Suggested Requirements for Purchase of Motor Graders by County Highway Departments

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The selection of a specific motor grader should be based on the needs of the county in which it will work. In order to do an effective job of machine selection, one has to answer the following questions:

1. What types of work are motor graders currently performing in this county?
2. Is it possible that they will be performing additional tasks in the future?
3. What has been our county's experience with motor graders?

If these three question areas are thoroughly investigated, an intelligent job of machine selection can be performed.

Most governmental purchases involve written specifications. It is the intention that the specification will permit a comparative analysis of all items under consideration. These specifications are written after the governmental body has determined and formally stated minimum product needs and requirements.

In some areas, this specification business has gotten completely out of hand. Some specifications have been developed with too much "outside" help. This "outside" help has not been primarily interested in the governmental body receiving the correct machine, but rather in seeing that their machine was purchased. As a result, many specifications and proposals contain extraneous information, unrealistic requirements, and poor comparative data.

I will not attempt to develop a set of motor grader specifications, but jointly we can explore this subject further. I can supply some information about machine performance, application, and design that can be added to your specialized knowledge of your county, with the result that the machine selection process may take on new meaning.

Earlier we examined three question areas that have an important bearing on machine selection. Let's examine each one again in more detail.

1. *What types of work are motor graders currently performing in your county?*

The answers to this question will give some indication of machine size, weight, and horsepower that are required for our county. For instance, if all of the motor grader work consists of road *surface* maintenance, a machine in the 75-100 HP class and weighing in the neighborhood of 20,000 lbs. is adequate. If the grader work involves ditching operations, shoulder and slope work, in addition to surface maintenance, a machine with 100-125 HP and weighing approximately 24,000 lbs. is better suited to the job. If the machines are currently applied on extremely adverse work and your county experiences heavy snow falls, it is entirely possible that you can justify a machine with approximately 150 HP and weighing in the neighborhood of 30,000 lbs. Winter applications may sometimes justify a larger machine than summer applications. We begin to see how important it is to look at the total application picture.

When we start getting specific with regard to machine requirements we will also probably start comparing machine features and specifications. It is important to compare *like* features or specifications. In other words, compare apples to apples and not apples to oranges. For example, we have arrived at rough relationship between types of work to be done and machine horsepower and weight. If we begin to compare the horsepower and weight of several machines, we must be certain that we are comparing like quantities. There are several ways to express horsepower. Each one is correct, but each one also results in a different horsepower value.

For example, horsepower can be expressed in the following ways:

a. Maximum horsepower
b. Flywheel horsepower at a specific rpm
c. Brake horsepower at rated rpm
d. Brake horsepower maximum

Regardless of the method used to express horsepower, we must make sure that we are comparing like terms. All expressions give some indication of the engines and hence the machine's capabilities, however, that horsepower that is available to the power train is the only power that can be used to do work. The term best describing this power is flywheel horsepower at rated rpm.

This same comparison applies to machine weight and even component or attachment weight. Machine weights are usually expressed in pounds. Is this the weight for the standard, bare machine or for a

machine equipped with optional attachments available at extra cost? Just what does it mean? An example of an attachment or machine component could be a snow plow and the grader main frame. Does the plow weight include mounting brackets, hardware, and crating, or is it just the plow blade? Does the frame weight include the operators platform assembly or is it simply the grader main frame? These are questions that one must answer in order to have a valid machine comparison.

Besides determining horsepower and weight, the work to be done also determines machine configuration. If present applications involve shoulder and slope work and if mail boxes, bridge abutments, curbs, or other obstacles, require frequent manual blade side shift adjustments or unnecessary machine maneuvering, there is justification for a hydraulically shifted moldboard. This attachment permits the operator to shift the moldboard from the operator's compartment. The blade can be extended or retracted to bypass obstacles and greatly reduce the maneuvering required. The blade can be extended for slope work and permits the machine to operate at a lower elevation on the slope. The extended blade will permit the machine to operate on surer footing in shoulder work. The attachment enables the operator to do a better job by giving him more positive control of his machine. This added machine feature can only be justified by a frequent requirement for its use. If this need does not exist, the manually shifted moldboard will be sufficient for your applications.

