



FACE CONSULTANTS LTD
Global Flooring Consultants

FACE CONSULTANTS LIMITED
DIN 15185
PROFILEOGRAPH SURVEYS

Further explanatory information



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Why Flatness is Important:

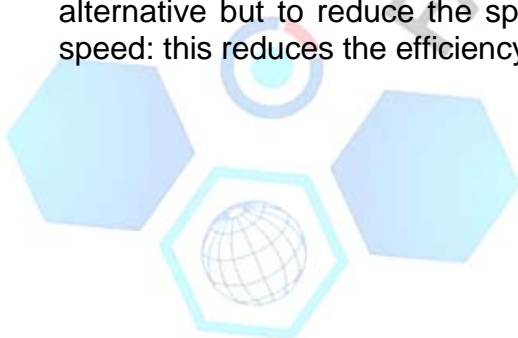
Flatness is an essential requirement of a ground floor slab in certain categories of industry. Undoubtedly, the most important of these categories is that of very narrow aisles in high warehouses where fixed path 'VNA' forklift trucks operate.

The static lean table (overleaf) indicates how the variations in level across the aisle between the load wheel tracks of the truck are magnified in direct proportion to the height of the racking. However, one can readily appreciate that this value, calculated directly from geometrical considerations, forms only part of the potential movement at the top of the mast of the truck.

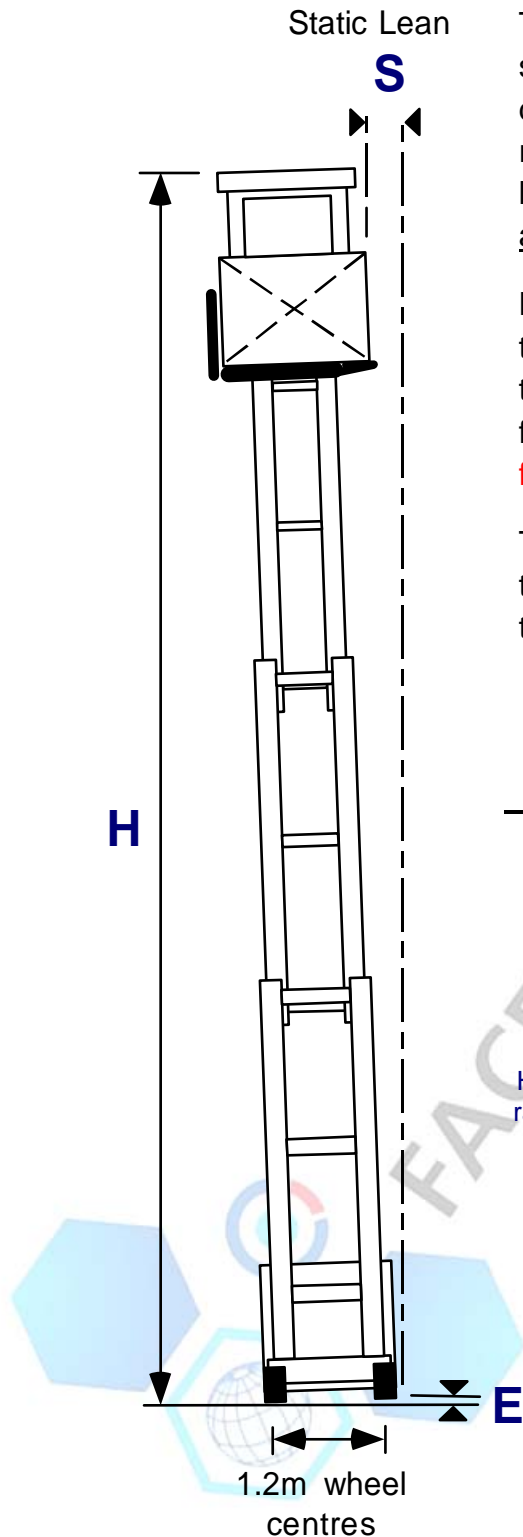
Variations in level, both laterally across the aisle and longitudinally down the aisle, induce dynamic movements in the mast which are much greater in magnitude than can be calculated from geometrical considerations alone. The stresses which are set up within both the mast and body sections of the truck can cause premature failure of welds and disrupt the performance of the electronic components that are now an essential feature of all trucks.

