Control unit

Task of control and side flag
The two flags of the KUKATE34 are used to control the turbine. They ensure that the turbine is optimally positioned in the wind and is turned out of the wind in the event of a storm.

Cross vane
The side flag is firmly attached to the nacelle and rotates with it. Its flag arm (2) ends at the outer edge of the side flag surface. This surface consists of a 1m² sheet. When viewed from the front - against the rotor - this surface must be seen in its entirety so that the wind can act completely on it.

Control vane
The control vane (1) measures 1m x 2m and is positioned at an angle of 45° to the wind direction. Seen from the front, it must also be completely visible in normal operation - angled backwards at 45 degrees.

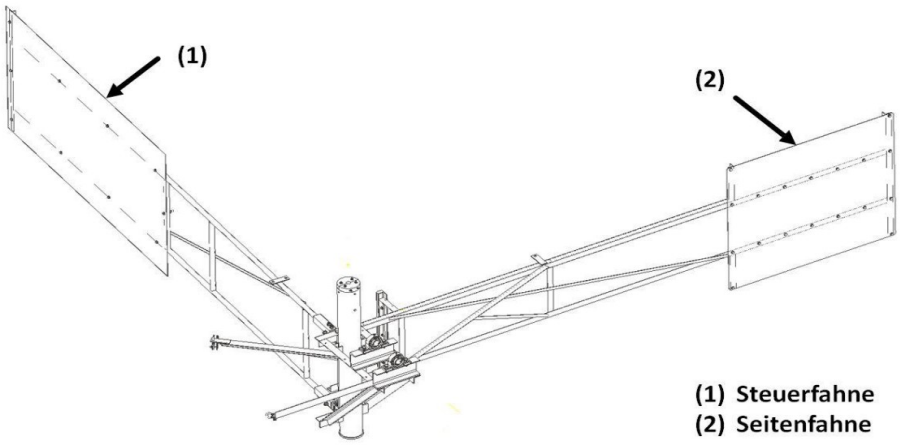


Figure 1 – Complete control unit

Function
The cable tension created by the control weight maintains an angle of 135 degrees between the two vane surfaces in normal operation. The weight of the control weight determines the wind speed at which the rotor is turned out of the frontal wind direction. If the torque generated from the wind force on the control vane surface and the effective control arm length (lever arm) is greater than the weight due to the wind pressure, the vanes swing towards each other.
The greater the wind pressure, the smaller the angle between the vane surfaces. When the pressure decreases, they swing back again until the rotor is perpendicular to the wind again and operates normally. The counterweight can be generated by stones in a bucket. Its mass must be determined by experimentation during commissioning. In the storm position, the two vanes are very close to each other. The angle between them is limited by a stop. The range of movement of the control vane is limited by steel cables. A mechanical spring damper in the rope, which determines the 135-degree angle, protects against strong shocks when the vane angle reaches 135 degrees again after regulation.

Safe regulation
In this way, the rotor turns more or less automatically out of the wind when the wind gets stronger and is only blown at an angle of approx. 25 degrees in a storm. Then the laminar flow at the rotor blades has long since broken off and the KUKATE34 is thus protected from too great a load.
Should the control cable break, the flags automatically swing into the protective storm position. This is an automatic safety device.

Control vane

The control vane consists of a frame (the vane arm), a vane and hinges. The figure shows the overall structure of the control vane.
The frame of the control vane is 3.6m long. The outer struts, as well as the cross struts are made of tubes. The cross strut at the end of the flag is made of an L-profile. This ensures a better connection between the frame and the flag.

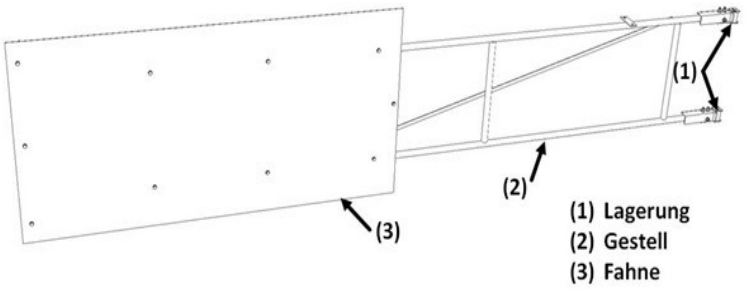
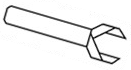
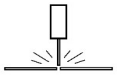
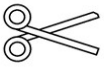


Figure 2 – Complete control vane

The flag is made of a 1.5mm thick steel sheet or 2mm thick aluminium sheet. The sheets of the flags are bent 90degrees on the side edges for aerodynamic reasons and to increase the strength. Sheet metal and flag frame are screwed together.

