Pannkoke
Flachglastechnik GmbH

 EMU	 8001-H2000	 7025-GGSO
 Balance	 7211-CeDe	 7011-F1200SO
 7011-DS	 7411-HV400	 7005-SO98

Help in Selecting the correct Vacuum Lifting Devices

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Pannkoke Flachglastechnik GmbH is a company specialising in manufacturing systems engineering for equipment, machines and tools in the glass processing industry. Our medium-sized engineering company was founded in 1900.

We have been developing and producing vacuum lifting and flat glass cutting machines to meet real life requirements since 1958. Our long term experience means that we can react in a flexible way to satisfy the wishes and requirements of our customers. Our strength lies in our ability to produce turnkey solutions for individual customers.

Quality and service take pride of place at Pannkoke. During the design phase, particular emphasis is placed on ensuring a long service life for equipment and machinery. When choosing our suppliers, high quality and stability of supplies are major considerations.
The oldest vacuum lifting units for which we still provide maintenance annually and which are still used in the production process, originate from 1965.
Cutting machines are still in use worldwide which, after being used in full production for decades, are still maintained in a serviceable state by us.
Our customers who have been implementing our products for decades, are our main criterion for the quality of our products.

Please ask for information
on our extensive production and delivery programme.

Machines for cutting flat glass
- from manual to CNC-machine

Vacuum lifting and holding technology
- for lifting, holding and transporting
  concrete, glass, plastics, metal, stone or lead blocks
  at temperatures of up to 200° C
- vacuum transporting equipment
  for roof and wall panels used in industrial construction

Tools
- suction handles, tools and equipment for the
  processing and handling of flat glass

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Groups of Devices
Vacuum Lifting Devices

Type Description	Description	Group of Device
Frame	Carrying Frames without Vacuum Generation	**7000**
Kombi	Carrying Frames with • mains-operated, electrical vacuum pump	**7001**
Vacuum Unit	mains-operated, electric Vacuum Unit	**7002**
Frame	Carrying Frames with • hand-operated vacuum pump	**7004**
Venturi device	Carrying Frames with • Compressed air-operated vacuum pump (venturi jet)	**7005**
Accu (Rechargeable Battery) Device Kombi	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump	**7011**
Accu (Rechargeable Battery) Vacuum Unit	mains-independent, electric (rechargeable battery-operated) Vacuum Unit	**7012**
Manipulation device	Carrying Frames with • mains-operated, electrical vacuum pump and • pneumatic drive	**7021**
Manipulation Device	Carrying Frames with • compressed air-operated vacuum pump (venturi jet) and • pneumatic drive	**7025**
Kombi	Carrying Frames with • mains-operated, electrical vacuum pump and • electrical drive	**7031**

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Groups of Devices
Vacuum Lifting Devices

Type Description	Description	Group of Device
Manipulation device	Carrying Frames with • compressed air-operated vacuum pump and • electrical drive	**7035**
Manipulation device	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump and • pneumatic drive	**7037**
Kombi	Carrying Frames with • mains-independent, electrical vacuum pump and • electrical drive	**7041**
Kombi	Carrying Frame • with mains-operated, electrical vacuum pump *with 2-circuit-technique for the latest safety standard of the EC*	**7201**
Vacuum Unit	mains-operated, electric Vacuum Unit *with 2-circuit-technique for the latest safety standard of the EC*	**7202**
Venturi device	Carrying Frames with • Compressed air-operated vacuum pump (venturi jet) *with 2-circuit-technique for the latest safety standard of the EC*	**7205**
Accu (Rechargeable Battery) Device Kombi	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump	**7211**

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Type Description	Description	Group of Device
	with 2-circuit-technique for the latest safety standard of the EC	
Accu (Rechargeable Battery) Vacuum Unit	mains-independent, electric (rechargeable battery-operated) Vacuum Unit *with 2-circuit-technique for the latest safety standard of the EC*	**7212**
Manipulation Device	Carrying Frames with • compressed air-operated vacuum pump (venturi jet) and • pneumatic drive *with 2-circuit-technique for the latest safety standard of the EC*	**7225**
Kombi	Carrying Frames with • mains-operated, electrical vacuum pump and • electrical drive *with 2-circuit-technique for the latest safety standard of the EC*	**7231**
Kombi	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump and • electrical (battery-operated) drive *with 2-circuit-technique for the latest safety standard of the EC*	**7241**
Accu (Rechargeable Battery) Device Kombi	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump *with 4-circuit-technique for the latest safety standard of the EC*	**7411**

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Groups of Devices
Vacuum Lifting Devices

Type Description	Description	Group of Device
Kombi	Carrying Frames with • mains-independent, electrical (battery-operated) vacuum pump and • electrical (battery-operated) drive *with 4-circuit-technique for the latest safety standard of the EC*	**7441**

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Possibilities of the Transport Movements

	vertical
	horizontal
	turning
	tilting vertical – horizontal horizontal – vertical
	tilting only vertical – horizontal
	lifting vertical – horizontal horizontal – vertical only via the lower edge

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Comparison

7000-xx Frame Carrying Frame without Vacuum Generation	
Advantage	**Disadvantage**
low cost of purchase	an additional vacuum generation is necessary
low weight	long vacuum supply line to the frame increases the risk of an untightness in the system
	construction of a 2-circuit-system difficult to execute
	unsuitable for the application at the construction site with long transport ways etc. because of the vacuum supply line