Floors with poor flatness characteristics also create conditions whereby there is a high risk of collision between the load on the carrying head of the truck and the stock or racking. As the majority of such collisions cause no serious human injury, there are no statistics recording the frequency of these incidents. It is, however, well known that they are quite numerous in all countries where there are high density warehouses working with typical clearances between the truck mounted load and the racked loads in the order of 100 and 150mm. These clearances are directly related to the floor flatness. If the value of this clearance is limited to 100mm then the requirements to construct the floor to a high standard of flatness becomes even more important.

Warehouses are designed to have a throughput of a given number of pallets per hour. To achieve this, the VNA trucks must operate at their peak performance. A warehouse manager faced with numerous collisions between the truck and the racking and long periods of down-time during repair has no alternative but to reduce the speed of the VNA trucks to below their optimum speed: this reduces the efficiency of his warehouse operations.



Static Lean Table:



This table shows the relationship between the static lean of a forklift truck due to the difference in elevation between the left and right hand forklift truck load wheels and the height of the racking, assuming that the mast is a rigid structure.

However, due to the mechanical tolerances in the mast and the dynamic considerations when the truck is moving with a load at a height, the figure shown below could **multiply by up to a factor of three.**

This particular set of figures is based on a typical wheel spacing of 1200mm from centre to centre of the outer load wheels.

	E (mm)= The difference in elevation between left and right hand VNA truck wheels									
	3	4	5	6	7	8	9	10	11	12
6.0	15	20	25	30	35	40	45	50	55	60
6.5	16	22	27	33	38	43	49	54	60	65
7.0	18	23	29	35	41	47	53	58	64	70
7.5	19	25	31	38	44	50	56	63	69	75
8.0	20	27	33	40	47	53	60	67	73	80
8.5	21	28	35	43	50	57	64	71	78	85
9.0	23	30	38	45	53	60	68	75	83	90
9.5	24	32	40	48	55	63	71	79	87	95
10.0	25	33	42	50	58	67	75	83	92	100
10.5	26	35	44	53	61	70	79	88	96	105
11.0	28	37	46	55	64	73	83	92	101	110
11.5	29	38	48	58	67	77	86	96	105	115
12.0	30	40	50	60	70	80	90	100	110	120
12.5	31	42	52	63	73	83	94	104	115	125
13.0	33	43	54	65	76	87	98	108	119	130

H =
Height of
racking in
metres

The Specification:

The flatness specification is DIN 15185.

Tables 1 and 2 (represented below) detail the allowable values of the properties of flatness for differing categories.

Table 1: Transverse Tolerances

	Permissible difference in height h as limit value between the outer driving tracks Sp with track width S in metres			
	up to 1.0m	1.0 to 1.5m	1.5 to 2.0m	2.0 to 2.5m
Truck lift height not exceeding 6.0m	2.0mm	2.5mm	3.0mm	3.5mm
Truck lift height exceeding 6.0m and mechanized operation	1.5mm	2.0mm	2.5mm	3.0mm