The control vane of the KUKATE34 is attached to the nacelle with two sliding bearing hinges. The hinges consist of two plain bearing bushes and two brass or bronze thrust bearings, which absorb the weight force. The bearing of the hinges are subject to the same principle as the mast-nacelle connection from chapter 4.1.1.2.

Tools

						
	9;11;13;22	WS 13; 16; 18; 30		90°		Metal

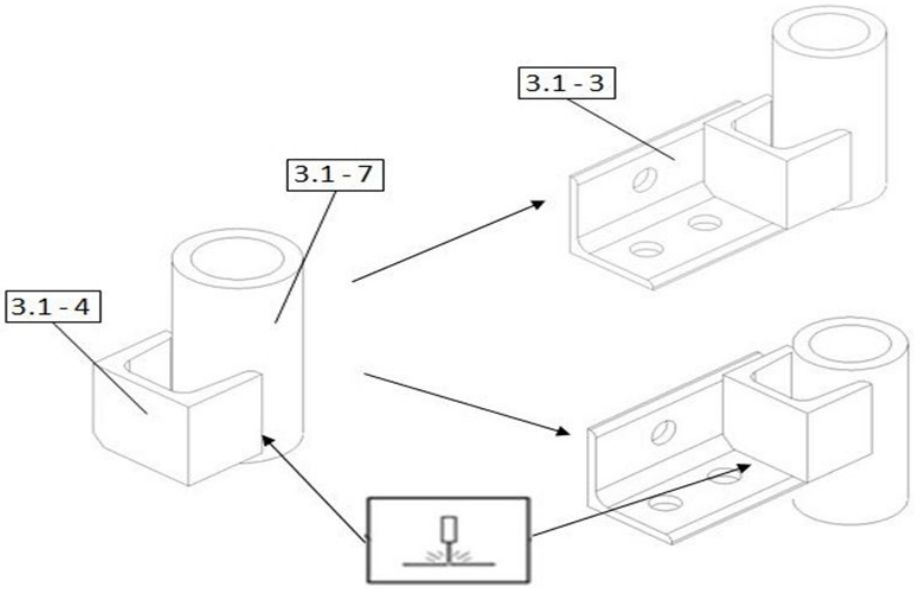
Material

Pos		Raw material	Name	Standard	Dimensions	Qty	Material
3.1	**-1**	**R - 28**	L-Profile	DIN EN 10056-1	30x30x3x985mm	1	S235
	-2	**R - 22**	L-Profile	DIN EN 10056-1	50x50x5x200mm	2	S235
	-3	**R - 22**	L-Profile	DIN EN 10056-1	50x50x5x100mm	2	S235
	-4	**R - 21**	U-Profil	EN 1026	U50x45mm	2	S235
	-5	**R - 30**	Pipe	DIN 2448	33,7x3,6x3900mm	2	S235
	-6	**R - 30**	Pipe	DIN 2448	33,7x3,6x586mm	3	S235
	-7		Pipe	DIN 2448	48,3x7,1x100mm	2	S235
	-8		Pipe	EN 12449	28x3,1x100mm	2	Brass
	-9		Pipe	EN 12449	21x2,5x100mm	2	Brass
	-10	**R - 29**	Flat steel	DIN EN 10058	20x3x2300mm	1	S235
	-11	**R - 31**	Sheet	EN AW 5754	2000x1000x2mm	1	Aluminium
	-12		Hexagon head screw	DIN ISO 4017	M8x25-8.8	3	
	-13		Hexagon head screw	DIN ISO 4017	M8x55-8.8	7	
	-14		Hexagon nut with torque part	DIN EN ISO 7040	M8-8.8	10	
	-15		Washer	ISO 7089	8	13	
	-16		Hexagon head screw	DIN ISO 4017	M12x35-8.8	6	
	-17		Hexagon nut with torque part	DIN EN ISO 7040	M12-8.8	6	
	-18		Washer	ISO 7089	M12	12	
	-19		Washer	ISO 7089	20	2	
	-20		Hexagon head screw	DIN EN ISO 4014	M20x120-8.8	2	
	-21		Hexagon nut with torque par	DIN EN ISO 7040	M20-8.8	2	
	-22		Sheet	EN 1652	50x50x3mm	2	Brass
	-23	**R - 29**	Flat steel	DIN EN 10058	20x3x1420mm	1	S235
	-24		pulley			1	
	-25		bow shackle	verzinkt		2	
	-26		Swivel shackle	verzinkt		1	
	-27		Wire			1	
	-28		Eyelet	DIN 6899		2	
	-29		Bucket			1	
	-30		Shock absorber			1	
	-31	**R - 29**	Flat stell	DIN EN 10058	40x5x120mm	1	S235
	-32	**R - 29**	Flat steel	DIN EN 10058	20x5x150mm	1	S235