7001-xx Kombi Carrying frame with mains-operated, electric vacuum pump	
Advantage	**Disadvantage**
complete vacuum lifting device	higher weight
easy installation	follow-up supply line of the mains supply
compact vacuum system without long vacuum supply line	
use of efficient vacuum pumps possible	
electric warning signals at low partial vacuum	
vacuum system is also tight at interrupted electric mains (depends on the lifted material)	

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Comparison

7011-xx Accu-Device Kombi Carrying frame with independent of mains-supply, electric (rechargeable battery (accumulator) operated) vacuum pump	
Advantage	**Disadvantage**
complete vacuum lifting device	higher weight
easy installation	vacuum pump not adaptable to the efficiency (low capacity)
compact vacuum system without long vacuum supply line	
electric warning signals at low partial vacuum	
no follow-up supply line of the mains supply	

7005-xx Venturi Device Carrying Frame with compressed air operated Vacuum Pump / Suction jet(s)	
Advantage	**Disadvantage**
complete vacuum lifting device	follow-up supply line of the air pressure system
easy installation	no electric warning signals at low partial vacuum
compact vacuum system without long vacuum supply line	not suitable for construction sites only for the production
use of officient suction jets possible	
low weight	
Vacuum system is also tight at interrupted air pressure supply (depends on the lifted material)	

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Safety requirements for vacuum lifting devices taken from the European Standard EN 13155:2003

This standard for safety requirements of non-fixed load lifting attachments outlines some essential requirements for vacuum lifting devices, which have to be fulfilled by **all load suspension devices,** while only some have to be fulfilled by vacuum lifting devices. Also, safety requirements for grabs and tongs are defined in this standard.

The title of this standard is:
Krane — Lose Lastaufnahmemittel
Cranes — Non-fixed load lifting attachments
Appareils de levage à charge suspendue — Equipements amovibles de prise de charge

This standard is valid in all the EU countries. All new load lifting attachments brought into circulation since the 01.01.2004 must conform to this standard, this, at least, is our understanding.

The forward to this standard contains the following:

> This document (EN 13155:2003) has been prepared by Technical Committee CEN/TC 147 “Cranes - Safety”, the secretariat of which is held by BSI.
>
> This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2004, and conflicting national standards shall be withdrawn at the latest by January 2004.
>
> This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).
>
> To determine the relationship to the EC Directive, see the information in Annex ZA, which is an integral part of this document.
>
> According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Section 5 lists safety requirements and or measures. Particular requirements relating to vacuum lifting devices are given under point 5.2.2 of the standard.

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Safety Requirements

	Requirement	Pannkoke Solution
5.2.2.1	**Vacuum lifters shall be dimensioned to hold at least a load corresponding to two times the working load limit at the end of the working range and the beginning of the danger range respectively at all intended angles of tilt.** The maximum angles of tilt shall be increased in accordance with 5.1.1.2. NOTE: The pressure range within which it is possible to work is termed the working range. The danger range adjoins the working range. In some vacuum lifting systems, in particular self-priming vacuum lifters, the resultant pressure decrease depends upon the weight of the load.	The loading capacity of our built-in suction cups have a 2-fold safety factor at the minimum permissible depression. The 388 suction cups were tested in the Fachhochschule Kiel with both a slide-off and a pull-off test. The 388 suction cup carries 100 kg with a 2-fold safety factor.
5.2.2.2	Non-self-priming vacuum lifters shall be equipped with a pressure measuring device showing the working range and the danger range of the vacuum.	Our control vacuum meter has already been in use for 20 years and each of our vacuum lifting devices has such a control vacuum meter. The working range is marked green, the danger range red.
5.2.2.3	Self-priming vacuum lifters shall be equipped with an indicator showing to the operator that the end of the working range is reached.	This type of device is not manufactured by Pannkoke.
5.2.2.4	The measuring device or the indicator respectively shall be fully visible for the slinger or, if there is no slinger, for the driver of the crane when in his normal working position.	Each vacuum lifting device with integral electrical vacuum generation has a control vacuum meter and an acoustic and visual warning signal generator that is triggered by too low vacuum pressure – both since the beginning of the 80's. Rechargeable battery-powered vacuum lifting devices have been equipped for **two** years with two optical warning signals. Optionally a large flashing light can be supplied as an alarm unit for all electrically powered devices with twin circuit system technology. Compressed air powered vacuum lifting devices have had a control vacuum meter and an acoustic warning signal since 2004.
5.2.2.5	Means shall be provided to prevent the risks due to vacuum losses. This shall be:	

