VERTICAL CENTER OF GRAVITY

In today's economic environment people are doing the most to maximize the value of their dollars. In the trucking industry this often manifests itself as customers trying to put the biggest body possible on the smallest (read that: least expensive) chassis.

While certain parameters will never change, we here at MFTA have tried to give you more flexibility in the range of acceptable body heights that will work on our chassis. Before we go any further down that road, this would be a good place to point out that, unless your customer truly needs an extraordinarily high body, you are doing them no favor by suggesting they equip their chassis with one. For every two inches of body height (on a standard 96" wide body), you are creating 1.3 square feet of frontal area that the engine must push through the wind. High bodies will degrade performance and fuel mileage and it's important for your customer to realize the trade-off so that they can make an informed decision.

For years we formulated acceptable body heights for a given chassis and simply plugged this into a chart format. Those heights are still valid, and if you don't wish to do the extra work required to accurately calculate a vertical center of gravity (VCG), then you can simply adhere to the guidelines of the chart. For your convenience the current chart is shown below.

MODEL / GVWR	MIN. WB / UCA	MAX. WB / UCA	MAX. IN. BDY. HT.*	COMMENTS
FE639 / 12,000#	108.3" / 83.1"	148.0" / 122.9"	91" w/o gate 93" w/gate	16' Body max.
FE-HD649 / 14,050#	108.3" / 83.1"	165.4" / 140.2"	18' body – 84" Std. bodies – Same as FE639	18' Body w/o gate – 148" WB OK 18' Body w/gate – 165.4" WB Required
FE-SP640-9 / 14,500#	108.3" / 83.1"	165.4" / 140.2"	Same as FE639	20' Body w/o gate – 165.4" WB OK
FG639 / 12,000#	133.1" / 107.3"	133.1" / 107.3"	77" From high frame	No Mods Permitted
FG649 / 14,050#	109.4" / 83.7"	133.1" / 107.3"	77" From high frame	No Mods Permitted
FH210 / 17,900#	130.3" / 106.3"	191.7" / 167.7"	96"	23' Body w/o gate - 191.7" WB OK
FH211 / 17,995#	114.6" / 90.5"	191.7" / 167.7"	96"	23' Body w/o gate – 191.7" WB OK
FK617 / 23,000#	140.0" / 104.6"	218.0" / 182.6"	No restriction as long as max VCG not exceeded	24' Body w/o gate – 200.8" WB OK 24' Body w/gate – 218.0" WB Required
FM-MR617 / 25,995#	144.9" / 109.6"	245.0" / 209.7"	No restriction as long as max VCG not exceeded	28' Body w/o gate – 239.4" WB OK 28' Body w/gate – 245.0" WB Required
FM-HR617 / 30,000#	144.9" / 109.6"	245.0" / 209.7"	No restriction as long as max VCG not exceeded	Same as FM-MR617
FM-SR657 / 32,900#	144.9" / 109.6"	245.0" / 209.7"	No restriction as long as max VCG not exceeded	Same as FM-MR617
FM-SP657 / 32,900#	144.9" **/ 109.6"	245.0" / 209.7"	No restriction as long as max VCG not exceeded	Same as FM-MR617

*Heights stated are guidelines ONLY. Chassis equipped with bodies higher than those stated must fall within MFTA's maximum VCG parameters found in the Data Manual.

**FM-SP657's equipped with the Allison MD3060P Transmission are restricted to OEM WB's only (no shorter than 181.9" / no longer than 239.4")
Applications shown in gray shaded areas must be approved by the Product Applications Group

So what exactly is a VCG, anyway?

Every three dimensional object has three centers of gravity – one for each dimensional plane. There is a horizontal center of gravity (HCG), a vertical center of gravity (VCG - the topic of this paper) and a lateral center of gravity (LCG). When applying this to a truck chassis, whether you realize it or not, we already deal quite extensively with the horizontal center of gravity. You may be more familiar with the term: Weight Distribution. What we are actually doing is optimizing the load on the axles to within MFTA parameters, by altering the HCG. We do this by the wheelbases we choose, the body lengths we use and the placement of those bodies and added equipment on the chassis in question. A shift in the HCG manifests itself as a change in the percentage of the vehicles total weight carried on each axle.

Lateral centers of gravity are something that we rarely have to deal with. That is due to the fairly symmetrical layout of most truck chassis and the attendant bodies and equipment attached to them. Think of a LCG as a side-to-side weight distribution.