Table 1 – Bill of material 3.1 control vane

Construction

1. Manufacture joints / hinges of the control vane.
After all components have been brought to size, the tube [3.1-7] is welded to the U-section [3.1-4], inside the U-section and outside the U-section. Since the control vane is supported twice, the construction must be manufactured twice accordingly.

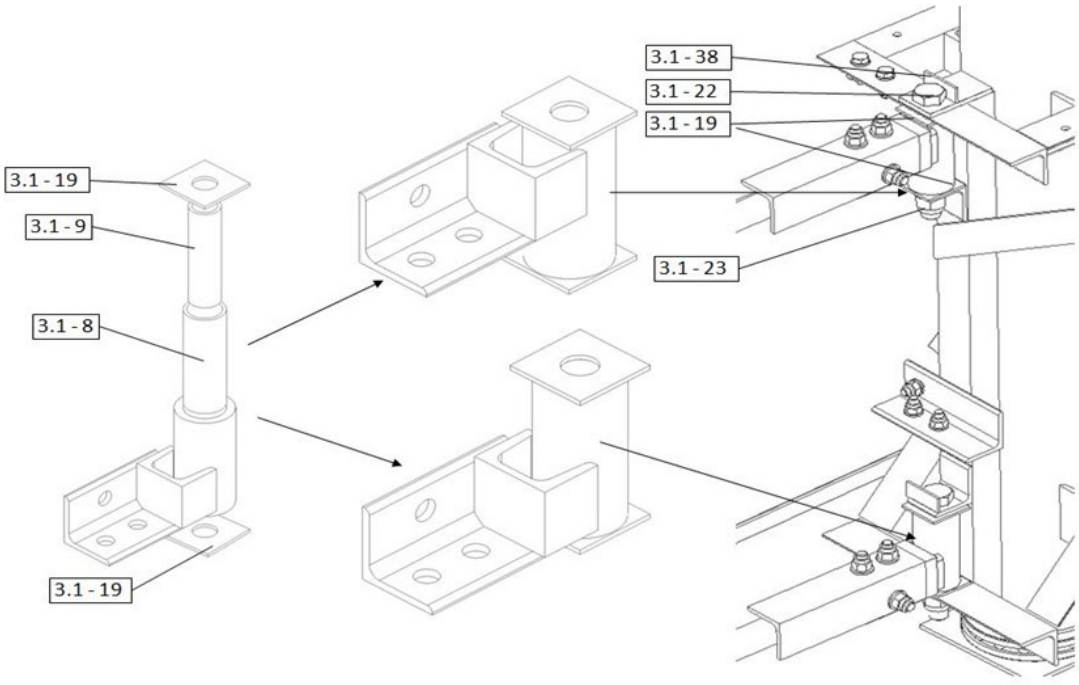


Then drill the L-profile [3.1-3] and weld it to the U-profile. It must be ensured that the mounting distance between the hinges is exactly maintained. Only in this way can both thrust bearings bear the weight of the control vane evenly!

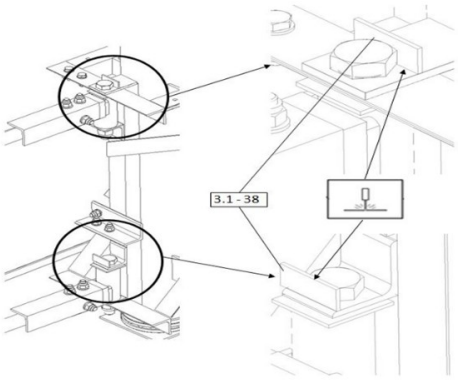
---

2. **Insert the bearings and glue the sleeves.**
Then insert the brass bearings. Insert the two brass tubes [3.1-8] and [3.1-9] into the tube [3.1-7] and glue them there.