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	Requirement	Pannkoke Solution
	a) in the case of vacuum lifters with a vacuum pump: a vacuum reservoir with a non-return valve between the vacuum reservoir and the pump, located as close as possible to the vacuum reservoir;	The support frame or parts of the support frame of our vacuum lifting device are generally configured as vacuum reservoirs. New device types will have a clearly identifiable vacuum reservoir, which does not form part of the supporting components. System leak tightness is tested prior to delivery. Only units that lose less than 5 % of their vacuum over 15 minutes are delivered. With the rechargeable battery powered vacuum lifting devices there is also the fact that if the vacuum falls below a certain limit during use, the vacuum will be increased via the accumulator vacuum pump.
	b) in the case of vacuum lifters with Venturi-systems: a pressure reservoir tank or vacuum reservoir tank with a non-return valve between the vacuum reservoir and the Venturi system, located as close as possible to the vacuum reservoir;	Only compressed air powered vacuum lifting devices with a closed vacuum system have been manufactured since 2000. The support frame or parts of the support frame of our vacuum lifting device are generally configured as vacuum reservoirs. New device types will have a clearly identifiable vacuum reservoir, which does not form part of the supporting components. System leak tightness is tested prior to delivery. Only units that lose less than 5 % of their vacuum over 15 minutes are delivered.
	c) in the case of turbine vacuum lifters: a supporting battery or an additional flywheel-mass;	This type of unit is not manufactured by Pannkoke.
	d) in the case of self-priming vacuum lifters: a reserve-stroke at least equal to 5 % of the total stroke of the piston. NOTE: Vacuum losses can occur for example, due to leaks, or in the case of non self-priming vacuum lifters, due to a power failure.	This type of unit is not manufactured by Pannkoke.
5.2.2.6	There shall be a device to warn automatically when the danger range is reached, if vacuum losses cannot be compensated. The warning signal shall be optical or acoustic, depending upon the circumstances of use of the vacuum lifter and in accordance with EN 981, EN 842 and EN 457. The warning device shall work even if there is a power supply failure to the vacuum lifter. NOTE: The warning device is not the pressure measuring device of 5.2.2.2 or the indicator of 5.2.2.3.	Each vacuum lifting device with integral electrical vacuum generation has a control vacuum meter and an acoustic and visual warning signal generator that is triggered by too low vacuum pressure – both since the beginning of the 80's. Battery powered vacuum lifting devices have been equipped with **two** visual warning indicators since 2000. Optionally a large flashing light can be supplied as an alarm unit for all electrically powered devices with twin circuit system technology. Compressed air powered vacuum lifting devices have had a control vacuum meter and an acoustic warning signal since 2004.

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	Requirement	Pannkoke Solution
5.2.2.7	In case of power failure, the vacuum lifter shall be able to hold the load for 5 minutes. This is not necessary in no-go areas and this is not necessary **for turbine vacuum lifters** if all the following conditions are met : • the operator maintains control of the load through steering handles which ensures that the operator is outside the danger zone in case of the load falling; • in addition to clause 5.2.2.6 a warning device shall be activated as soon as the power fails; • the manufacturer shall prohibit lifting of the geometric centre of the suction pads above 1.8 m by marking and instructions for use.	Since 2000, we have only manufactured vacuum lifting devices with one or more closed vacuum circuits (see 5.2.2.5). System leak tightness is tested prior to delivery. Only units that lose less than 5 % of their vacuum over 15 minutes are delivered.
5.2.3.8	For vacuum lifters intended to be **used in a building area a secondary positive holding device is required** or there shall be **two vacuum reserves each fitted with non-return valves**. **Each vacuum reserve shall be connected to a separate set of suction pads.** **Each set of suction pads shall fulfil the requirement of the clause 5.2.2.1.**	All units in the 7201, 7211 or 7411 ranges have two independent vacuum circuits and are suitable for building site use. The conversion to point 5.2.3.8 **means that each vacuum circuit must be able to support the nominal load with 2-fold safety.** This is only necessary for devices which are to be used on a building site. Each vacuum circuit requires the same monitoring functions as a device with only one vacuum circuit. When using a single circuit vacuum lifting device on a building site, an additional locking-fit support device must be used, which must be able to support the nominal load by itself at all times with the required degree of safety in every position. For example, this can be resolved by using brackets or a load strap up until the time of use. All of these measures fail only in an actual dangerous activity and the operator is then hard pressed to explain how the working of his safety measure conforms to the standard, when an accident has already occurred.
5.2.2.9 5.2.2.10	The releasing of the load shall be actuated by a two action control. This is not necessary if the release of the load is not possible until the load has been put down or in no-go areas. Controls for tilting or turning movements shall be hold-to-run type.	For electrical lifting devices this is achieved by using a mushroom button (such as an emergency-off switch). The must be turned to achieve a switching action. The mushroom button is located in a housing with edge protection, so that the actuating element is protected by the surrounding mechanical guard. A mechanical guard is provided around hand valves to prevent their unintended activation. Since 2004, compressed air powered devices have only been supplied with single-hand twofold actuation.

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	Requirement	Pannkoke Solution
5.2.2.11	The shape of the suction pad shall be matched to that of the intended load(s). If more than one suction pad is used in conjunction with a lifting beam, the layout and working load limit of the suction pads shall be matched to that of the intended load(s). The share of the load which can foreseeably be imposed on each suction pad shall not exceed its working load limit taking account of the rigidity of both the load and the vacuum lifter.	

Point 7 sets special requirements for user information.

