



# PRODUCT WORKBOOK



## AIR & ELECTRICAL

Y1-Q4



# GETTING THERE

It doesn't seem possible, but yes, this is the fourth workbook in the StarMaster Parts Training Program. This quarter's instruction involves air and electrical systems and includes products from Delco Remy America, Dominion Automotive and AlliedSignal Bendix.

## SYSTEMS THAT FLOW

The electrical systems discussed within this workbook consist of the charging system and lighting systems.

A truck **charging system** functions to charge the battery after it cranks the engine and to provide all electrical power to the vehicle after it has started. The main component of the charging system is the generator. Many manufacturers and parts countermen often refer to a generator as an "alternator." Both terms are correct ... but since Delco Remy America, our featured manufacturer, refers to this specific part as a "generator" on their boxes, product catalogs and literature ... we have adopted the same terminology for this training workbook.

The charging system provides the electricity to power the numerous **lighting systems** on a truck. Some lights help the truck driver see the road ahead of him while others alert motorists of the truck dimensions and the driver's intentions. Many lights and their positions are mandated by strict federal and state regulations for safety reasons. Whatever the function or design, Dominion Automotive probably has the light.

The **air brake system** on a truck provides necessary stopping power. Many components including the compressor, governor and reservoirs work to compress, regulate and store compressed air. This compressed air is then converted into mechanical energy which forces the brake shoes into contact with the drum to slow and stop the truck. Bendix air brake systems from AlliedSignal provide plenty of stopping power for your customers.

## WINDING UP

This workbook completes the first training cycle of the StarMaster Parts Training Program. If you have successfully completed all other modules including Y1-Q1 Frame and Undercarriage, Y1-Q2 Power Transmission and Y1-Q3, Cab and Hood ... complete this Y1-Q4 Air and Electrical module as quickly as possible. Once we have verified that you have completed all four sections with at least 80 percent accuracy, you will receive your first annual award. Congratulations! More details will follow.

**If you have questions or need more information, call the Western Star Training Center at 1-800-704-1105.**

*The contents of this workbook have been developed from material supplied by the manufacturers represented herein.*

## Delco Remy America Generates Trust

Generators actually supply the electrical power necessary to charge the truck battery and to operate most accessories. When a generator fails to function properly, a driver can be left sitting at the side of the road or stuck in a repair shop far from home and miles away from his load destination.

When you think of high quality and high performance, it's only natural to think of generators from Delco Remy America. Starting in 1890 as the Remy Electric Company and merging in 1926 with Dayton Engineering Laboratories Co., the Delco Remy name has always stood for innovation and value. A realignment and concentrated effort to focus specifically on heavy duty electrical systems has now generated a new name: Delco Remy America. But you can still be assured that DRA has a generator suited for all your customers' needs.

20-SI



26-SI



21-SI



30-SI

## Power Defined

To understand a little about the design, purpose and operation of a generator, a few basic definitions might be helpful. By definition:

- A **generator** is a machine that uses mechanical energy from the engine and converts it into electrical energy.

- **Electrical current** is the movement of electrons through a conductor such as copper wire. Current flow is measured in amperes (amps).
- One **amp** is equal to 6.28 billion, billion electrons passing through a certain point in a conductor in one second. Amperes = volts divided by ohms.
- **Force** causes the electrons or electrical current to flow and is expressed in terms of voltage.
- **Voltage (volts)** is the difference in electrical pressure measured between two points in an electrical circuit. For example, the voltage measured between two posts on a 12-volt battery is 12 volts. This difference is what causes current to flow within a circuit. Voltage = amps multiplied by resistance (ohms).
- **Ohms** represents the resistance to the flow of electricity. Generators, radios, air conditioner systems ... all the components within electrical circuits create resistance and, in turn, heat. Ohms = voltage divided by amps. **Ohm's law** states that one volt will cause one ampere of electricity to flow through a resistance of one ohm.
- **Electrical power** is the actual energy produced by a generator to run various components connected to the electrical system and is expressed in watts.

## Generating Power

The three basic fundamentals that determine the output of a specific generator are the speed of rotation, the number of conductors and the strength of the magnetic field.

### Creating voltage

As the rotor begins to rotate within a generator, it creates electrical pressure within the coils causing current to flow through the field coil and load circuits. The voltage developed within the generator will climb to any value necessary to overcome the resistance in the attached circuits, as long as the speed of the rotor is sufficient.