Now both bearings are connected to the nacelle frame [2.2] and the hinge screws are secured against rotation.
Mounting is done with M20 [3.1-22] screws. When mounting, the brass plates [3.1-19] are used to improve the bearing. The screws [3.1-22] are fixed with a flat bar [3.1-38] in such a way that twisting is not possible, but the screw can still be removed upwards.



The hinge screw must not rotate in the angles [2.2.-7 and 2.2.-10] of the nacelle frame.

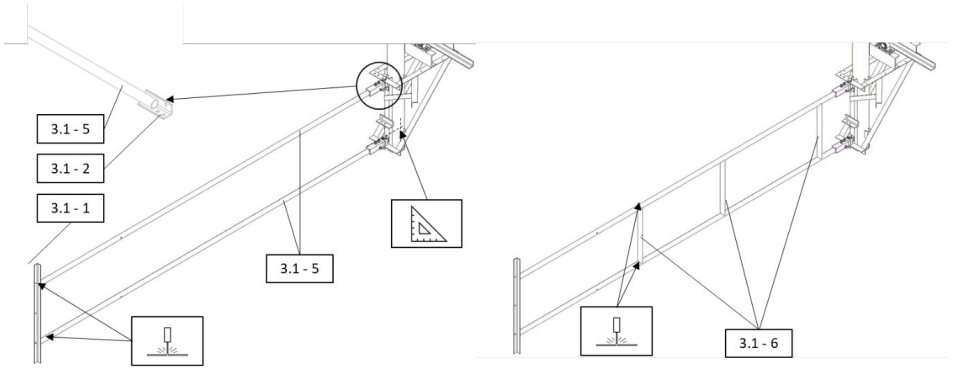


The holes in the angles would enlarge due to friction and the flag would fall off.

Possible positioning of the flat bars [3.1-38] for screw locking in the illustration.

---

3. **Control vane arms Drill, screw and align parts.**
   Next, the tubes [3.1-5] must be adapted to the bearing. To do this, first drill the L-sections [3.1-2] and weld them exactly aligned to the tubes. Make sure that the holes are uncovered and that there is enough space for screwing. Then both tubes [3.1-5] are screwed to the L-profiles [3.1-3] of the bearing and aligned.
   To prevent stresses during operation, the tubes must be aligned at right angles to the nacelle. Then the L-section [3.1-1] is spot-welded at right angles to the end of the two tubes. Now it should be checked once again whether the construction is right-angled.



Position, align and weld cross struts.
The ease of movement of the bearing must also be checked by swiveling the tubes back and forth. The tubes [3.1-6] serving as cross struts must also be spot-welded. Then loosen the bolted connection between the two L-sections [3.1-2] and [3.1-3]. The frame is finished diagonally on the workbench with short welding intervals.

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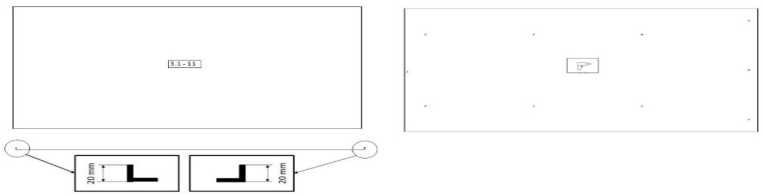
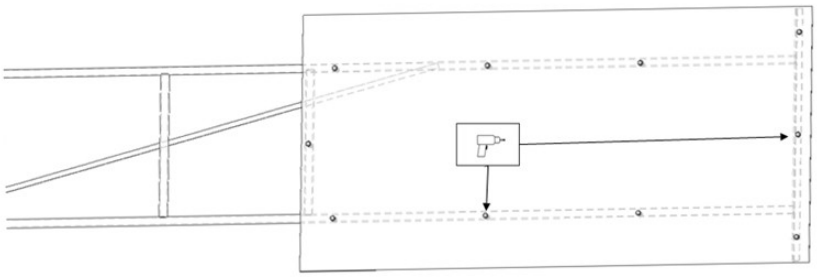
4. **Edge control vane plate**
   The sheet [3.1-11] made of steel or aluminum is first bent at the outer two ends by 20 mm at 90 degrees.