Point “7.1.2.2 Vacuum Lifter” contains the special requirements for user information:

A) checking of the vacuum level;
B) measures to be taken as soon as the warnings are actuated;
C) checking of the condition of the vacuum connections and hoses;
D) checking of the condition of the suction pads;

The minimum label is clarified under point 7.2.1.
The minimum label must be permanently attached to a nameplate.

a) identification of manufacturer (or authorized representative or importer);
b) model;
c) serial number;
d) weight of unloaded attachment
e) year of manufacture;
f) working load limit in tonnes or kg
g) CE-label (for new devices)

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Safety Requirements

Requirements over and above this are taken from the draft safety standard of the **CEN/TC 151/WG 13/SG A1**.
This working group has the following title:

Machines and plants for the manufacture,
treatment and processing of flat glass
- Safety requirements -
Part 1: Storage, handling and transportation equipment inside the factory

	Requirement	**Pannkoke Solution**
5.7.1.1	The vacuum system shall have redundancy so that if part of the system fails then the remaining part of it shall be capable of supporting the actual load.	This is the case for our new device series with a twin circuit vacuum system (2KS) and applies to both electrical and compressed air powered vacuum lifting devices
5.7.4	Systems shall be provided to control and monitor vacuum losses comprising:	
	a) In the case of vacuum lifters with a vacuum pump a vacuum tank of minimum volume of at least twice the total evacuated volume of the system.	The support frame or parts of the support frame of our vacuum lifting device are generally configured as vacuum reservoirs. New device types will have a clearly identifiable vacuum reservoir, which does not form part of the supporting components. System leak tightness is tested prior to delivery. Only units that lose less than 5 % of their vacuum over 15 minutes are delivered. Additionally, for battery powered vacuum lifting devices, if the vacuum falls below a certain limit within the working range, it is increased again using the battery-powered vacuum pump.
	b) In the case of vacuum lifters with injector venturii, every injector shall be equipped with a non-return valve.	Behind the suction air nozzle (the injector) is a non-return valve and then a vacuum reservoir. For twin circuit systems, each vacuum circuit has a vacuum reservoir with a non-return valve.
5.7.5.1	For raw glass either guarding on the rear of the frame with handles or guide handles alone shall be fitted and arranged in a way which protects the operator from falling glass.	Optional - dependent on the glass size – available on request.
5.7.5.2	It shall be possible to guide vacuum lifters using both hands, even if the operator has to simultaneously operate a hoist.	Optional - dependent on the glass size – available on request.

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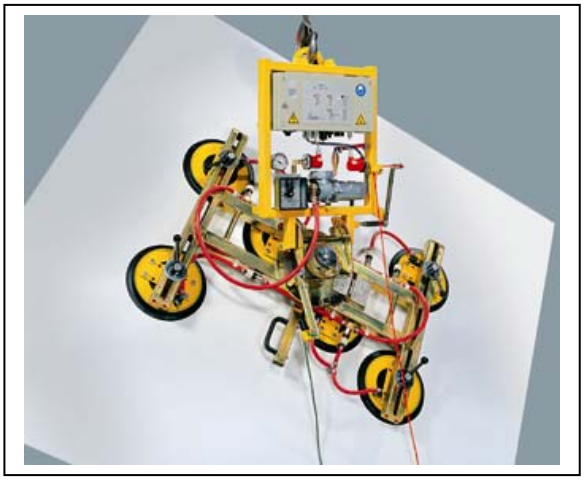
Remote control / Hand valve

The advantages and disadvantages of the remote control are explained with the example of the accu device Kombi 7011-DS. This can be applied to all other accumulator operated vacuum lifting devices.



Control via the hand valve	
	
Advantage	**Disadvantage**
works without mains supply	position of the operation not chaneable
longer working with the charged accumulator	more difficult to operate at larger dimensions of the transport load
simple execution	

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Remote Control

Control via the cable remote control	
	
Advantage	**Disadvantage**
position of the operation changeable	does not work without mains supply
easier to operate at larger dimensions of the transport load (in general is the cable length 2 m around the switch box)	shorter operation with the charged accumulator
detachable cable remote control	disturbing cable with the danger to get caught
switch condition recognizable via the position of the mushroom shaped key	fastening of the housing on longer transport distances a loose hanging remote control can lead to misoperation
switch condition recognizable via the position of the mushroom shaped key	slightly proud mushroom shaped key
hand made robust housing for the operation key	
screwed down with the device via a screw-type locking connector (cannot be lost easily)	

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Remote Control

Control via the infrared remote control	
	
Advantage	**Disadvantage**
position of the operation changeable	does not work without mains supply
easier to operate at larger dimensions of the transport load (approx. 6 m around the switch box)	shorter operation with the charged accumulator
no disturbing cable no danger of getting caught	switch condition at the remote control not recognizable
detachable infrared remote control	battery for the sender necessary (replacement approx. each year)
simple change between infrared remote control and cable remote control	sender is not fastened to the device sender can get lost or can be forgotten
no loose hanging remote control, which could lead to misoperations	
hand made robust housing for the operation key	
no proud operating parts at the housing	

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The Influence of the size of the transport load

The carrying capacity of a vacuum lifting device depends not only on the carrying capacity of the suction cups but also or the carrying frame and on the size of the transport load, especially.

If you transport a larger sheet with a small carrying frame, the suction cups are affected not only by even if distributed gravity (gravitation at power) on the transport load but also additional forces such as bending and leverage forces. Under certain conditions may this lead to the overstressing of an individual suction cup.