### Regulating voltage

The voltage output of the generator should not exceed its specified rating. If it does, the electrical system including

light bulbs, external wiring, relay coils, and all other electrical components of the vehicle can be damaged.

To protect the generator and the electrical system, a built-in voltage regulator (also referred to as circuit regulator) limits the maximum voltage that the generator will produce by controlling the magnetic field present in the rotor.

### Rating voltage

The physical strength of a generator should be great enough to withstand the electrical power it is designed to produce. Therefore, ratings are used for each generator to identify which system(s) it can be used in. For your customer, those ratings mean that a specific generator is designed to produce a particular amount of voltage for any length of time under normal vehicle operating conditions, certain weather conditions and temperatures.

For a 12-volt system, various generator output levels are available ranging from 60 amperes to 145 amperes. And for a 24-volt system, output ratings range from 35 to 100 amperes.

## Generator Requirements

Generators are designed for certain speed and load characteristics.

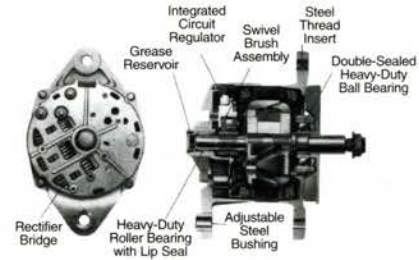
A normal load includes basic operating and charging requirements plus accessories including lights, ignition, radio, heater, etc. Consider all these parts and their required amps, then add another 10 to 20 percent to that number. In most applications, a generator should be able to produce 10 to 20 percent more output than required by the total connected load. This additional output is sometimes necessary to replace electrical energy used from the battery when the generator is not at operating speed.

## Generators for Heavy Duty Needs

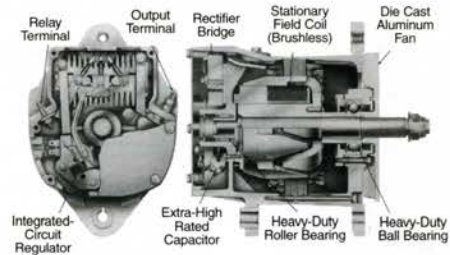
All Delco Remy America heavy-duty generators with the "SI" model number are actually integrated charging systems that combine a diode rectified AC generator with a dependable solid state regulator. These generators are designed for various needs as previously discussed.

However, the two DRA generators suitable for many of your customers' needs are the 21-SI Heavy Duty Brush Generator and the 30-SI Heavy Duty Brushless Generator. The chart on page five lists basic features and specifications to help you better inform your customers.

### 21-SI Heavy Duty Brush Generator



### 30-SI Heavy Duty Brushless Generator



## DRA Reman Generators Perform

Delco Remy America also offers "like new" remanufactured heavy-duty generators for your customers who prefer a less expensive replacement part. Other companies may simply "rebuild" their generators but at DRA the remanufacturing process is as stringent and exacting as the original manufacturing process.

- Each remanufactured generator is completely disassembled and thoroughly cleaned.
- Any part that does not meet original specifications and any high wear or hardware items are automatically replaced.
- If technical improvements have been made in certain parts since the original manufacture of a specific generator, those improvements are automatically incorporated into the remanufacturing process.
- The generator is then reassembled to the same exact tolerances and specifications and it undergoes the same rigorous testing as any new unit.