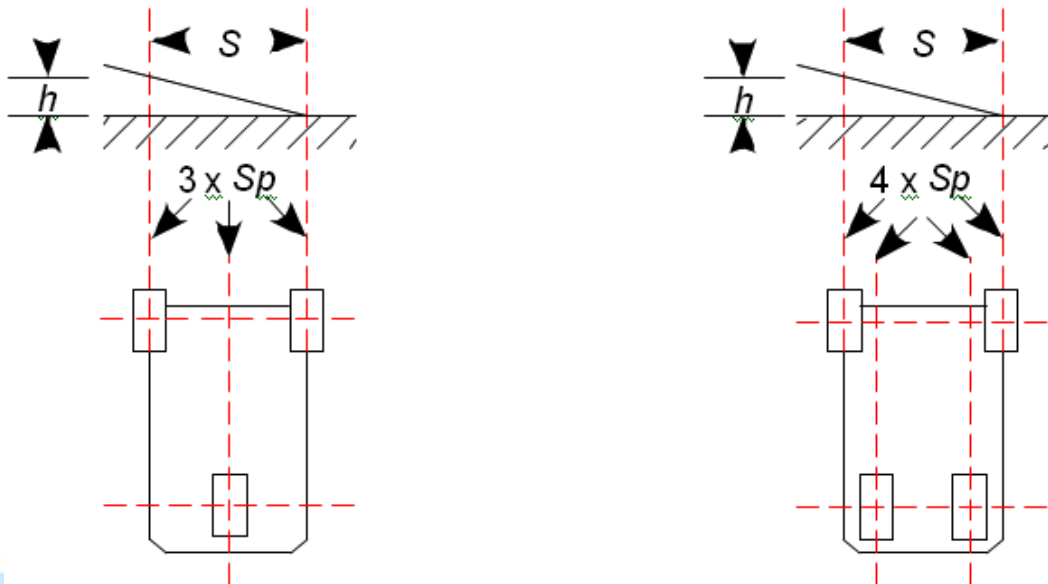


Table 2: Longitudinal Tolerances

Fixed measure for limit values in the drive tracks Sp				
Length of simulated straightedge	1.0m	2.0m	3.0m	4.0m
Maximum permissible clearance under simulated straightedge	2.0mm	3.0mm	4.0mm	5.0mm
The checking of the flatness is done according to DIN 18202				

As the tolerance limits of the DIN 15185 vary with the size of the MHE and the MHE lift height, an example is necessary to show how the limits are applied.

EXAMPLE - Face Consultants DIN 15185 Survey Summary Sheet:

Summary Of Results

Job Name:	Job Name	Job Number:	FC/XX/XXXX
Location:	Location	Date:	DD/MM/YYYY
Surveyor:	Surveyor		

Specification	Description	Limit
Height > 6m	1 Metre (Longitudinal) Limit	2.0 mm
	2 Metre (Longitudinal) Limit	3.0 mm
	4 Metre (Longitudinal) Limit	5.0 mm
	Transverse Limit	2.0 mm

Transverse Axle Separation: 1450

Run No.	Aisle Ref	Limits	Max Diff	Achieved	Run Length
1	1	Left Long. 1 Metre Limit	2.5 mm	99.0%	60.3 m
		Left Long. 2 Metre Limit	4.0 mm	96.1%	
		Left Long. 4 Metre Limit	5.4 mm	99.3%	
		Right Long. 1 Metre Limit	2.9 mm	98.4%	
		Right Long. 2 Metre Limit	5.2 mm	94.8%	
		Right Long. 4 Metre Limit	5.3 mm	99.1%	
		Transverse Limit	3.6 mm	84.6%	
2	2	Left Long. 1 Metre Limit	2.0 mm	100%	60.6 m
		Left Long. 2 Metre Limit	4.6 mm	97.8%	
		Left Long. 4 Metre Limit	4.5 mm	100%	
		Right Long. 1 Metre Limit	1.9 mm	100%	
		Right Long. 2 Metre Limit	3.7 mm	99.4%	
		Right Long. 4 Metre Limit	4.0 mm	100%	
		Transverse Limit	2.5 mm	97.9%	

In the above example the MHE has a load axle width of 1450mm and a lift height exceeding 6.0m.

To comply with DIN 15185 there should be no figure coloured in red (in the example aisles 1 and 2 fail to comply with DIN 15185).

The limits in the example are derived as follows:

LONGITUDINAL (Left and Right Wheel Tracks)

The longitudinal specification of DIN 15185 refers to several different lengths of straightedge which are simulated by the electronic software on board the DIN Profileograph. The figure quoted as the maximum permissible to comply with DIN 15185 refers to the maximum clearance under a straightedge if it were placed on the floor at the point illustrated by the Graphic Trace, and is determined by the width of the front load axle of the MHE and the maximum lift height. The straightedges are represented by electronically simulated mean lines (how the mean lines and the deviation from them is calculated is explained in the following pages).

We can see from the Range of the Specification table (overleaf) that in this example the maximum deviation from the mean line would be:

1 metre - 2.0mm

2 metre - 3.0mm

4 metre - 5.0mm

Aisle 1 of the example (previous page) fails to comply with longitudinal element of DIN 15185 because the maximum deviation from the 1 metre mean line is 2.5mm, whereas 2.0mm is the maximum permissible; and the maximum deviation from the 2 metre mean line is 4.0mm, whereas 3.0mm is the maximum permissible. Where percentages on the summary sheet are shown in **red**, this indicates the limits of the specification have been exceeded. To be fully compliant with the specification each aisle should achieved 100% for each Longitudinal (and Transverse) limits, Highlighted on the summary sheet in **green**.

TRANSVERSE (Difference in Elevation Between Load Wheels)

The transverse specification of DIN 15185 refers to the difference in elevation between the front load wheels of the MHE, as measured by sensors on board the DIN Profileograph. The figure quoted as the maximum permissible is determined by the width of the front load axle of the MHE and the maximum lift height.