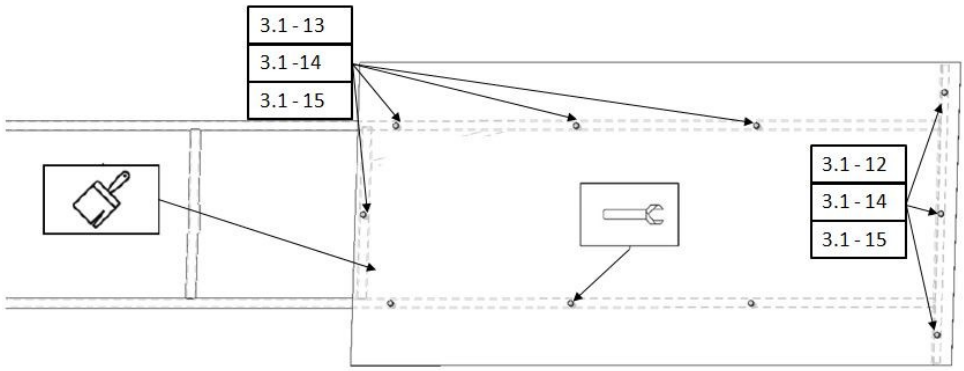


Marking and drilling of the sheet.
After the sheet is edged, you need to drill the holes.

5. **Drilling the flag arm tubes**
   After the sheet metal has been drilled, it can be screwed onto the frame. For this purpose, the sheet metal is placed on the frame as a template and the holes for the flag can be drilled into the frame.

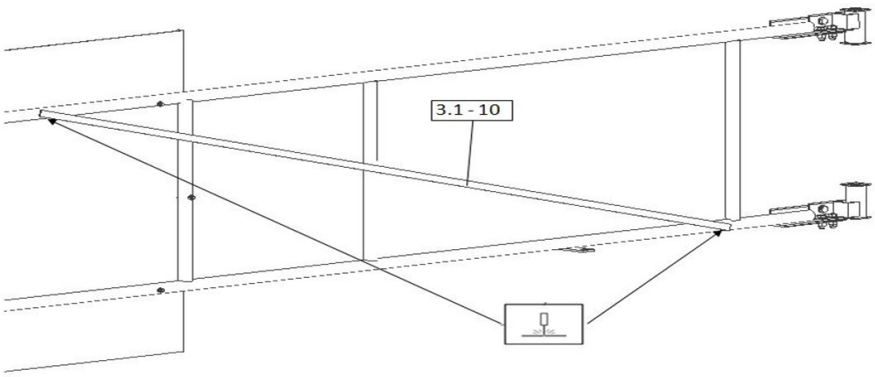


6. **Screwing the control vane plate to the arm**
   After the holes have been drilled, the frame can be screwed to the control vane plate. For this purpose, short screws [3.1 - 12] are used on the L-section and the longer screws [3.1 -13] on the tube.
   In order to reduce corrosion, silicone strands can be applied to the contact lines
   - between sheet metal and tube and
   - between the angle and the surface.



7. In the last step, weld the diagonal brace [3.1-10] to the frame. Make sure that it runs downwards from the upper nacelle support to the control vane.

   This illustration shows the control vane from the rear side. When mounted, it is rotated 180 degrees. After mounting the sheet metal, the entire control vane must be painted.



Cross vane

Control description

The side vane of the KUKATE34 is a component of the mechanical safeguard. This safeguard serves to protect the rotor during high wind speeds or storms.
At high wind speeds, the force of its torque is greater than the weight force holding the control vane in its home position.

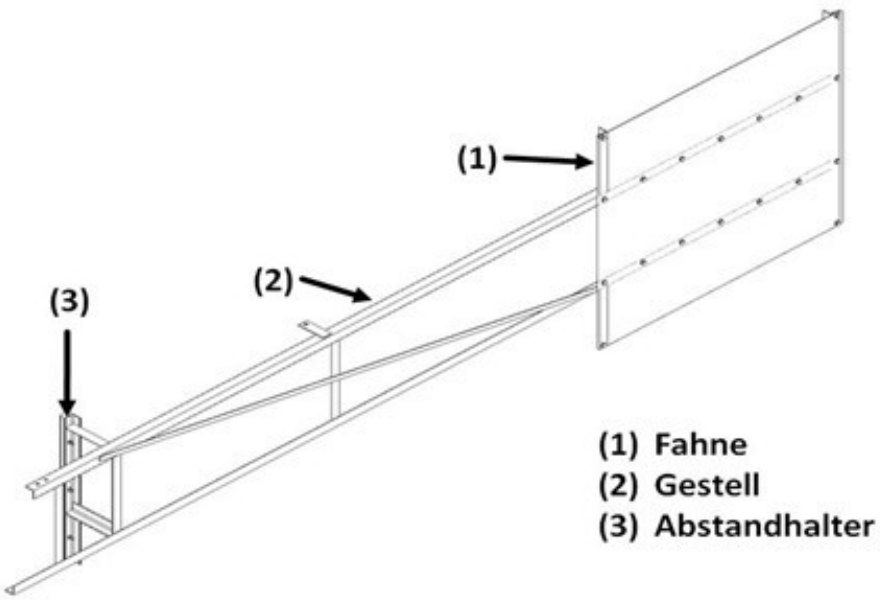
The weight is lifted and the control vane moves towards the side vane.
The nacelle with the rotor is turned out of the wind. The rotor is blown sideways by the wind. The rotor power decreases.