Slope, ditch, or side-hill work will also justify leaning front wheels. This feature permits easier control of the machine in these applications by opposing the drift forces of the blade and moving material. Leaning front wheels also help the machine maintain its position on a slope. A relatively long machine wheelbase is necessary to give a motor grader the desired properties for finishing work. This same wheelbase distracts from the machines maneuverability and primarily its turning diameter. Leaning front wheels will also reduce the required turning diameter.

In certain applications it is desirable to be able to use the blade when traveling both forward and reverse. This situation exists when working in confined quarters, such as grading a narrow road whose length is such that it is impractical to blade only on the forward pass. It is also an advantage in ditching operations where the ditch is cut on the forward pass and the windrow of cut material is moved away from the ditch on the reverse pass. In these situations, there are two considerations to keep in mind; circle reverse capabilities and blade width. Is the circle design such that it has the capability of rotating

highways increases every year. We are now talking in terms of the two car family. This factor has affected the snow removal problem. However, an equally important factor is the rural resident who derives a significant part or possibly his total income from work in the city. He may live on a farm and work his fields on part-time basis, but his primary income comes from working in a factory located in a metropolitan area. We can be sure that this man wants to be able to get to work. There are hundreds of people like him today, and they all want to be able to get to work. This factor has certainly affected the snow removal situation.

Snow removal is one example of future demands; let's examine one more. Since 1959, our spring months have been extremely wet. The contractor has certainly been aware of this condition. It has caused him to start work later in the spring and use two-shift operations during the good months in order to make up for time lost due to rain. It has also affected his thinking regarding machinery purchases.

Wet springs also affect county highway departments. You have a fairly definite length of roadway to recondition after winter. Generally, summer plans include your major road projects. Certain roads have to be reconditioned again before winter arrives. In short, you have a known amount of work to be done in a known amount of time. The trouble is that the time factor has been getting smaller during the past few years. In order to complete the planned work, two alternatives are available. One, more machines and men are required or, two, larger, more productive, machines are required. These are the alternatives. The choice is yours.

We can all think of other factors that will affect this picture, however, the examples that we have discussed are real. These two problems may be facing you. As we said before, the machinery decision required to solve these problems is yours. I think that these examples illustrate that future machine demands must be examined and taken into consideration in a machine purchase.

3. *Local Experience with Motor Graders.*

The county's past experience with machines merits important consideration. By experience, I mean your experience in the following areas:

1. Machine design
2. Downtime
3. Parts and service
4. Production capabilities
5. Cost records
6. Resale value or trade-in value

under power for a full 360°, and are there any restrictions placed on this capability by blade width? This is the question we want answered in this situation. The standard blade width is determined by the manufacturer. This blade is generally conceded to be of such a width that it will perform best in the widest varieties of applications and materials. In severe applications or in extremely heavy material, a shorter blade may perform better. In lighter material or more ideal conditions, the standard blade will perform well, but the machine could move more material with a wider blade. The choice of blade width for your county is really dependent upon the material encountered; however, the standard blade will generally fit the widest applications. We should be sure that the blade width will permit full use of the circle reverse feature if necessary. If blade width requirement is such that the moldboard will have to be shifted to get full rotation, we can see justification for a hydraulically shifted moldboard or a compromise on blade width.

The type of work to be done also determines the blade positions that should be available. If slope or banks are to be maintained, the selected grader must have the proper blade positions to perform this work. If frequent blade position changes are required by the work to be done, it would certainly be desirable to have these positions controlled from the operator's cab.

Some counties will want their motor graders equipped with scarifiers. This machine attachment allows the machine to be used to prerip harder surfaces before blading. The work to be performed will also determine if mounting provisions are to be made for snow removal equipment or any other specialized attachment that further adapts the machine to the job to be done.

By taking a closer look at the work to be performed, we have seen that it determines machine configuration. The machine must be equipped and capable of performing the work it will be called on to do in your county or you have not selected the proper machine or the proper attachments.

2. *What future demands may be placed on this machine in the way of new applications?*

This area should be examined thoroughly in order that the purchased machinery will have the necessary reserve capacity for future applications. The future applications may be totally new or simply increased utilization on existing applications. Probably the most universally accepted example of the situation is the increasing emphasis that is being placed on snow removal. Our civilization is totally dependent upon the automobile. The number of automobiles on the

There are many ways to incorporate different design principles in machinery. The final test of the differences is the end result, machine performance. If your machines have hydraulic controls, are you satisfied with their performance? Generally, we find that hydraulic controls may be plagued by leakage, hose breakage when not properly protected, and by sluggish action when two or more controls are used at the same time. As a hydraulically controlled machine ages, seal and valve wear sometimes causes the controls to creep. By this, we mean that they do not maintain their pre-set position. If your machines are mechanically controlled you must be satisfied with their performance also.

