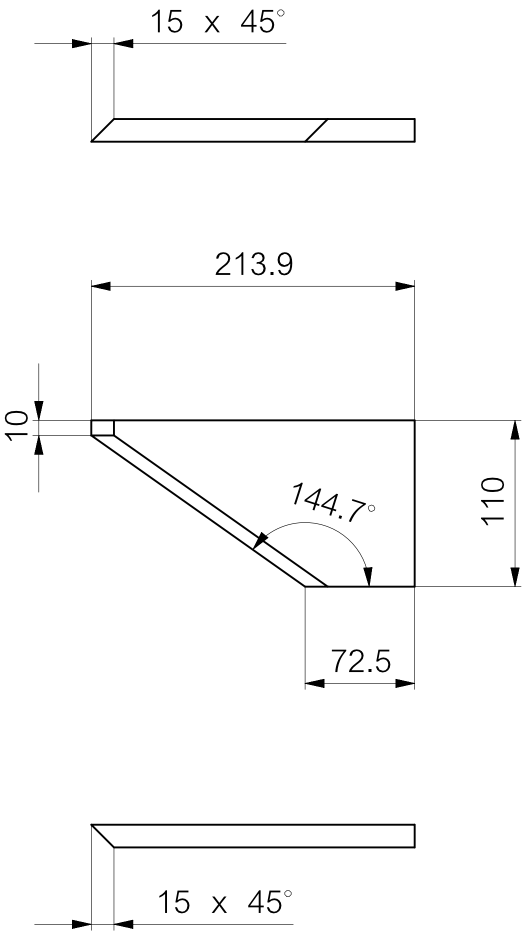
Legal owner: kverneland group

Item number: VNRAM-0079

Revision: 01

VNRAM-007986=RAL7021 VNRAM-007994=RAL3000 VNRAM-0079
VNRAM-007984=RAL1003 VNRAM-007988=RAL6016 VNRAM-0079
VNRAM-007993=DELTATONE VNRAM-0079 VNRAM-0079

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer:	Drafter:	Date 1. creation:	Project:	Treatment/Other:
gr_rma	gr_rma	09-Dec-2014	-	-

Approved by:	Approval date:	Weight:	Responsible department:
	00-Jan-0	Kg	C

Description of Change | Person | Date | RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Mounting frame diagonal reinforcement 2 -

Surface roughness: ISO 1302

Legal owner: kverneland group

Item number: VNRAM-0080

Revision: 01

Scale:

Reference: -

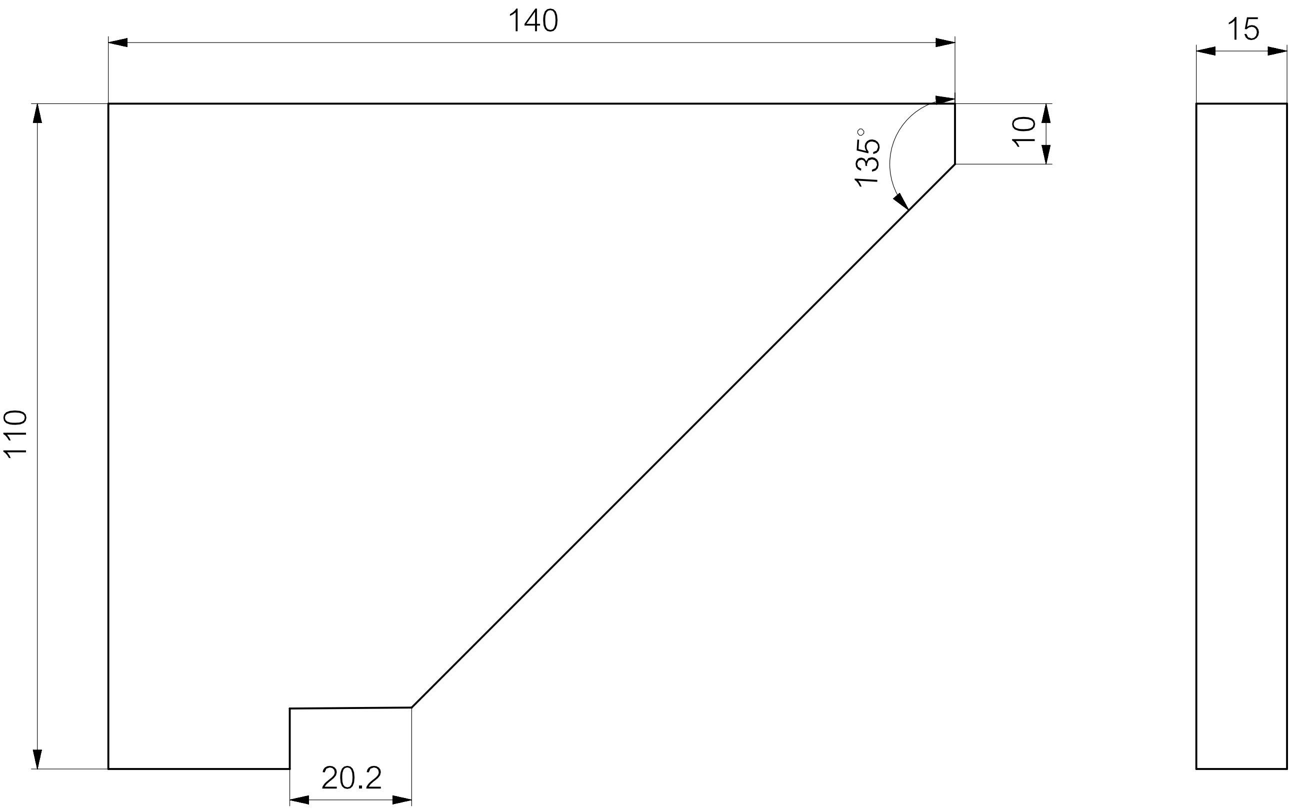
VNRAM-008086=RAL7021 VNRAM-008094=RAL3000 VNRAM-0080
VNRAM-008084=RAL1003 VNRAM-008088=RAL6016 VNRAM-0080
VNRAM-008093=DELTATONE VNRAM-0080 VNRAM-0080

Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Description of Change

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance
ISO 2768-1-Coarse

Item name:
Mounting frame bearing housing reinforce
-

Person

Surface roughness:
ISO 1302

Legal owner:
kverneland group

Item number:
VNRAM-0081

Revision
01

Date

Scale:

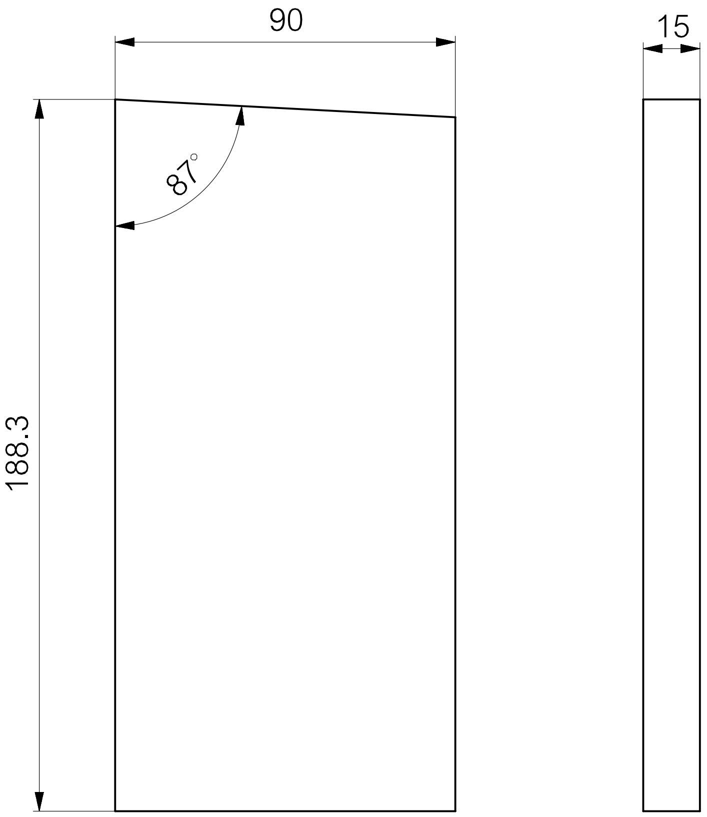
Reference:
-

VNRAM-008186=RAL7021 VNRAM-008194=RAL3000 VNRAM-0081
VNRAM-008184=RAL1003 VNRAM-008188=RAL6016 VNRAM-0081
VNRAM-008193=DELTATONE VNRAM-0081 VNRAM-0081

RvMo

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip

WIP



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: ©	

Description of Change

Person

Date

RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp end position limit plate -

Surface roughness: ISO 1302

Scale:

Reference: -

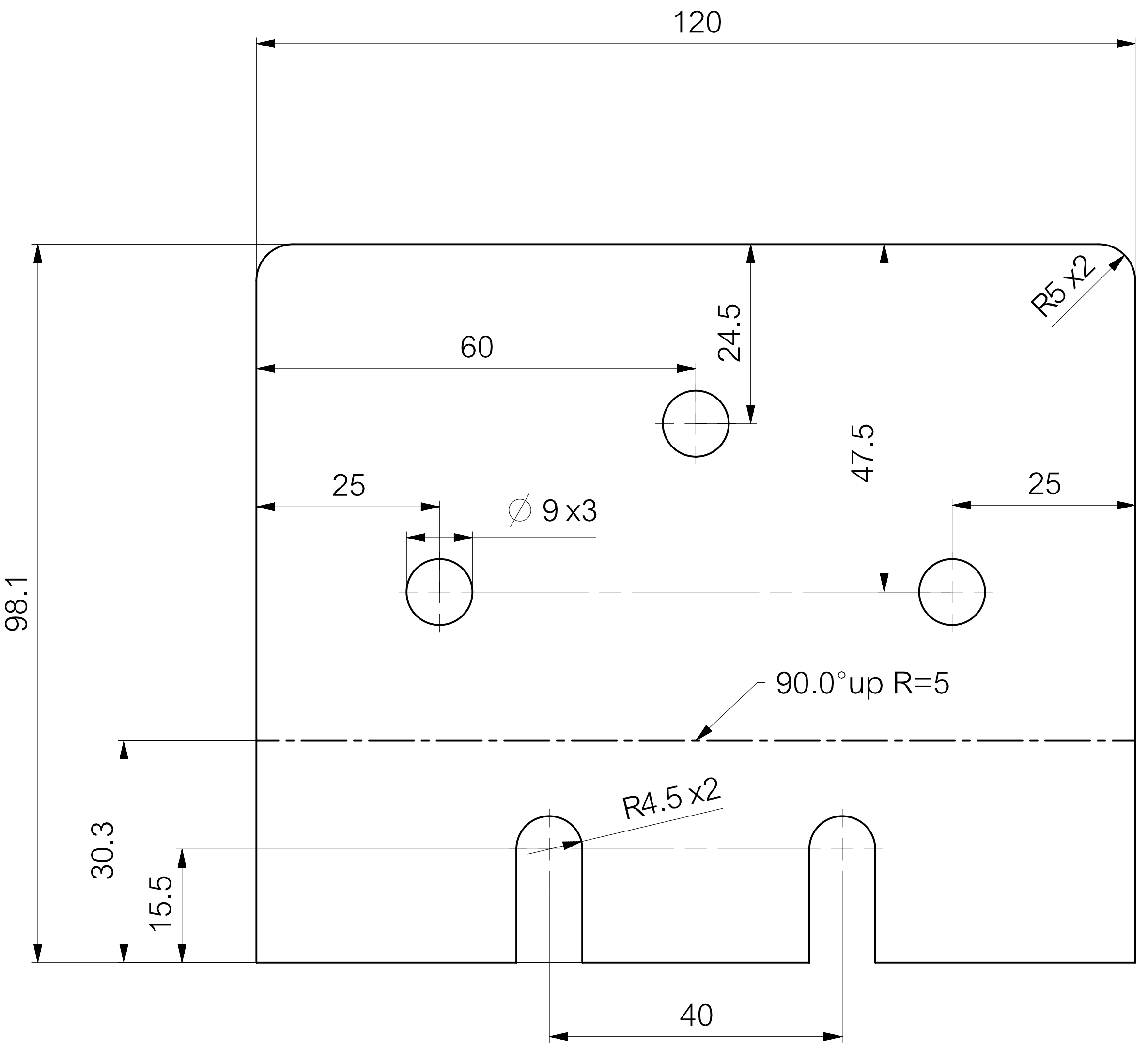
Legal owner: kverneland group

Item number: VNRAM-0083

Revision: 01

VNRAM-008386=RAL7021	VNRAM-008394=RAL3000	VNRAM-0083
VNRAM-008384=RAL1003	VNRAM-008388=RAL6016	VNRAM-0083
VNRAM-008393=DELTATONE	VNRAM-0083	VNRAM-0083

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 5	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance: ISO 2768-1-Coarse