## GENERATOR FEATURES AND SPECIFICATIONS

	21-SI Heavy Duty Brush Generator	30-SI Heavy Duty Brushless Generator
<b>Voltage Regulator</b>	<ul style="list-style-type: none"> <li>Built-in, solid state integrated circuit regulator is designed for low parasitic draw</li> <li>Load dump protection guards against voltage spikes</li> </ul>	<ul style="list-style-type: none"> <li>Built-in, solid state integrated circuit regulator contains no moving parts to wear or arc</li> <li>Eliminates possible wiring errors that might occur between a generator and separately mounted regulator</li> <li>Features low parasitic draw and low turn-on speed</li> <li>Load dump protection guards against voltage spikes</li> </ul>
<b>Rectifier Bridge</b>	<ul style="list-style-type: none"> <li>Specially designed bridge provides protection for other electronic devices and clamps voltage surges up to 40 volts</li> </ul>	<ul style="list-style-type: none"> <li>Easily located under a removable access cover for servicing convenience</li> </ul>
<b>RFI (Radio Frequency Interference) Suppression</b>	<ul style="list-style-type: none"> <li>Voltage regulator offers improved RFI suppression</li> </ul>	<ul style="list-style-type: none"> <li>Voltage regulator offers improved regulator switching and improved RFI suppression</li> <li>Increased capacitor rating also aids in RFI suppression</li> </ul>
<b>Brushes</b>	<ul style="list-style-type: none"> <li>Improved brushes offer increased service life</li> <li>Special swivel brush holder design minimizes brush side wear, bounce, hang-up and erosion</li> </ul>	<ul style="list-style-type: none"> <li>Brushless design and stationary field coil means there are no moving electrical connections</li> <li>Brushless design ensures increased durability and service life</li> <li>The absence of brush/slip ring contact and resulting electrical connections eliminates sparks</li> </ul>
<b>Charging System</b>	<ul style="list-style-type: none"> <li>Adaptable for one-wire system to make generator placement simple</li> <li>Available in two-wire system</li> <li>Effective in three-wire systems to facilitate "turn-on" speed at or below engine slow idle and to sense voltage at a remote point</li> <li>Terminal boots guard against damage</li> <li>"I" and/or "R" terminals are optional</li> </ul>	<ul style="list-style-type: none"> <li>Features a one-wire system to prevent wiring errors that sometimes occur with multiple connections</li> <li>Makes generator replacement simple</li> <li>Also available in two-wire system</li> </ul>
<b>Heavy-Duty Design</b>	<ul style="list-style-type: none"> <li>Permanently sealed drive-end ball bearing is capable of handling heavy belt loads and diesel vibration</li> </ul>	<ul style="list-style-type: none"> <li>25mm drive-end ball bearing allows heavier belt loads</li> <li>Heavy-duty roller bearing on rectifier end</li> <li>Wires and connectors are brass, galvanized or plated to better resist corrosion</li> <li>After assembly, rectifier-end frame is dipped in a special coating to protect against dirt and corrosives</li> </ul>
<b>Ambient Temperature Limits</b>	<ul style="list-style-type: none"> <li>-34 degrees C to +93 degrees C</li> <li>-30 degrees F to +200 degrees F</li> </ul>	<ul style="list-style-type: none"> <li>-40 degrees C to +93 degrees C</li> <li>-40 degrees F to +200 degrees F</li> </ul>
<b>Polarity</b>	<ul style="list-style-type: none"> <li>Negative ground</li> </ul>	<ul style="list-style-type: none"> <li>Negative ground</li> </ul>



	21-SI Heavy Duty Brush Generator	30-SI Heavy Duty Brushless Generator
<b>Rotation</b>	• Clockwise	• Clockwise or counterclockwise
<b>Weight</b>	• 14.2 lbs (6.46 kg)	• 26.2 lbs (11.9 kg)
<b>Performance</b>	<p>21-SI Performance Curve (28V @ 25°C)</p> <p>21-SI Performance Curve (14V @ 25°C)</p>	<p>30-SI Performance Curve (14V, 28V or 37.5V @ 25°C)</p>
<b>Applications</b>	<ul style="list-style-type: none"> <li>• Large and mid-range, on-highway diesel and gasoline engines</li> <li>• Off-road, farm and construction vehicles</li> <li>• High electrical loads</li> </ul>	<ul style="list-style-type: none"> <li>• Large heavy-duty diesel vehicles</li> <li>• Mid-range diesel vehicles</li> <li>• Heavy belt loads and vibrations</li> <li>• High electrical loads</li> </ul>

## Simplified Core Return Policy

Recently, DRA modified and streamlined its core return policy for generators. You no longer have to worry about variable rates and figures for various conditions. Now it's either all or nothing.

- For generator cores from the Delco Remy America program, you get 100 percent core credit.
- NO core credit is available for Non-DRA cores or junkyard cores.

Specific dollar amounts for core credits and the exact core return policy and procedures are available from your DRA representative. Or you can call 1-317-646-7731 Monday through Friday, 8:00 a.m. - 5:00 p.m. E.S.T. for quick assistance to your core-related questions.