That leaves only one more plane – the vertical one. The vertical center of gravity is normally expressed as being “x” number of inches above level ground. This is the midpoint of the vertical distribution of the weight of the unit. The vertical center of gravity has a direct correlation to vehicle rollover stability. The higher the VCG, the higher the rollover propensity. If you follow the news in the automotive sector, this is exactly the issue that has the National Highway Traffic Safety Administration (NHTSA) so concerned with regard to sport utility vehicles and has resulted in a rollover probability rating being formulated for these vehicles. Since we supply you, our dealers, with an incomplete chassis, it is incumbent on the selling dealer and the Final Stage Manufacturer to insure that the vehicle falls within our parameters with regard to VCG and HCG (weight distribution). We have TruSpec2000 to calculate the weight distribution of a given unit, but the VCG needs to be calculated manually. This bulletin will help you with that calculation by explaining what information is needed, where to find it and how to apply it to calculate the VCG. A worksheet will be provided at the end of this bulletin.

Each of the individual components that make up a completed chassis, loaded to full-rated weight, has its own VCG and weight. In order to calculate a VCG for the complete unit we need the following:

- The weight and the VCG of the cab/chassis
- The weight and the VCG of the body (including underpinnings)
- The weight and the VCG of any added equipment (liftgates, reefers, etc.)
- The weight and the VCG of the cab occupants
- The weight and the VCG of the cargo (payload)

We'll examine each of these in turn. First the cab/chassis – perhaps the easiest to find. Since the 2000 model year MFTA has been publishing the VCG for each chassis model in the Data Manual for that particular model year (hard copy manuals 2000 through 2002. 2003 manual can be found on FusoNet). It can be found on the page entitled "Typical Body Lengths" which is usually listed in the index as "Body Applications" or "Body Lengths". It can be found on the chart on that page and is designated as "HG" which stands for "height, gravity" – meaning at what height above level ground the VCG is located. The curb weight of each chassis (varies with wheelbase and transmission) is usually found on the page immediately preceding the "Typical Body Lengths" page. Chassis weights for specific chassis can also be found in TruSpec2000. The VCG's for each chassis model have been the same since 1996 and will continue through the 2004 model year. Following is a chart showing the VCG of the various MFTA models.

Chassis Model	**VCG (from level ground)**
FE	23.6"
FE Crew-Cab	26.2"
FG	28"
FH	26.8"
FK	31.3"
FM617	32.3"
FM657	32.9"

Next we need to know the weight and the VCG of the body. This will require a phone call to your body builder. If you are dealing with a distributor, they may have to call the manufacturer's engineering department. They should be able to give you the body's weight and the location of the VCG, usually expressed as the height (in inches) above the top flange of the truck frame. Since we are using the (level) ground as our datum line, you need to add the frame height to the dimension furnished by the body company. The following chart lists the values that should be used for frame height for the purpose of VCG calculation.

Chassis Model	Frame Height
FE	31”
FE Crew-Cab	31”
FG	33” (low) / 39.7” (high)
FH	33”
FK	42.5”
FM617	43”
FM657	43”

Often times added components, such as refrigeration units or liftgates, will be installed by the body builder. If this is the case, the body builder will most likely calculate the VCG of the body with these components included. You have to make sure exactly what the VCG they furnish you includes. If they are unable to furnish the combined VCG, or if you are using components installed by someone other than the body builder, then you will have to find the weight and VCG of those components – usually from the manufacturer. Make sure that the VCG specified for these extra components are specified from a known datum line; i.e. the ground, or frame flange. Add the frame height if necessary.

The next value is the weight and the VCG of the cab occupants. If you know who the operator is, then simply ask them the weight. If that information is not available to you, use the same criteria as we use when doing the HCG (weight distribution). Following NTEA’s guidelines we allow 150 pounds per seating position. Even though our small cab chassis come to you equipped for three persons in the cab, use the value for two seating positions (300#) if the actual number of cab occupants is unknown. If you know that this particular application uses three-person crews, then use that value (3 x 150# = 450#). The VCG of the cab occupants falls at what is termed the “H” point. That would be the position of the occupant’s hip. The following chart lists the “H” points for our chassis.