Item name: Clamp brake supported plate

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0084

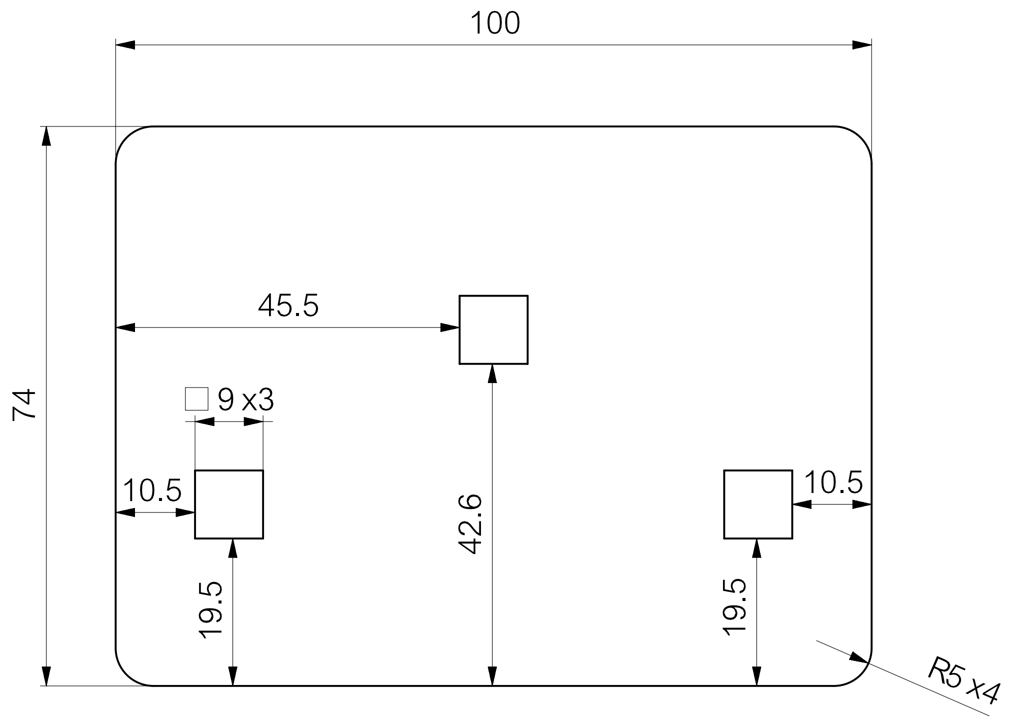
Revision: 01

VNRAM-008486=RAL7021
VNRAM-008484=RAL1003
VNRAM-008493=DELTATONE
VNRAM-008494=RAL3000
VNRAM-008488=RAL6016
VNRAM-0084
VNRAM-0084
VNRAM-0084
VNRAM-0084

Description of Change | Person | Date | RvMo

Units in mm | Proj | NX A4v

Replacement for: - | NX drafting version: 01.001 | State: Wip



S235JR/ Mat.nr.:10038	EN 10051	Pl. 5	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: (C)	

Tolerance: ISO 2768-1-Coarse

Item name: Clamp brake secondary plate
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

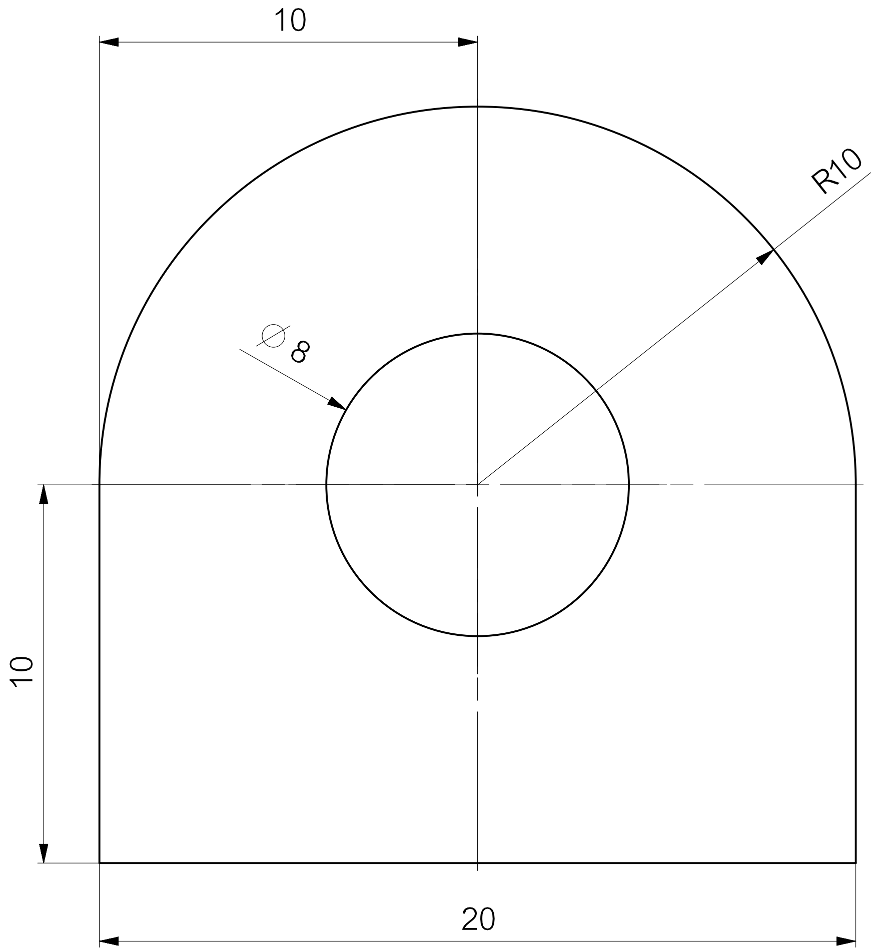
Item number: VNRAM-0085

Revision: 01

VNRAM-008586=RAL7021 VNRAM-008594=RAL3000 VNRAM-0085
VNRAM-008584=RAL1003 VNRAM-008588=RAL6016 VNRAM-0085
VNRAM-008593=DELTATONE VNRAM-0085 VNRAM-0085

Description of Change | Person | Date | RvMo

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip



DD11/ Mat.nr.:10332	EN 10051	Pl. 1	EN 10111
Material	Norm	Dimension	Norm

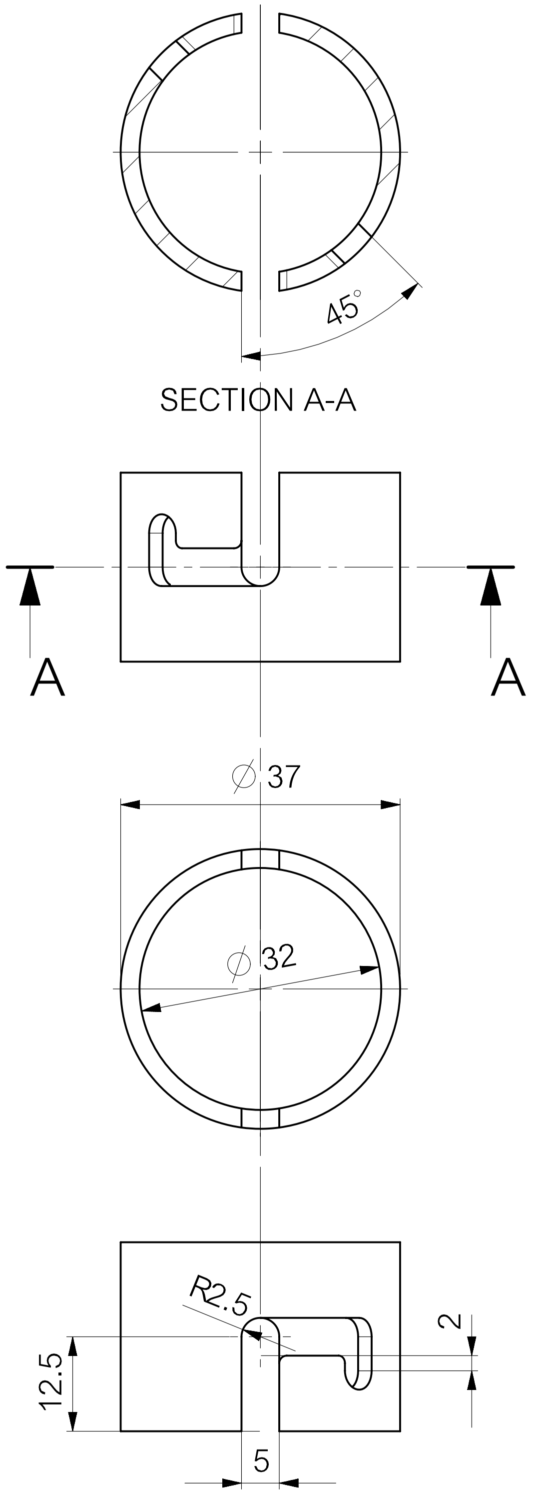
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance: ISO 2768-1-Coarse	Item name: Inductive sensor holder -
Surface roughness: ISO 1302	Legal owner: kverneland group
Scale:	Item number: VNRAM-0087
Reference: -	Revision: 01