We can see from the Range of the Specification table (overleaf) that in this example the maximum difference in elevation would be:

2.0mm

Aisle 1 of the example (previous page) fails to comply with transverse element of DIN 15185 because the maximum difference in elevation is 3.6mm, whereas 2.0mm is the maximum permissible. Where percentages on the summary sheet are shown in **red**, this indicates the limits of the specification have been exceeded. To be fully compliant with the specification each aisle should achieved 100% for the Transverse (and each Longitudinal) limit, Highlighted on the summary sheet in **green**.

Note: It is not possible to test against the DIN 15185 specifications unless the precise position of each VNA is known.

The Range of the Specification:

The two aspects that affect the differing allowable values as set out under DIN 15185 are the Load Axle Width of the MHE and the Maximum Lift Height of the MHE. The full variations are shown in the table below (the example used in previous pages is outlined in red):

Variables under DIN 15185		Tolerances for each contingency			
Load axle width	Racking height	Transverse	1.0m mean line	2.0m mean line	4.0m mean line
n.e. 1.0m	n.e. 6.0m	2.0	2.0	3.0	5.0
1.0 to 1.5m	n.e. 6.0m	2.5	2.0	3.0	5.0
1.5 to 2.0m	n.e. 6.0m	3.0	2.0	3.0	5.0
2.0 to 2.5m	n.e. 6.0m	3.5	2.0	3.0	5.0
n.e. 1.0m	exc. 6.0m	1.5	2.0	3.0	5.0
1.0 to 1.5m	exc. 6.0m	2.0	2.0	3.0	5.0
1.5 to 2.0m	exc. 6.0m	2.5	2.0	3.0	5.0
2.0 to 2.5m	exc. 6.0m	3.0	2.0	3.0	5.0
The range given refers to the distance between the centre of the left front load wheel and the centre of the right front load wheel	The figure given refers to the maximum lift height of the MHE	The figure given refers to the maximum permissible difference in elevation in millimetres between the left and right wheel Track	The figure given refers to the maximum permissible deviation from a 1.0m mean line in millimetres	The figure given refers to the maximum permissible deviation from a 2.0m mean line in millimetres	The figure given refers to the maximum permissible deviation from a 4.0m mean line in millimetres



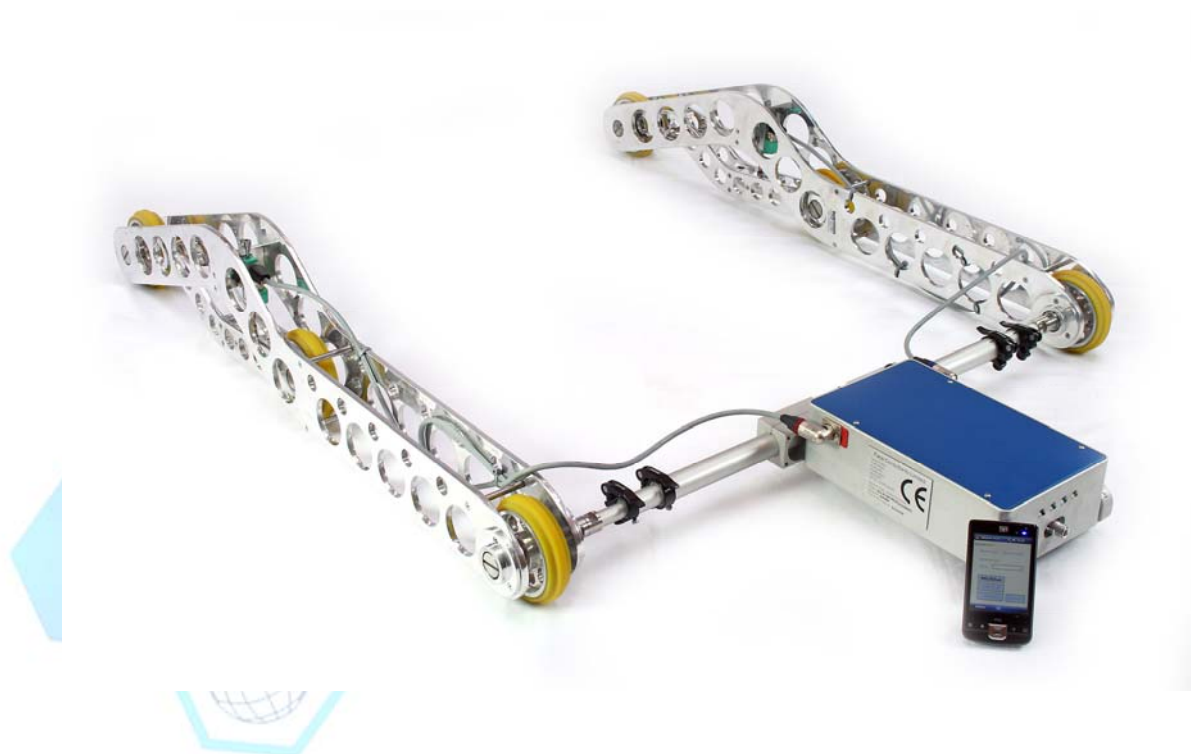
Test Instruments:

It is recommended that a continuous method of measurement should be adopted in all cases of defined traffic movement.

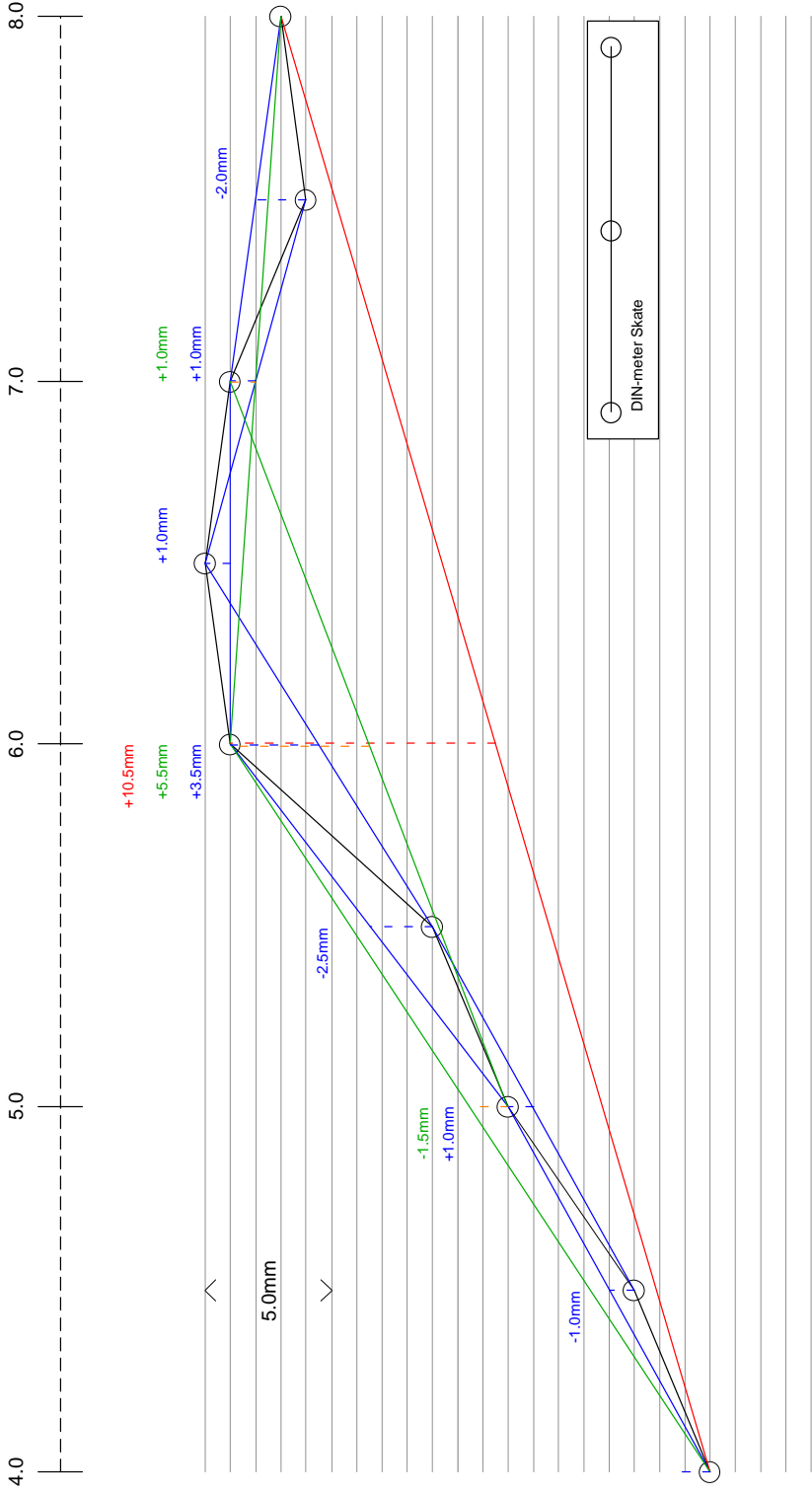
For continuous measurement the Face DIN Profileograph is used. The DIN Profileograph is a self propelled wheeled instrument which travels along the centreline of the VNA aisle taking continuous measurements both transversely and longitudinally as it does so. The DIN Profileograph is adjustable so that the skates run in the wheel tracks of the front load wheels of the MHE.