Chassis Model	“H” Point (from ground)
FE	54”
FE Crew-Cab	54”
FG	63”
FH	57”
FK	65”
FM617	70”
FM657	70”

Now for perhaps the hardest component – the cargo or payload. Generally, we want to perform our VCG calculation based on a "worst case scenario", which in this instance means the truck is going to be loaded to the full-rated weight of the chassis. This means the actual weight of individual pieces of cargo isn't important, but where the cargo carries its weight is. An over-height body is usually specified because the need is there to carry very tall items. Retail or wholesale furniture carriers will want to optimize load space by placing items, such as sofas, on end. The may also need the added height for things like wall units or china closets. Mattress delivery trucks also carry the cargo standing on edge. Appliance delivery units need the height for things like refrigerators, or stacked washer/dryer units. What we need to know is: Where is the weight of the items being carried?

In the case of items such as mattresses or sofas on end you have equal item density top to bottom. Therefore, the VCG of these items would be located at the midpoint of the height dimension. For example: A sofa, that is 96" long, is stood on end in the truck. Its VCG would be 48" above the truck floor.

On the other hand, items like refrigerators generally carry the main mass low in the appliance. The compressor (the heaviest component) is usually mounted in the base of the refrigerator. In this case the VCG would most likely fall below the midpoint of the height dimension. On items such as this, you sometimes have to make an educated guess based on your knowledge of what constitutes a typical payload. Remember to err on the side of caution – I doubt that I would ever specify a VCG of less than 33% of the height dimension of any payload component.

Payload weight will be based on the chassis achieving full-rated weight. Take all the components (cab/chassis, body, occupants and any accessories) and calculate the total weight. Subtract this sum from the GVWR of the chosen chassis and use this number for the payload weight.

Now that you have gathered all the information necessary to calculate the VCG for your application, it is time to perform that calculation. You can do that one of two ways. If you click on the Adobe icon below, you will open a printer-friendly version (.pdf) of a VCG worksheet. Print this out; fill in the information requested. Insert the values from the charts in this document and those received from your body builder, along with the other requested values, in the appropriate boxes on the worksheet. Extra rows are printed in case you have more components than those that are pre-printed. Multiply column A times column B and write the product of that calculation in column C. Total column A (column A's

total should equal the GVWR of the specified chassis). Total column C. Divide column C's total by column A's and write the quotient on the line that says: VCG. Fax the completed worksheet back to the Product Applications Group at (856) 467 – 5553. We will check your calculations, and based on the data you furnish, stipulate whether the arrangement falls within acceptable parameters. We will fax the document back to you so that you can furnish it to the body company.

The second method is currently under construction. We hope to incorporate a link in the body of this document that will take you to an interactive worksheet. All that will be necessary is for you fill out the basic information and then insert values into appropriate input boxes. The calculations needed to compute the VCG will be "built-in" to the page. All you need do, once all input boxes are filled, is to click on a submit button. If the application falls within our acceptable parameters you will receive a return e-mail stating that, for your body builder.

As a final note, there are some applications, for which a VCG should be calculated, regardless of overall body height. These would include, but are not limited too: Bodies with "attics" (remember to include the weight of the payload carried in the attic in your calculation). Cold-plate applications, where the plates are located above the body's horizontal centerline. Bodies that include ladder, scaffolding or pipe racks high on, or in, the body. Bodies equipped with liftgates that have unusually large platforms that fold up against the end of the body. I think you get the idea...anything that causes weight to be carried high in the body.

Remember, unless your customer really has need of a higher than normal body, you're better off sticking with standard body heights commensurate with the chassis upon which they are mounted.

Any questions please call or e-mail the product applications group at the following numbers and addresses:

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VCG WORKSHEET

Name_____ **E-mail Address**_____

Dealer Name/Number_____ **Date**_____

Telephone_____ **Fax**_____

Chassis and Model Year_____ **Wheelbase**_____

Body: Type_____ **Length**_____ **Height (inside)**_____

Manufacturer_____ **Application**_____

Payload (What is it?)_____ **Accepted by**_____**Date**_____

COMPONENT	(A) WEIGHT	x	(B) VCG	=	(C) FORCE
Cab / Chassis		x		=	
Body		x		=	
Additional Equipment		x		=	
Occupants		x		=	
Payload / Cargo		x		=	
		x		=	
		x		=	
		x		=	
Total Column (A)		**Total Column (C)**			

Divide Total C by Total A (C/A = VCG) **VCG**_____