VNRAM-008786=RAL7021 VNRAM-008794=RAL3000 VNRAM-0087
VNRAM-008784=RAL1003 VNRAM-008788=RAL6016 VNRAM-0087
VNRAM-008793=DELTATONE VNRAM-0087 VNRAM-0087

Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip

Description of Change | Person | Date | RvMo

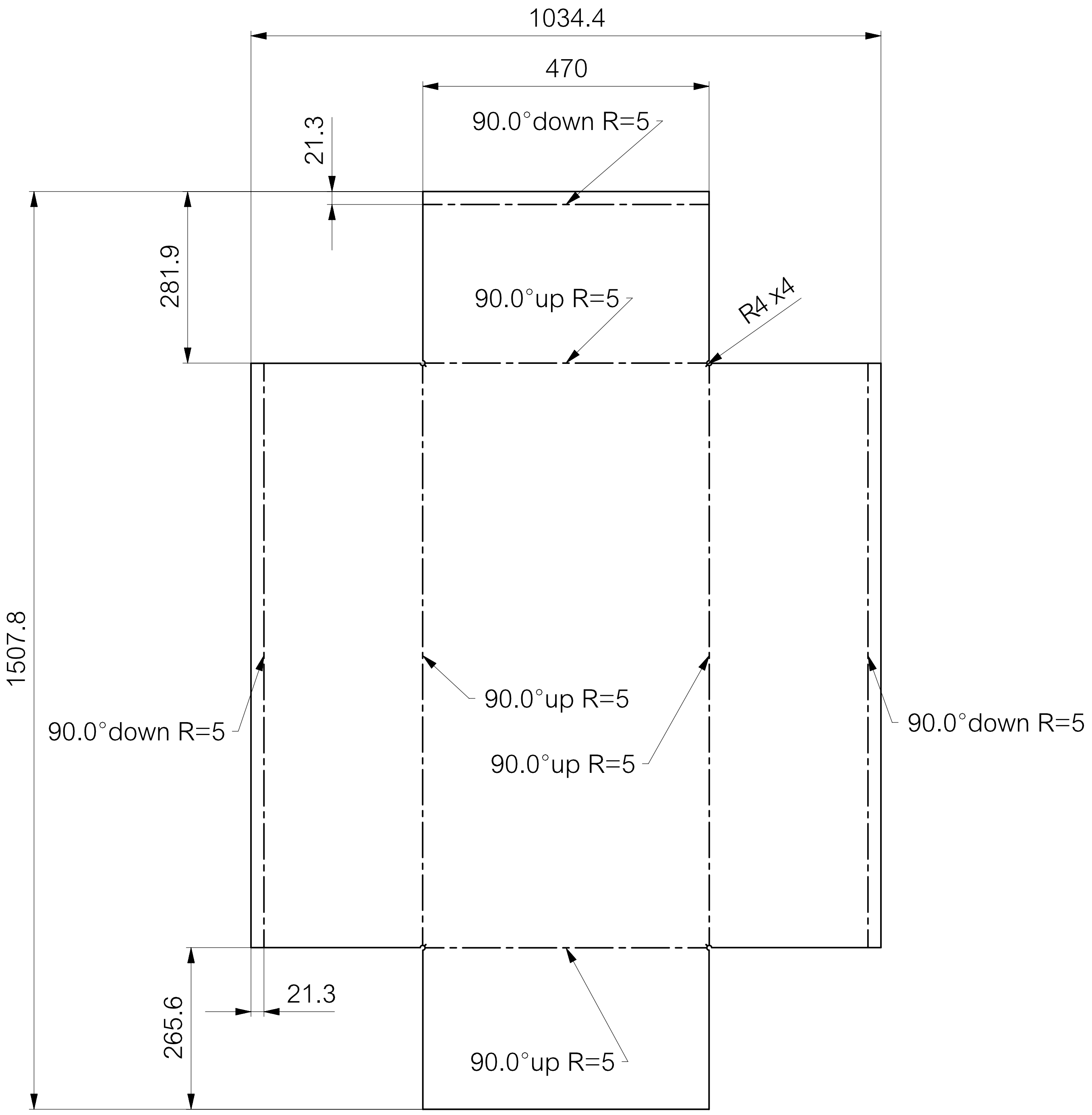


S235JRC+C/SH/ Mat.nr.:10122	EN 10277-2	Rd. 45h9	EN 10278
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

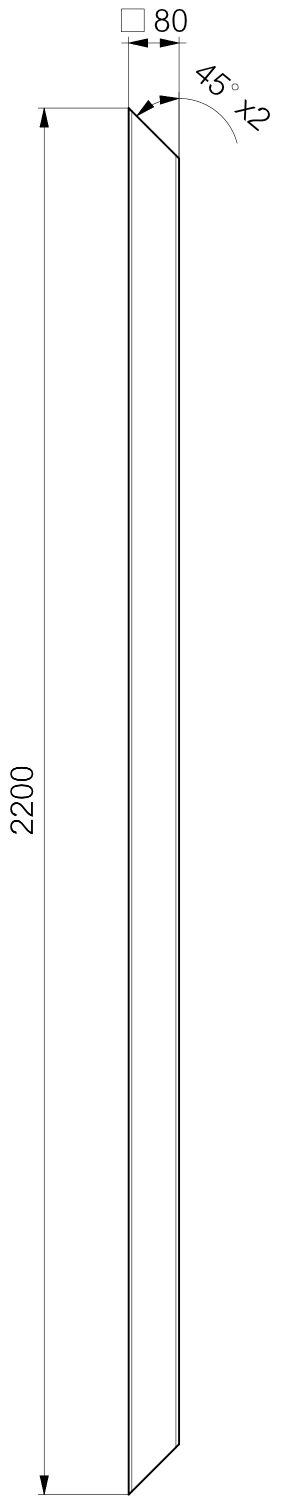
Tolerance: ISO 2768-1-Coarse	Item name: Pin lock -
Surface roughness: ISO 1302	Legal owner: kverneland group
Scale:	Item number: VNRAM-0088 — Revision: 01
Reference: -	VNRAM-008886=RAL7021 VNRAM-008884=RAL1003 VNRAM-008893=DELTATONE VNRAM-008894=RAL3000 VNRAM-008888=RAL6016 VNRAM-0088 VNRAM-0088 VNRAM-0088 VNRAM-0088
Units in mm — Proj — NX A4v	Replacement for: - — NX drafting version: 01.001 — State: Wip

Description of Change — Person — Date — RvMo



DD11/ Mat.nr.:10332	EN 10051	Pl. 1		EN 10111
Material	Norm	Dimension		Norm
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	
Tolerance ISO 2768-1-Coarse		Item name: Gear motor box -		
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0092	Revision 01
Scale:			VNRAM-009286=RAL7021 VNRAM-009284=RAL1003 VNRAM-009293=DELTATONE	VNRAM-009294=RAL3000 VNRAM-009288=RAL6016 VNRAM-0092 VNRAM-0092 VNRAM-0092 VNRAM-0092
Reference: -				
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001 / State: Wip