These readings are generated by the three sensors, which are set up to measure the longitudinal and transverse properties of the specification. These readings are collected on a data logger and are subsequently downloaded to a PC where our software generates the graphic traces and compliance results.

The Face DIN Profileograph:



How the Mean Lines are Generated by the DIN-meter



True Profile of Floor - to Scale: 1000mm

Indicates Mean 1.0m Lines

1.0mm Indicates Deviation from Mean 1.0m Line

Indicates Mean 2.0m Lines

1.0mm Indicates Deviation from Mean 2.0m Line

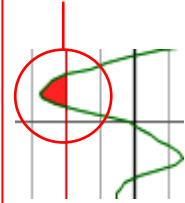
Indicates Mean 4.0m Line

1.0mm Indicates Deviation from Mean 4.0m Line

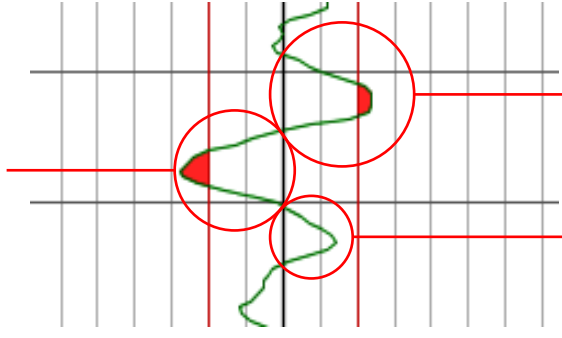
Detailed Explanation of 2.0m DIN-meter Graph

P Indicates position of the DIN-meter

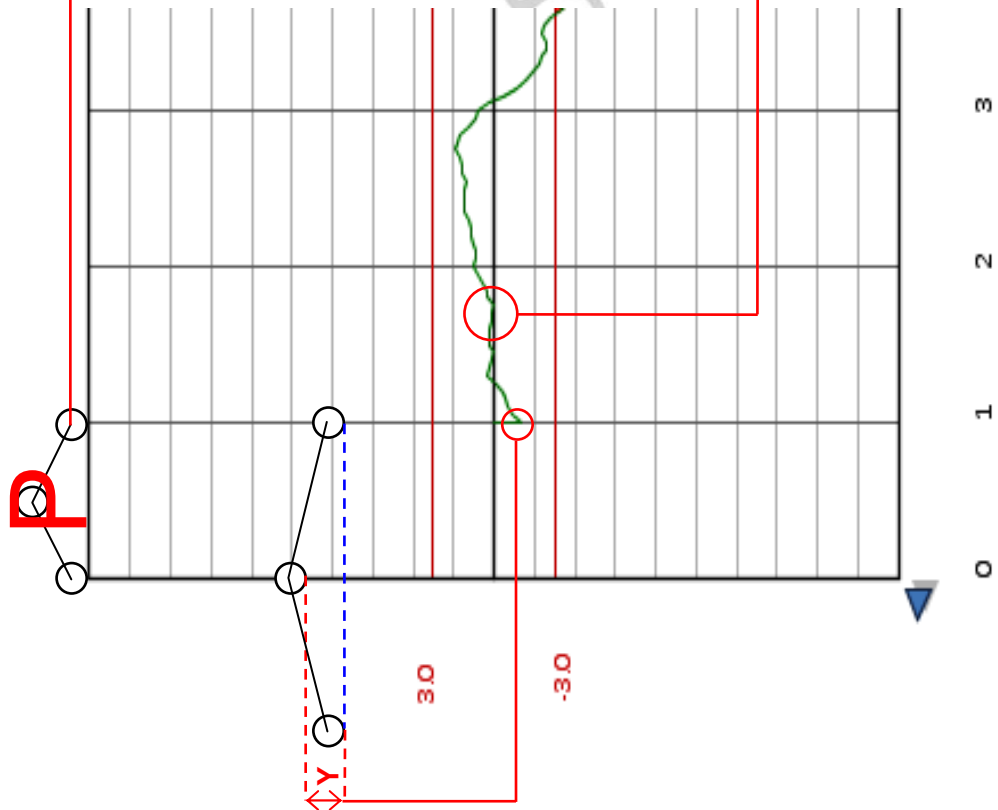
Where the graph is coloured red, the limits of the specification have been exceeded. The whole run fails to comply with the specification if any part of the graph is coloured red.