The side vane swivels towards the control vane. The spacer (3) is held in a certain position. In this position (storm position), the side vane, control vane and rotor surface are almost parallel in the wind direction. The rotor is blown at a very oblique angle and thus has little resistance.

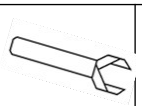
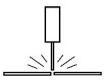
As soon as the wind force on the vane surfaces decreases, the side vane - pulled by the control weight - swings into the starting position. The rotor is again blown frontally by the wind. Operation of the pump is resumed. The size of the counterweight determines the wind speed at which the side vane swings the rotor out of the wind.

The cross vane surface (1) must be installed laterally next to the rotor. In this way, the side vane surface is completely blown by the wind. The functionality of the mechanical control is thus guaranteed. The side vane frame positions the vane surface next to the rotor.

In normal operation, the vane is aligned with the frontal wind flow. The torque generated by its drag is compensated by the torque of the completely swung-out control surface.



Tools

						
	9;11	WS 13; 16		90°		Metal

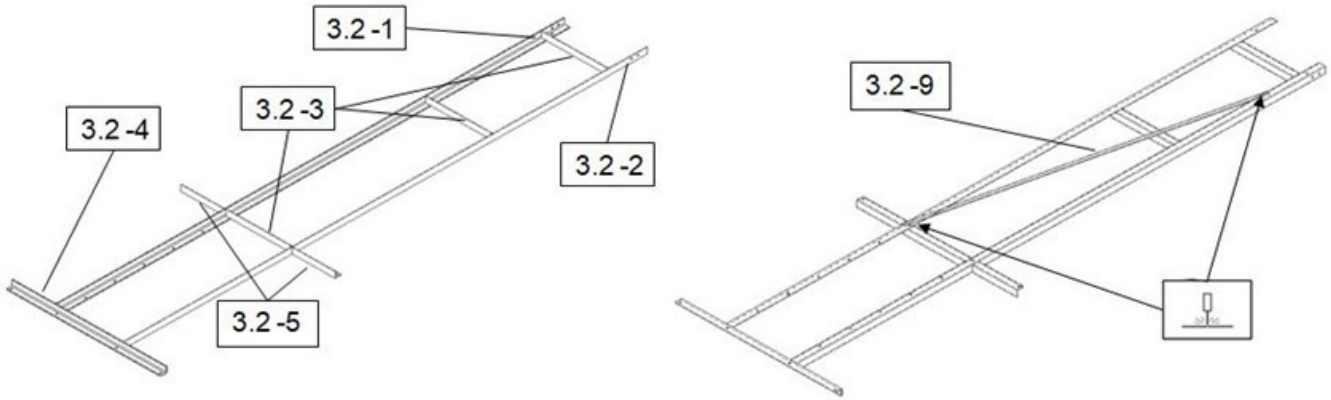
Material

Pos	Raw material	Name	Standard	Dimensions	Qty	Material
3.2 **-1**	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x3300mm	1	S235
-2	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x3400mm	1	S235
-3	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x424mm	3	S235
-4	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x1000mm	1	S235
-5	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x280mm	2	S235
-6	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x207mm	2	S235
-7	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x685mm	1	S235
-8	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x1450mm	1	S235
-9	**R - 29**	Flat steel	DIN EN 10058	20x3x1920mm	1	S235
-10	**R - 31**	Sheet	EN 10051	1x1000x1000mm	1	Aluminium
-11		Hexagon head screw	DIN ISO 4017	M10x20-8.8	14	
-12		Hexagon head screw	DIN ISO 4017	M10x30-8.8	8	
-13		Hexagon nut with torque part	ISO 7040	M10-8.8	22	
-14		Washer	ISO 7089	M10	44	
-15		Hexagon head screw	DIN ISO 4017	M8x30-8.8	1	
-16		Hexagon nut with torque part	ISO 7040	M8-8.8	4	
-17		Washer	ISO 7089	8	8	
-18	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x685mm	1	S235
-19	**R - 28**	L-Profile	DIN EN 10056-1	40x40x4x220mm	2	S235
-20		Wood		25x40x685	1	Hardwood
-21		Hexagon head screw	DIN ISO 4017	M8x50-8.8	3	
-22	**R - 29**	Flat steel	EN 10278	20x3x120mm	1	S235
-23	**R – 29**	Flat steel	EN 10278	20x3x850mm	1	S235