Description of Change / Person / Date / RvMo



S275JOH/J2H/Mat.nr.:10149/10138	EN 10219-1	Tube sq. 80X5	EN 10219-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 09-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance: ISO 2768-1-Coarse

Item name: Base frame beam long

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0095

Revision: 01

VNRAM-009586=RAL7021	VNRAM-009594=RAL3000	VNRAM-0095
VNRAM-009584=RAL1003	VNRAM-009588=RAL6016	VNRAM-0095
VNRAM-009593=DELTATONE	VNRAM-0095	VNRAM-0095

Description of Change | Person | Date | RvMo

Units in mm | Proj | NX A4v

Replacement for: - | NX drafting version: 01.001 | State: Wip

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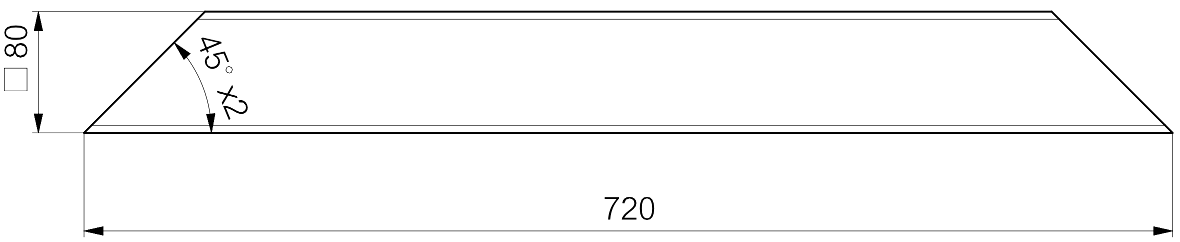


Description of Change
Person
Date
RvMo

S275JOH/J2H/Mat.nr.:10149/10138 — Material
EN 10219-1 — Norm
Tube sq. 80X5 — Dimension
EN 10219-2 — Norm

Designer: gr_rma
Drafter: gr_rma
Date 1. creation: 09-Dec-2014
Project: -
Treatment/Other: -

Approved by:
Approval date: 00-Jan-0
Weight: Kg
Responsible department: C

Tolerance
ISO 2768-1-Coarse

Item name:
Base frame beam short
-

Surface roughness:
ISO 1302

Scale:

Reference:
-

Legal owner: kverneland group

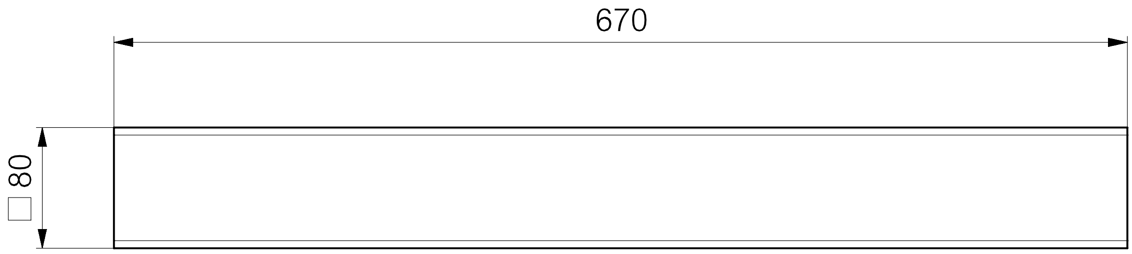
Item number:
VNRAM-0096

Revision
01

VNRAM-009686=RAL7021 VNRAM-009694=RAL3000 VNRAM-0096
VNRAM-009684=RAL1003 VNRAM-009688=RAL6016 VNRAM-0096
VNRAM-009693=DELTATONE VNRAM-0096 VNRAM-0096

Units in mm
Proj
NX A4v

Replacement for: -
NX drafting version: 01.001
State: Wip



S275J0H/J2H/Mat.nr.:10149/10138	EN 10219-1	Tube sq. 80X5	EN 10219-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Tolerance: ISO 2768-1-Coarse

Item name: Base frame pillars

-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0097

Revision: 01

VNRAM-009786=RAL7021 VNRAM-009794=RAL3000 VNRAM-0097
VNRAM-009784=RAL1003 VNRAM-009788=RAL6016 VNRAM-0097
VNRAM-009793=DELTATONE VNRAM-0097 VNRAM-0097

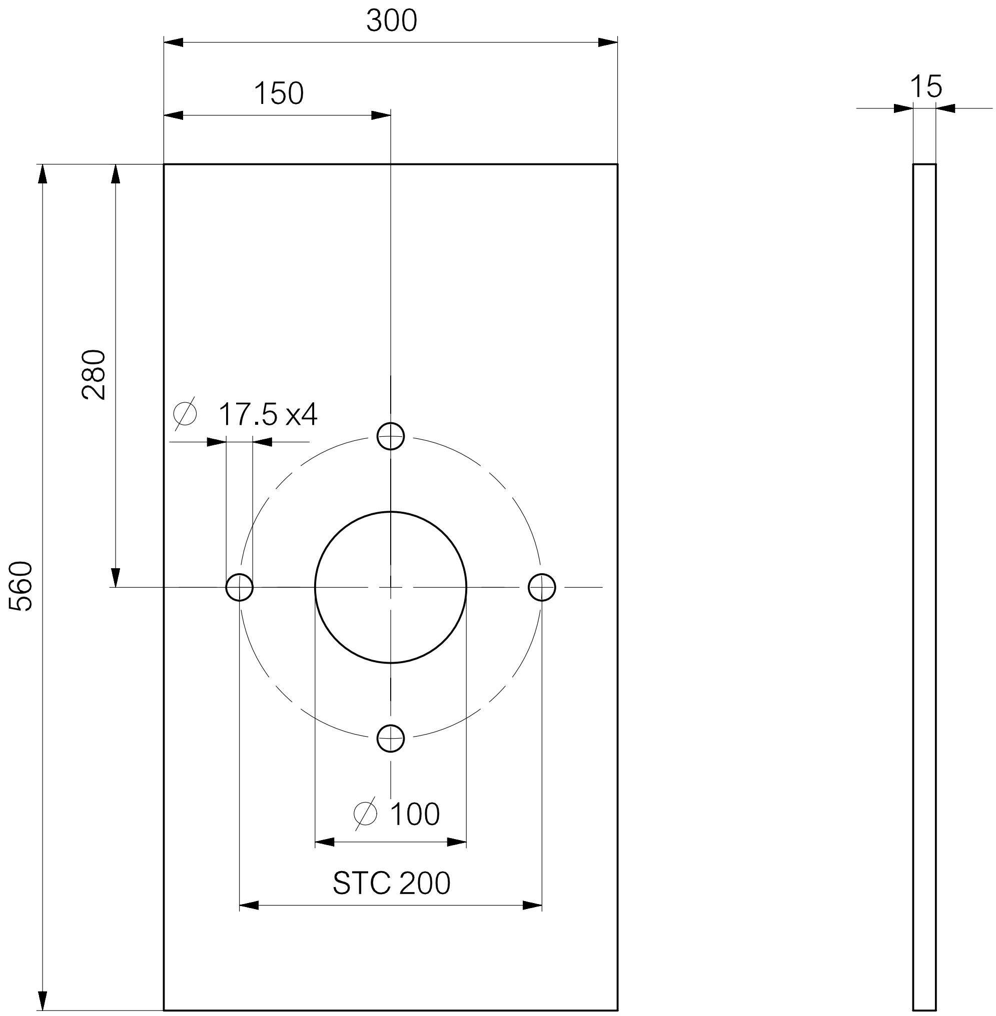
Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip

Description of Change | Person | Date | RvMo



S235JR/ Mat.nr.:10038	EN 10051	Pl. 15	EN 10025-2
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Tolerance: ISO 2768-1-Coarse

Item name: Cylinderbase
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

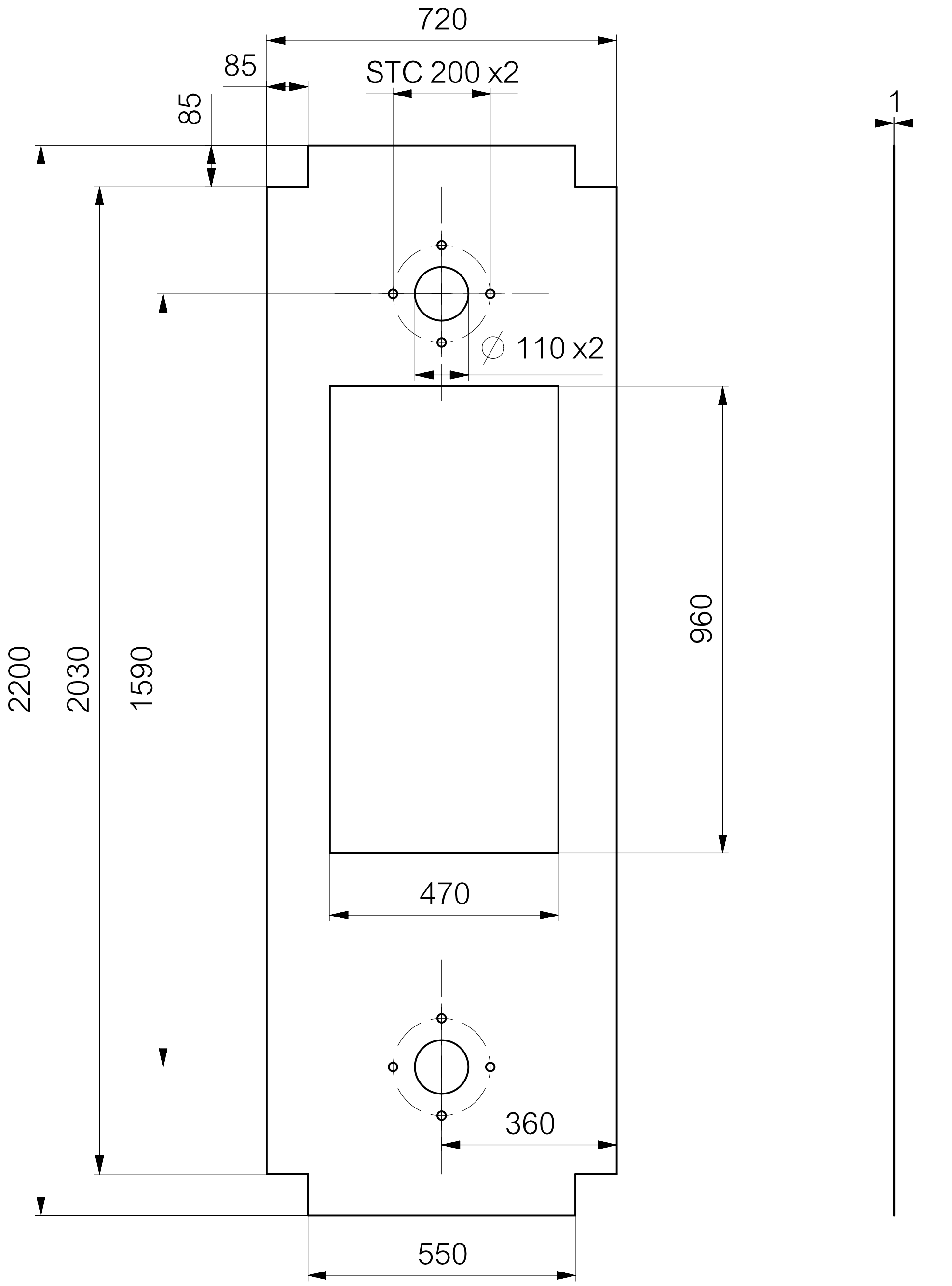
Item number: VNRAM-0098

Revision: 01

VNRAM-009886=RAL7021 VNRAM-009894=RAL3000 VNRAM-0098
VNRAM-009884=RAL1003 VNRAM-009888=RAL6016 VNRAM-0098
VNRAM-009893=DELTATONE VNRAM-0098 VNRAM-0098

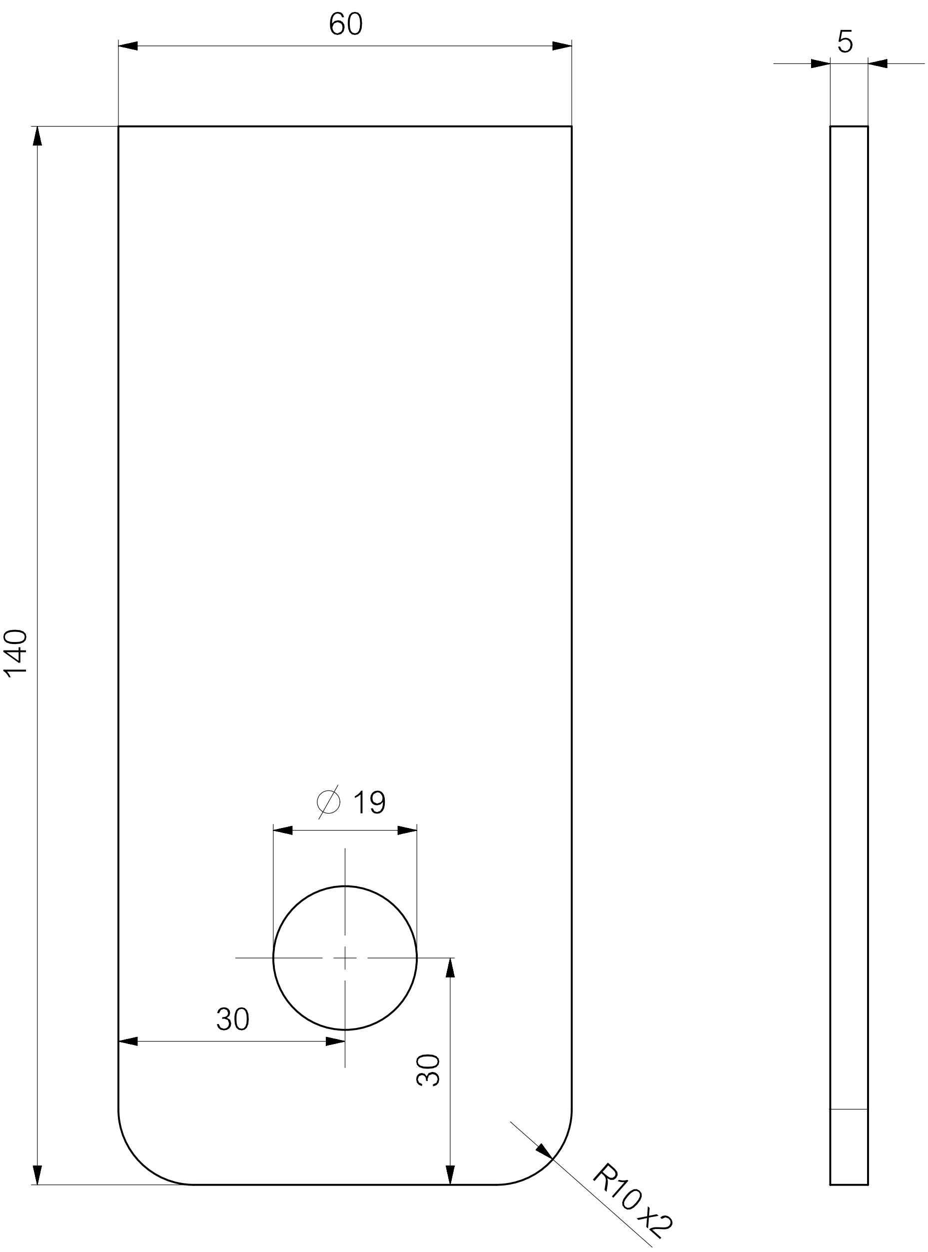
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip

Description of Change | Person | Date | RvMo



DD11/ Mat.nr.:10332		EN 10051	Pl. 1		EN 10111
Material		Norm	Dimension		Norm
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -	
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: ©		
Tolerance ISO 2768-1-Coarse		Item name: Base frame floor plate -			
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0099		Revision 01
Scale:			VNRAM-009986=RAL7021 VNRAM-009984=RAL1003 VNRAM-009993=DELTATONE	VNRAM-009994=RAL3000 VNRAM-009988=RAL6016 VNRAM-0099	VNRAM-0099 VNRAM-0099 VNRAM-0099
Reference: -			Replacement for: -	NX drafting version: 01.001	State: Wip
Units in mm	Proj	NX A4v			

Description of Change | Person | Date | RvMo

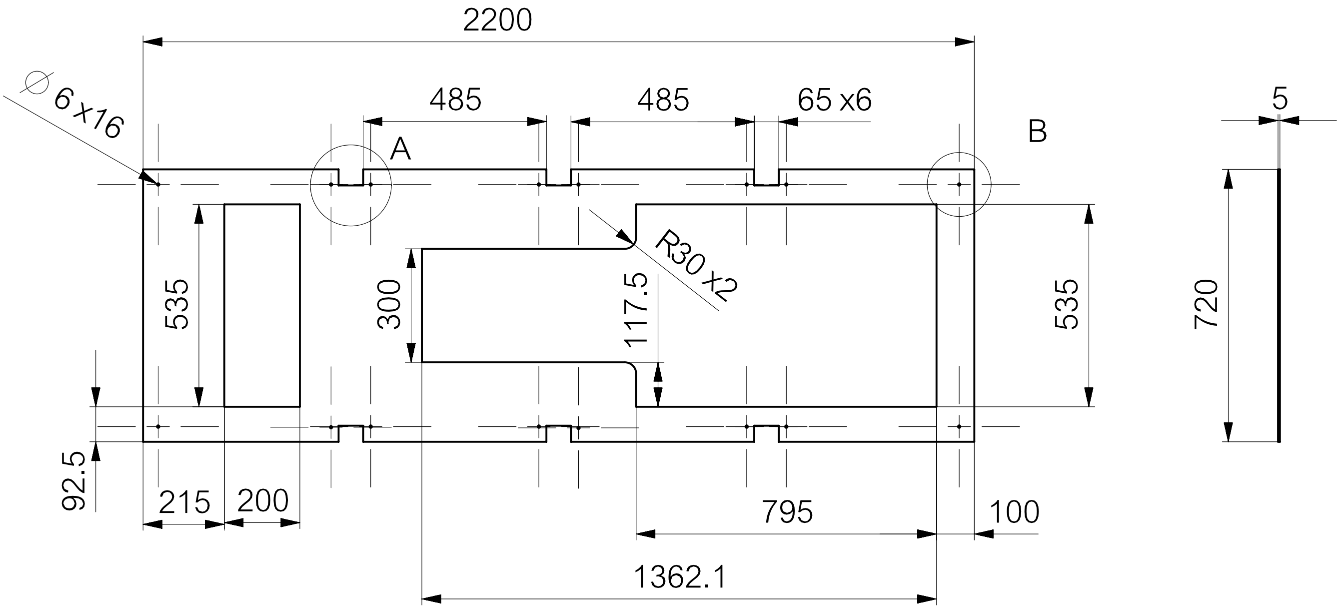


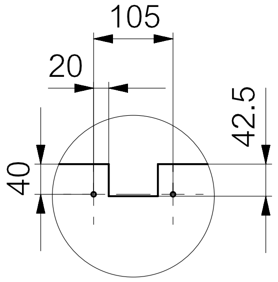
S235JR/ Mat.nr.:10038	EN 10051	Pl. 5			EN 10025-2
Material	Norm	Dimension			Norm
Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -	
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C		
Tolerance ISO 2768-1-Coarse		Item name: Base frame securing plates -			
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-0100		Revision 01
Scale:					
Reference: -					

VNRAM-010086=RAL7021	VNRAM-010094=RAL3000	VNRAM-0100
VNRAM-010084=RAL1003	VNRAM-010088=RAL6016	VNRAM-0100
VNRAM-010093=DELTATONE	VNRAM-0100	VNRAM-0100

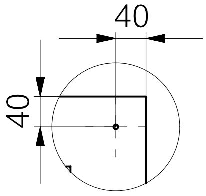
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001	State: Wip

Description of Change
Person
Date
RvMo





DETAIL A
SCALE 1:10



DETAIL B
SCALE 1:10

S235JR/ Mat.nr.:10038	EN 10051	Pl. 5	EN 10025-2
Material	Norm	Dimension	Norm

Description of Change

Person

Date

RvMo

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: Ⓒ	

Tolerance: ISO 2768-1-Coarse

Item name: Base frame cover plate
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0101