Experiment:
(horizontally)
Take a thicker 20 x 30 cm magazine and put it on the fingertips of your out stretched hand.
Now the magazine is nearly straight and flat on your fingertips. You will feel an even pressure on your fingertips.

Now try to move the fingertips equally to the middle of the magazine, (but don't allow the magazine fall down.
You will notice a change in the pressure conditions.
The weight of the magazine has not changed, but additional forces are in affect and these are not distributed equally.

This also happen to the suction cups if the carrying frame is not adapted to the transport load.
With that we have demonstrated the dependency of the transport load size on the horizontal loading case.

Experiment:
(vertically)
Take a thicker 20 x 30 cm magazine and hold it only with your thumb and forefinger at the longitudinal side of the magazine edge. In order to get a good demonstration of this experiment place your "finger tong" in the range 2/5 to 3/5 of the side length. That means quite aware of the middle of the magazine. Hold the magazine up with your "finger tong", so that it hangs vertically down under your "finger tong".
The position of the magazine is inclined. As expected. You need a certain, not too high pressure of your "finger tong", to hold the magazine.

Now try to align the magazine so that the upper edge of the magazine is ligned up horizontally and this only with your "finger tong".
You will feel a change of the pressure conditions of your "finger tong".
The weight of the magazine has not changed but additional forces are in affect and these are not distributed equally.

The same occurs to the suction cups if the carrying frame is not adapted to the transport load.
With that we have demonstrated the dependency of the transport load size on the vertical loading case.

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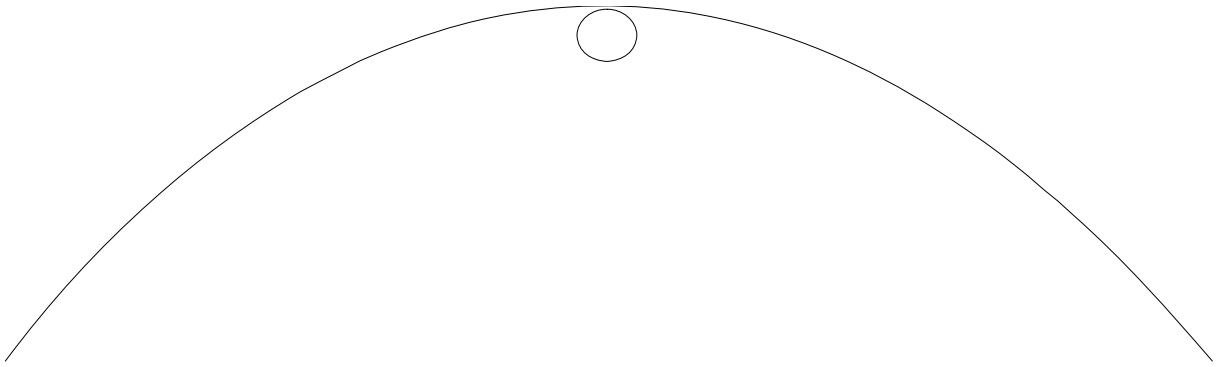
The Influence of the size of carrying frame on the carrying capacity

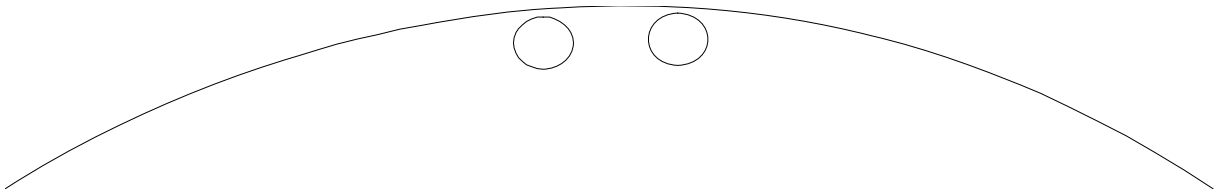
The carrying capacity of a vacuum lifting device depends not only on the carrying capacity of the suction cups but also especially on the size of the carrying frame.

The maximum projecting end of the material to be lifted is difficult to define and depends on many factors. the stiffness of the material is very important. In relation to this question - generally the horizontal application is always the more critical consideration. If the material projects too far and does not have a sufficient stabilization, it will arch.

Experiment:
Hold a pencil horizontally, take a 20 x 30 cm sheet of paper and center it over the pencil. What does your paper do? Is it straight or does it hang down?



Now take two pencils and hold them in a distance of approx. 1 cm and now center the paper over the two pencils. What does your paper now do?



You can go on with this experiment by positioning the pencils further and further apart.

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The result will be: the furher apart, the less bending of the ends of the sheet – until the point you will now need a support.

This experiment is a very good demonstration of the horizontal transport. Can you now imagine how strong the outer suction cups are stressed because of the bending? And not only the bending but also the force from the corresponding lever arm make it impossible for the outer suction cup to hold the load. Therefore, the frame with the suction cups must nearly reach the size of the transport load. Especially the bending of the materials leads to pull-off of the suction cup.

With a 1-circuit vacuum system it is so that, if one suction cup is overstressed, a leak occurs in the vacuum system and all suction cups will release within a very short time. This loss of vacuum can no longer be compensated.