When the graph is above the centreline, the deviation is above the mean line.



When the graph is below the centreline, the deviation is below the mean line.



The 2.0m DIN-meter graph starts 1.0m from the start of the run.
 $Y = \text{deviation from mean } 2.0\text{m line} - \text{calculated by the } 1.0\text{m long DIN-meter: the } 2.0\text{m mean line and the deviation from it are both calculated from two consecutive measurements, } 1.0\text{m apart, of the } 1.0\text{m mean line and the deviation from it (see overleaf for detailed explanation).}$

The deviation from a mean 2.0m line drawn back along the aisle from this point 1.70m from the start of the aisle is -0.00mm (i.e., neither above nor below the mean line).

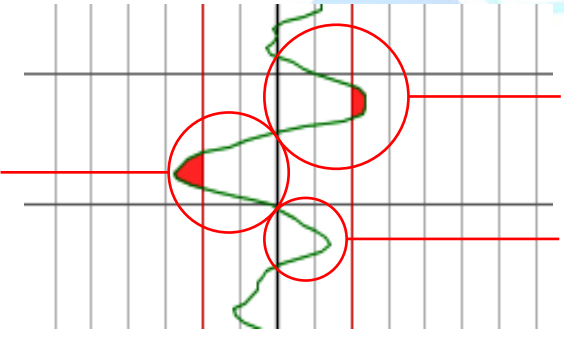
Detailed Explanation of 4.0m DIN-meter Graph

P Indicates position of the DIN-meter

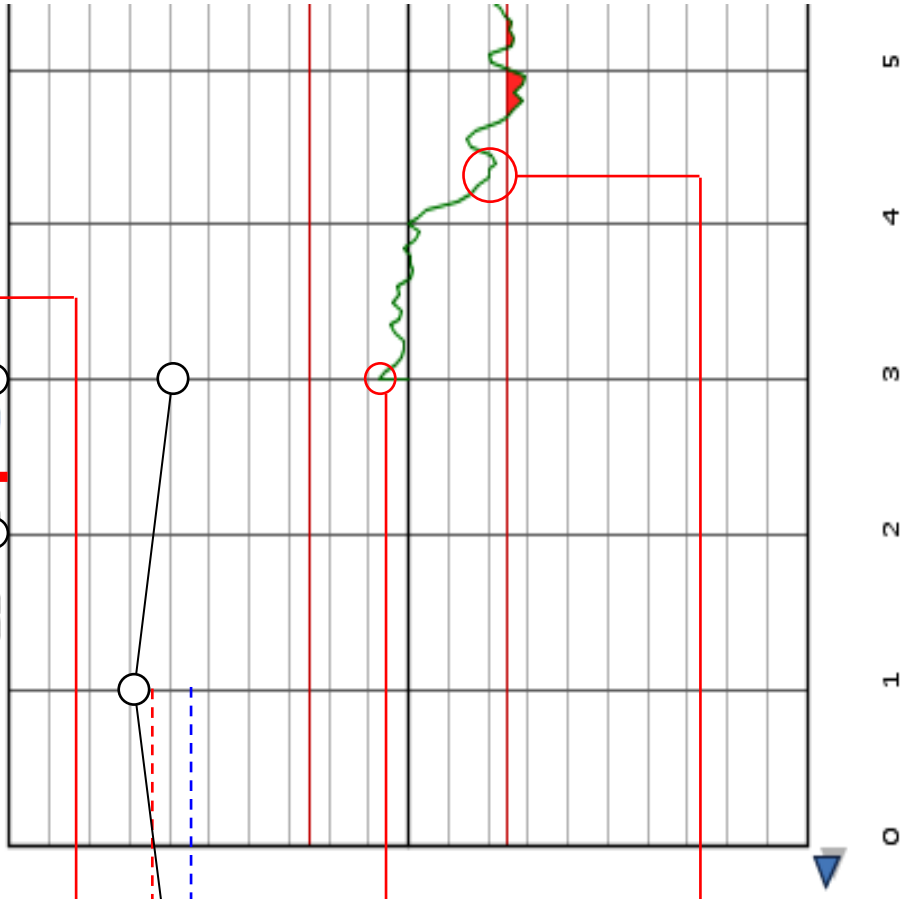
Where the graph is coloured red, the limits of the specification have been exceeded. The whole run fails to comply with the specification if any part of the graph is coloured red.