Revision: 01

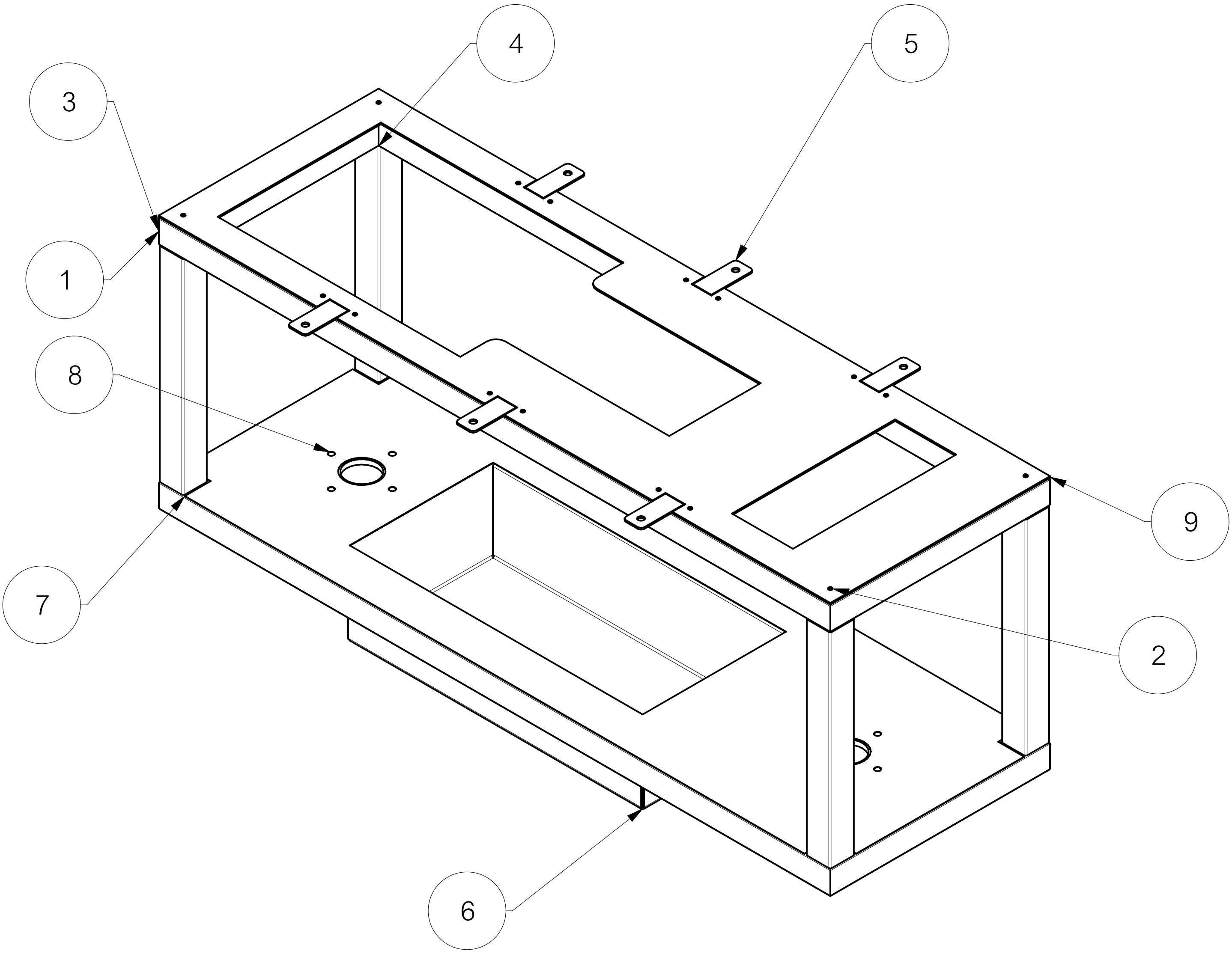
VNRAM-010186=RAL7021	VNRAM-010194=RAL3000	VNRAM-0101
VNRAM-010184=RAL1003	VNRAM-010188=RAL6016	VNRAM-0101
VNRAM-010193=DELTATONE	VNRAM-0101	VNRAM-0101

Units in mm | Proj | NX A4v

Replacement for: -

NX drafting version: 01.001

State: Wip



Pos.	Number	Qt.	Item name
9	VNRAM-0101	1	Base frame cover plate
8	VNRAM-0098	2	Cylinder base
7	VNRAM-0099	1	Base frame floor plate
6	VNRAM-0092	1	Gear motor box
5	VNRAM-0100	6	Base frame securing plates
4	VNRAM-0097	4	Base frame pillars
3	VNRAM-0096	4	Base frame beam short
2	KG00750700	16	TAPPING SCREW 5.5X19 A2
1	VNRAM-0095	4	Base frame beam long

Description of Change

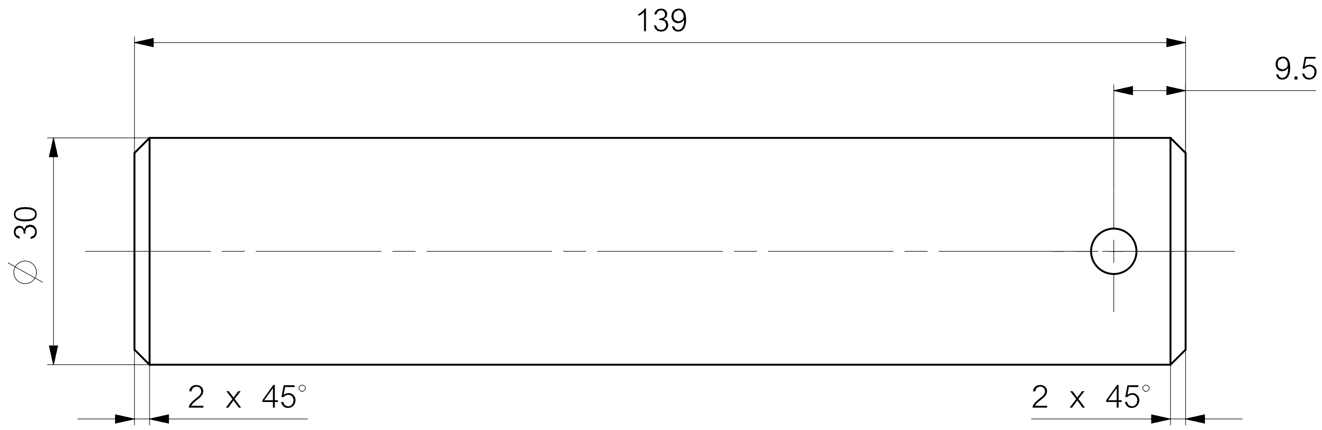
Person

Date

RvMo

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 12-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	
Tolerance ISO 2768-1-Coarse		Item name: Base frame assembly -		
Surface roughness: ISO 1302		Legal owner: kverneland group	Item number: VNRAM-00102	Revision 01
Scale:			VNRAM-0010286=RAL7021 VNRAM-0010284=RAL1003 VNRAM-0010293=DELTATONE	VNRAM-0010294=RAL3000 VNRAM-0010288=RAL6016 VNRAM-00102
Reference: -				VNRAM-00102 VNRAM-00102 VNRAM-00102
Units in mm	Proj	NX A4v	Replacement for: -	NX drafting version: 01.001
				State: Wip

WIP



S235JRC+C/SH/ Mat.nr.:10122	EN 10277-2	Rd. 30h9	EN 10278
Material	Norm	Dimension	Norm

Designer: gr_rma	Drafter: gr_rma	Date 1. creation: 10-Dec-2014	Project: -	Treatment/Other: -
Approved by:	Approval date: 00-Jan-0	Weight: Kg	Responsible department: C	

Description of Change | Person | Date | RvMo

Tolerance: ISO 2768-1-Coarse

Item name: Support clamp hinge pin
-

Surface roughness: ISO 1302

Scale:

Reference: -

Legal owner: kverneland group

Item number: VNRAM-0105

Revision: 01

VNRAM-010586=RAL7021 VNRAM-010594=RAL3000 VNRAM-0105
VNRAM-010584=RAL1003 VNRAM-010588=RAL6016 VNRAM-0105
VNRAM-010593=DELTATONE VNRAM-0105 VNRAM-0105

Units in mm | Proj | NX A4v | Replacement for: - | NX drafting version: 01.001 | State: Wip