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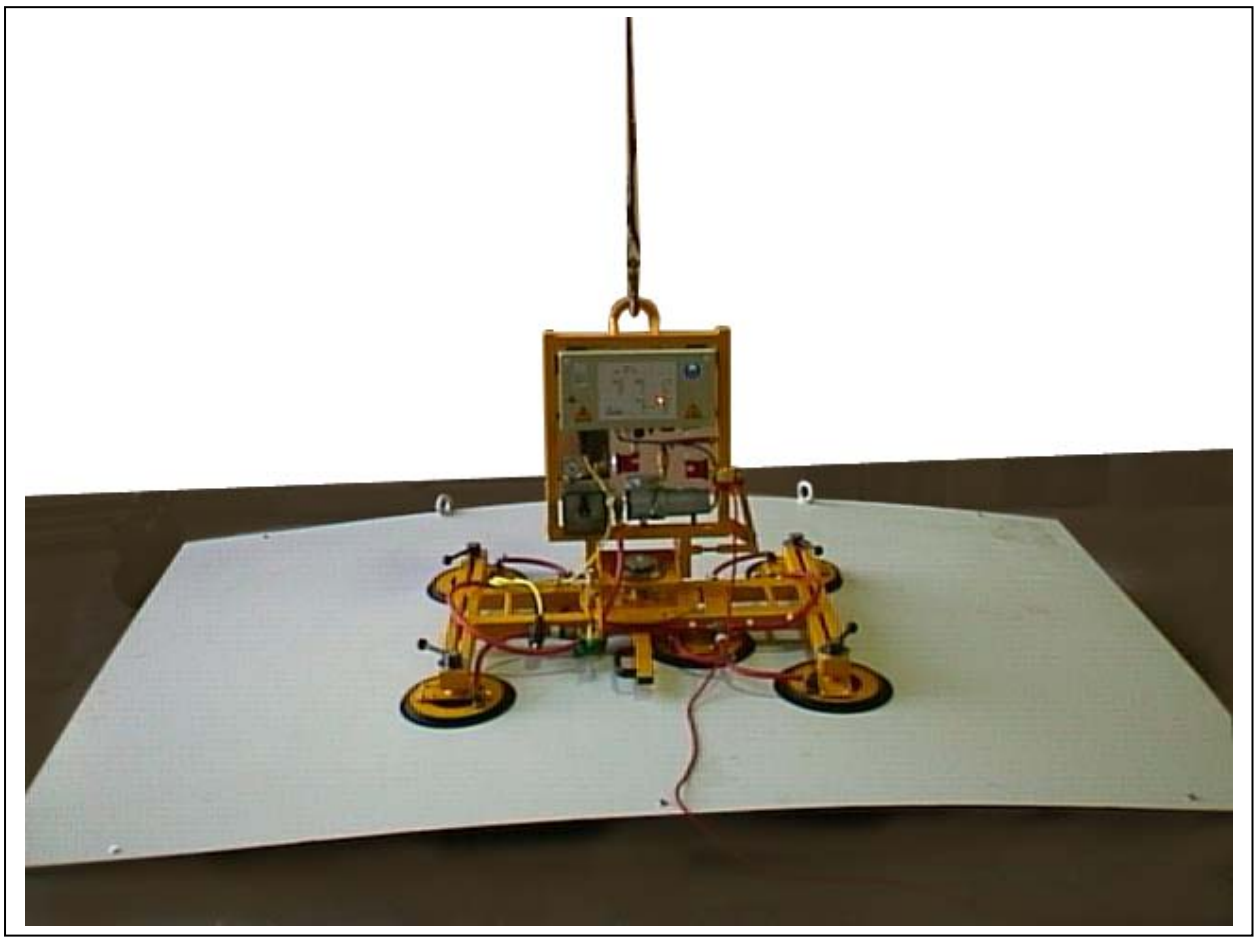
Size of Carrying Frame

When taking into consideration the accumulator device Kombi 7011-DS it means, that:
The suction cups 388 used by us can hold onto a clean glass sheet until they pull-off, according to the type of force and speed, approx. 300 kg at a partial vacuum of 0.6 bar, without taking into consideration a safety factor. In theory, with a 7011-DS with 6 suction cups, one could hold approx. 1800 kg horizontally (without a safety factor).
The frame dimensions are approx. 1.0 x 0.8 m. Due to limitations it is possible to move materials up to the maximum dimension of 2.0 x 1.8 m.

Take for example a steel plate with the dimensions 3.0 x 2.0 m and a weight of approx. 580 kg and you want to move it horizontally.

It would take about 10 seconds before the plate would fall down.



If you strengthen the steel plate with supports, the transport is possible, provided that you take care that no bending occurs.