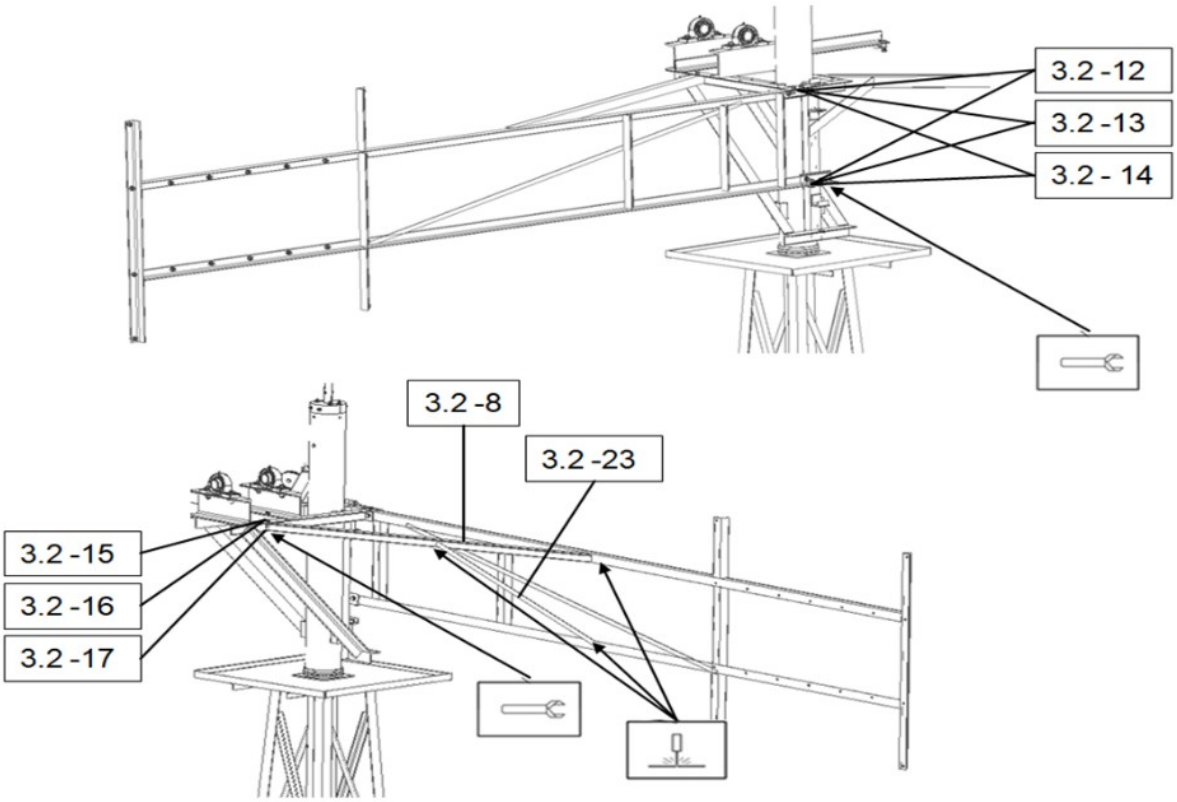
Tabelle 2 - Stückliste 3.2 Seitenfahne

Construction

1. **Construction of the side flag arm**
   First, all components are sawed and drilled. Then align the longitudinal struts [3.2-1, 3.2-2] in parallel and insert the cross struts [3.2-3]. Likewise, make sure that the longer longitudinal strut [3.2-2] is mounted to the lower nacelle support.
   Now the individual struts are first spot welded and then finish welded. Then turn the frame by 180 degrees to lay out and weld the diagonal strut. Note that the strut [3.2-9] runs from the top of the nacelle down to the vane.