Serviceability and rebuildability is another important design area. Is the design of your machines such that critical machine members, such as the circle, have adequate support? Are there provisions to compensate for wear in the high-wear areas of the machine such as the circle suspension, blade side shift mechanism, and other critical areas? If you are able to compensate for wear, rather than replace worn members with new parts, the useful life of the machine is extended and the machine repair costs are reduced.

Machine travel speeds are another important design consideration. The speed of the machine should only be as fast as the reaction of the blade controls and of the man who uses these controls. Some people have been led to believe that a motor grader is a form of a race car and that machine speed is the most important design consideration. They have overlooked the man who must control and work the machine. In this area, your experience will tell you whether your machine's speed is a usable speed or whether you have paid for a capability that you can not use.

It is impossible to discuss all of the design considerations but let's examine two more. Various manufacturers have accepted the machine design responsibility to varying degrees. All manufactures have suppliers of machine components, but in some instances certain machines appear to be almost totally assembled from commercially available parts. This situation may cause divided service and warranty responsibility and it may result in an unbalanced machine design, with overdesign in some areas and underdesign in others. Earlier, we mentioned that the operator must be considered in connection with travel speeds. He should also be considered in connection with a safe machine design. This includes a low machine center of gravity, protective guarding over rotating shafts, pulleys, and fittings, and a comfortable and safe operators station. The motor grader design should provide adequate machine breaking capacity, more positive control with an accelerator-

decelerator, and either mechanical or boosted mechanical steering that assures full time steering control. If hydraulic lines or fittings are present they should be located in positions where rupture or breakage will not result in spraying the operator with hot hydraulic oil.

These comments do not cover completely all of the design considerations, but merely point out that there are some important considerations in this area.

The experience that surrounds machine downtime, parts and service considerations, and cost records is interrelated experience. These factors are also dependent upon design in many instances. Machine records covering costs incurred by the machine and records of its availability are probably the most important indicators of true machine value and performance. With cost records, the original machine investment can be compared to the investment that is necessary to keep the machine producing. This comparison is sometimes overlooked; however, it is extremely important. For example, if a motor grader is purchased for $20,000, how much money will probably be spent on it during its useful life of five to seven years? Cost records for construction machinery indicate that it is possible to spend up to twice its initial price, or $40,000, just keeping it producing throughout its life. We see, then, that initial price is the smallest part of the total cost picture, yet the larger part is often overlooked. Records on machine availability will indicate just how much productive time was obtained from your machines. We know that all machines, regardless of brand or make, will experience some downtime. Records can indicate this time and you can then decide if the downtime is justifiable or completely out of line. In some situations, downtime has required that a machine be rented to replace the down-machine. When this happens, the machine rental cost is an added penalty for downtime. Downtime can be minimized if your distributor carries a complete stock of high demand replacement parts and has adequate service know-how and facilities. If your distributor has these qualities, a machine purchased from him is accompanied by an unwritten minimum downtime insurance policy.

Past experience with your machinery will indicate if its production capabilities are sufficient for your county's needs. Past experience will indicate if a change in machine size is needed.

One additional area requires investigation. To complete the picture, we should give some consideration to the machine resale or trade-in value. This is an extremely hard quantity to define accurately. However, there are two sources for information on this subject. In both cases, the primary source of this information is the used machinery

auction. Forke Brothers, Inc., of Lincoln, Nebraska, is the most reputable machinery auction firm in the business. Information is available from them, regarding the auction prices of used machines. The auction price is an indication of the customers' opinion of machine values. By comparing the prices of similarly equipped machines of the same age and horsepower class, it is possible to get an indication of the machine's value as it ages. Traditionally, there are some pretty definite patterns traced out by machine resale values and this consideration should be included in a purchasing decision.

This completes our investigation. We have briefly examined the considerations that should result in an effective motor grader selection procedure. It is our opinion as a manufacturer, that a purchase decision that has not included all of these considerations leaves room for error.