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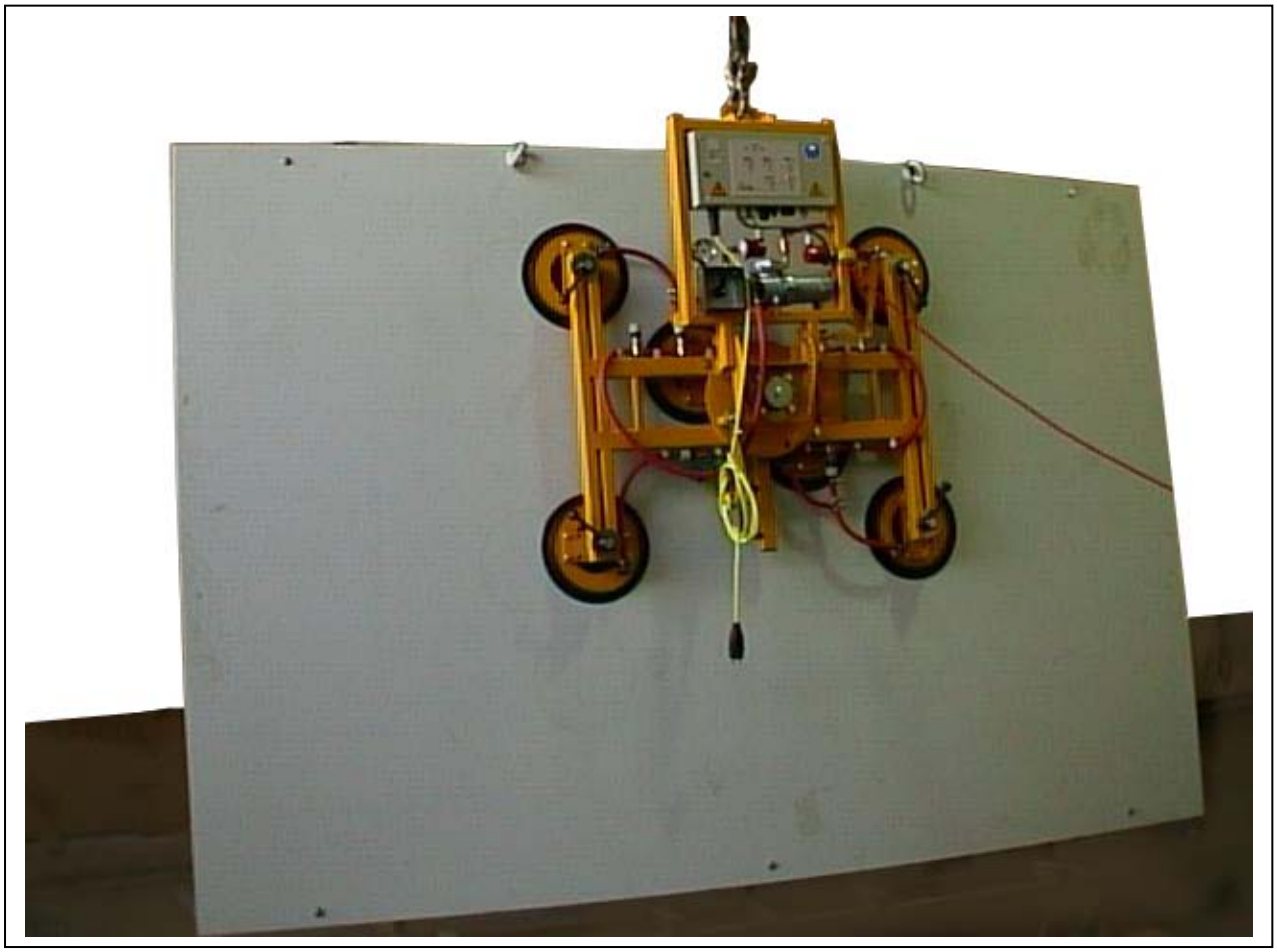
Size of Carrying Frame

During the vertical use the stiffness is not as important because each plate material has a certain inherent stability in this direction. Pick the sheet of paper up with two fingers on one corner and hold it vertically so that the side with the 30 cm is horizontal and the 20 cm side vertical. The sheet will hang nearly straight without bending.

If the inherent stability is too low, the bending of the material can lead to the same effect as in the horizontal application.

When taking into consideration the accumulator device Kombi 7011-DS it means, that:
The suction cups 388 used by us can hold onto a clean glass sheet until they pull-off, according to the type of force and speed, approx. 200 kg at a partial vacuum of 0.6 bar without taking into consideration a safety factor. In theory, with a 7011-DS with 6 suction cups, one could hold approx. 1200 kg vertically (without a safety factor).
The frame dimensions are approx. 1.0 x 0.8 m. Due to limitations it is possible to move materials up to the maximum dimension of 2.0 x 1.8 m.

Take for example a steel plate with the dimensions 3.0 x 2.0 m and a weight of approx. 580 kg and you want to move it vertically.



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In fact the steel plate can be held but the bending of the steel plate can already be recognized clearly. We have now reached the limit.

Another factor is of greater importance. This is the lever arm effect, caused by not centering the sucked-on load. Forces greater than presumed can affect the suction cup in that additional stress occurs via the displacement of the centre of gravity of the load in relation to the suspension point. This can also lead to an overstressing of the suction cup.

Experiment:
For demonstration of the influence of the force caused by the lever arm effect, take a hammer (about 250 g in weight), hold the end of the handle with your thumb and forefinger so that the steel part hangs down vertically.
This is the example of when the load center corresponds with the suspension point i. e. the load is sucked on centrically.

Now try to hold the handle horizontally so that the iron part faces horizontally to one side. Don't forget to hold the hammer only with your thumb and forefinger.

Do you now understand the influence of the lever arm effect on the suction cup? The force you now have to use is many times higher than before.