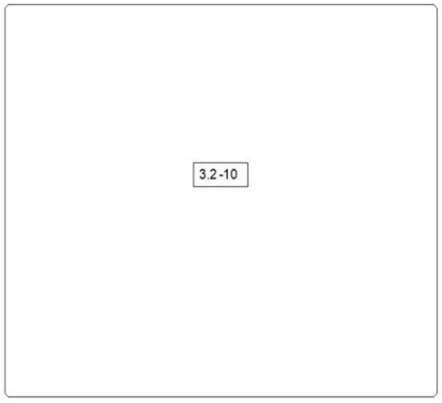
2. **Mounting and adjusting the diagonal braces between the nacelle and the arm.**
   In the next step, mount the frame to the nacelle [2.2]. Likewise, screw the L-profile [3.2-8] to the gondola and align it so that it can be welded to the upper L-profile [3.2-1] of the flag frame.



The flat bar [3.2-23] is positioned on top of the strut [3.2.-8] at half its length. It is welded there and at its lower end to the second cross strut [3.2-2].

After all welded joints are finished, the frame should be removed from the nacelle again.

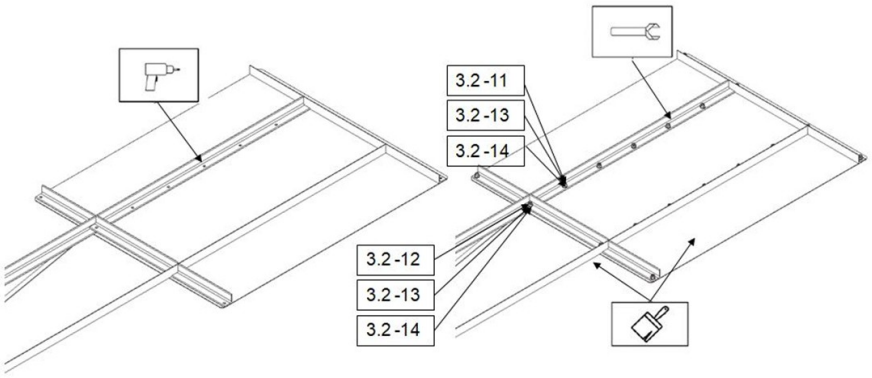
3. **Cut and deburr side flag plate.**
The sheet metal for the side flag of the KUKATE34 [3.2 - 10] is a 1mm thick steel sheet or a 2mm thick aluminum sheet, with the dimensions 1m x 1m. It must be deburred at the sharp edges and rounded at the corners. This reduces the risk of injury.



4. **Drill and mount**

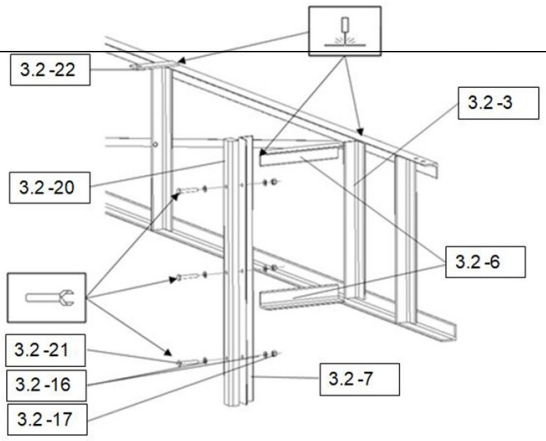
To drill the sheet and the rack, the rack is placed on the sheet and aligned. The holes are then drilled through the rack into the sheet metal. The screws can then be inserted and tightened. For the front center L-section, M10x30 screws [3.2 - 12] must be used. The rest is tightened with M10 x20 screws [3.2 - 11].

To reduce corrosion, silicone strands can be applied to the contact lines between the angle and the surface and around the screw holes before screwing. The sheet is painted after assembly to protect it against corrosion.



5. **Fabricate spacer**

The last step is to fabricate the spacer (stop) between the control vane and the side vane. To do this, insert the L-section [3.2-3] between the longitudinal struts of the side vane, set it upright and spot-weld it. Then place the L-sections [3.2-6] at right angles and spot-weld them as well. Then weld the L-section [3.2-7] to the cross struts [3.2-6]. It is important to align the stop so that the control vane does not hit the screws when it is struck.



The arm of the side vane should hit the complete width of the wooden beam [3.2-20] in the storm position. Therefore, the profile of the wooden beam should be planed at an angle for this purpose. After painting the arm and the stop, the wooden beam [3.2-20] is screwed.