The 4.0m Longitudinal DIN-meter graph starts 3.0m from the start of the run. Z = deviation from mean 4.0m line - calculated by the 1.0m long DIN-meter: the 4.0m mean line and the deviation from it are both calculated from four consecutive measurements, 1.0m apart, of the 1.0m mean line and the deviation from it (see overleaf for detailed explanation).

When the graph is above the centreline, the deviation is above the mean line.



When the graph is below the centreline, the deviation is below the mean line.



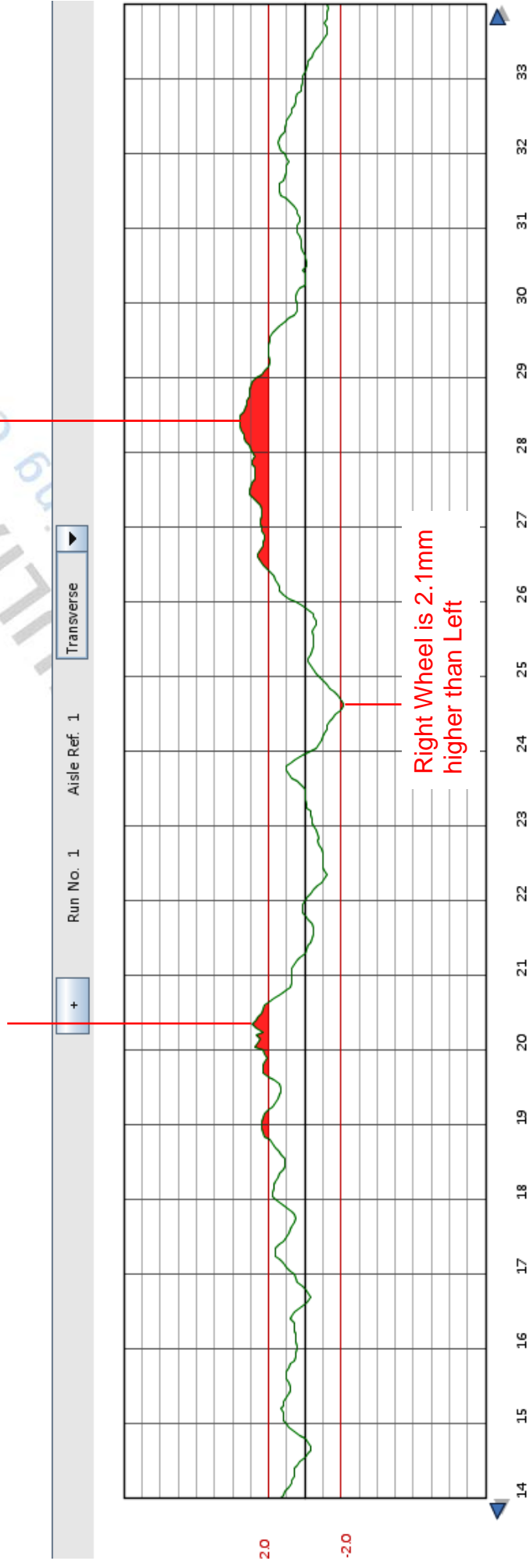
The deviation from a mean 4.0m line drawn back along the aisle from this point (4.3m from the start of the aisle is -4.0mm (i.e., -4.0mm below the mean line).

Detailed Explanation of DIN Profileograph Transverse Graph

Red coloured section of graph indicates that the elevational difference between the left and right wheel tracks is too great +3.0mm at this point. If any portion of the graph is coloured red that means that the whole aisle fails to comply with the Transverse aspect of the DIN 15185 specification.

Left Wheel is 3.5mm higher than Right

Right Wheel is 2.1mm higher than Left



Further advice can be obtained from [FACE Consultants](#) on:

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