If the transport load is to be turned vertically, it is very important that the transport material is sucked on **at** the centre of gravity. Otherwise, it could be that the force of the corresponding lever arm effect could have a negative impact – and all the calculated safety factors would be exceeded very quickly.

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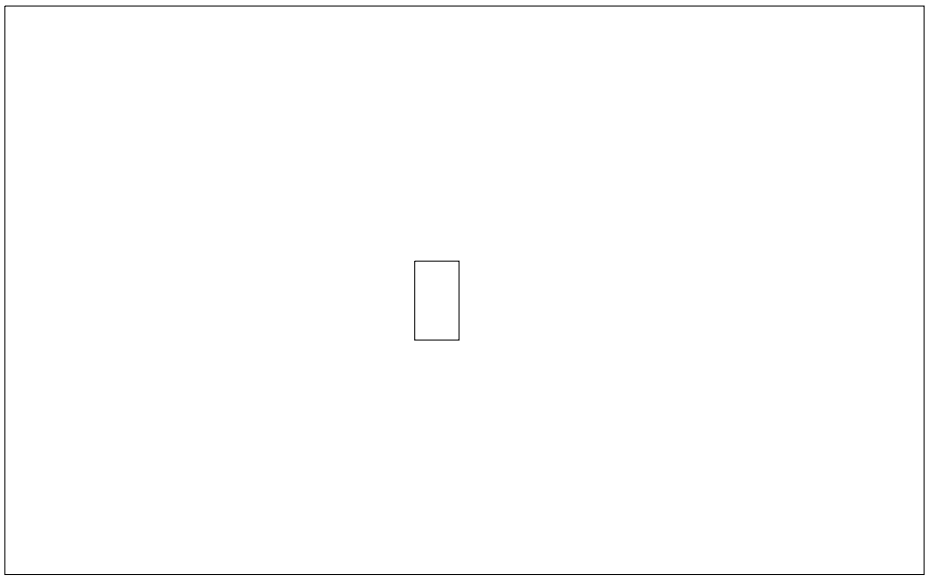
Size of Carrying Frame

The larger the frame the easier the frame can be positioned on the transport load. Take a stamp and try to center it with the naked eye on the sheet of paper (20 x 30 cm).



Repeat it with a paper of the size 10 x 15 cm. You will find out that it is much easier to center the 10 x 15 cm paper on the large sheet (20 x 30 cm) than the stamp.

We hope that these explanations help you to clarify the significance of the relationship of the carrying frame size to the size of the transport load.

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Pannkoke
Flachglastechnik GmbH

Questionnaire: Vacuum Handling Technique

Company
(company stamp)

Contact Mr / Ms: _____ Phone: _____

eMail: _____ Telefax: _____

With our vacuum equipment devices you can lift, hold and transport many different materials such as glass, synthetics, concrete, sheets, plastic coated and gastight chip board, stone etc. The surface can be planed and in some cases curved or beaded. It is also possible to work with materials up to 330 degrees Celsius.

1. Material to be lifted: _____

2. Condition of the surface

gastight	[ ] yes [ ] no	Surface temperature: _____ °C	
damp	[ ] yes [ ] no		
dusty	[ ] yes [ ] no		
surface plane	[ ] yes [ ] no	Radius: _____	
	[ ] even [ ] rough	[ ] _____	

3. Weight of the transport load: _____

4. Max. dimensions of the transport load (length x width x thickness): _____

5. Min. dimensions of the transport load (length x width x thickness): _____

6. How shall the transport load be moved?
   [ ] horizontal [ ] vertical [ ] horizontal and vertical

7. Which manipulating possibilites are preferred?
   [ ] tilting by 90° [ ] turning by 90° [ ] _____

8. How shall the manipulating movement be executed?
   [ ] manual [ ] electrical [ ] pneumatic [ ] _____

9. How is the transport load being stored?
   [ ] standing [ ] lying
   [ ] in a rack [ ] in a case [ ] _____

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Questionnaire: Vacuum Handling Technique

10. Where shall the transport load be transported?
    [ ] within the factory [ ] on the site
    [ ] in the open [ ] _____

11. Which load suspension device is available?
    [ ] crane way [ ] column crane
    [ ] mobile crane [ ] fork lifter [ ] _____

12. Which suspension will you prefer?
    [ ] steel cable sling [ ] suspension eye [ ] _____

    crane hook for _____ kg

13. Which power supply is available and/or requested?

    [ ] current voltage: _____ V frequency: _____ Hz (cycles) phases: _____
    [ ] storage battery

    [ ] air pressure _____ bar

14. How shall the connection to the power supply be executed: hose winder, cable lap winder, length etc.?

    _____

15. How shall the vacuum be generated?
    [ ] built-in vacuum pump [ ] external vacuum pump

    [ ] suction jet [ ] _____

16. How long must the vacuum be held? _____

17. Should the device be dismountable (for transport and/or storage)?
    [ ] no [ ] yes how? _____

18. Do you need a remote control?
    [ ] no [ ] yes ( ) at the guide handle of the device
    ( ) in the hand --- how long?____m

19. Should the suction cups be individually lockable?
    [ ] no [ ] yes

20. Is the surface easily soiled?
    [ ] insensitive [ ] the suction cups may not leave marks (non-abrasive)

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