## STARMASTER SUMMARY

Delco Remy America

### YOUR CUSTOMER GETS...

Easier wiring and better RFI suppression in SI generators

Improved brush service life in the 21-SI generator

Increased durability and service life, plus fewer sparks in the 30-SI generator

Quality reman generators that perform like new

### BECAUSE OF...

- Built-in, integrated voltage (circuit) regulators

- Special swivel brush holder design

- Brushless design and stationary field coil

- Stringent DRA remanufacturing process and rigorous testing

# STARMASTER REVIEW

When you have read this section of the workbook, complete the review below. Read each question and mark your answers on the answer page at the back of this workbook. Then send your completed review to the Western Star Training Center for evaluation.

1. Electrical current is the movement of electrons through a conductor, and that current flow is measured in \_\_\_\_\_.
  - a. volts
  - b. ohms
  - c. amperes
2. The three basic fundamentals that determine the output of a specific generator are the \_\_\_\_\_, the number of armature conductors and the strength of the magnetic field.
  - a. ohm rating of the generator
  - b. speed of the armature rotation
  - c. RFI suppression
3. A voltage (or circuit) regulator \_\_\_\_\_ the generator produces to protect the generator and electrical system.
  - a. increases the minimum voltage
  - b. limits the maximum voltage
  - c. increases the ohms
4. RFI refers to:
  - a. Reverse Field Induction
  - b. Radio Free Iowa
  - c. Radio Frequency Interference suppression
5. A generator should be capable of producing \_\_\_\_\_ percent more output than is required by the total connected load in order to replace electrical energy used from the battery when the generator is not at operating speed.
  - a. 1 to 2
  - b. 10 to 20
  - c. 100
6. The "SI" model number on a Delco Remy America generator indicates that it is a(n) \_\_\_\_\_ that combines a diode rectified AC generator with a dependable solid state regulator.
  - a. brushless model
  - b. integrated charging system
  - c. positive ground model
7. Based on the chart titled "Generator Features and Specifications," which generator models offer a one-wire system to prevent wiring errors?
  - a. the 30-SI
  - b. the 21-SI
  - c. both
8. Based on the chart titled "Generator Features and Specifications," which generator model features improved brushes and a special swivel brush holder design for increased service life?
  - a. the 30-SI
  - b. the 21-SI
  - c. both
9. \_\_\_\_\_ generators available from Delco Remy America offer a less expensive alternative for your customers, yet provide "like new" performance due to the stringent and exacting cleaning, replacement and testing procedures at DRA.
  - a. Brushless
  - b. Rebuilt
  - c. Remanufactured
10. The new core return policy at DRA now means that you'll receive \_\_\_\_\_ credit for a generator manufactured by a company other than Delco Remy America.
  - a. 0 percent
  - b. 50 percent
  - c. 100 percent

## Dominion Automotive® Lights Up Trucking

Lights on a truck serve many functions to help a driver perform his job in a safe and productive manner. Headlights help illuminate the road so the driver can see where he's going as well as any obstacles or other vehicles ahead of him. Turn signal lights, brake lights and back-up lights alert drivers of other vehicles of the truck driver's intentions so they can respond appropriately. Marker and clearance lights help identify the general outline of the truck and trailer to help the truck driver and drivers of other vehicles judge distances and heights.

One source for all these lights and more is Dominion Automotive®. Dominion started out in the early 1930's as a manufacturer of battery straps and cables. Over the years they have expanded and improved their product line to include lamps, safety lighting and accessories for large trucks and off-road equipment. The recent acquisition of Target Tech, Inc. added a line of strobe lights, light bars and warning alarms to the already impressive product line. As a result, Dominion Automotive now offers the broadest selection in the industry of quality lighting, safety equipment and accessories for use on trucks, off-road vehicles and industrial equipment.

## An Illuminating Lesson

For a specific object to be seen, light has to travel from that object to an eye that can sense it. During daylight hours, sunlight is reflected off objects so we can see them. But at night or on a foggy morning, there is little light to "bounce off an object." In order to drive safely, we need additional "luminous" light-generating sources.

### Types of light

There are several different kinds of light sources depending on the application. Following are explanations of four basic types of light:

- When certain substances or elements are heated, they give off visible light rays plus invisible heat rays. An example is your typical household light bulb in which electrical current is forced through a fine metal (tungsten) filament that has high resistance. The energy used in

overcoming this resistance produces a white heat, making the filament glow, thus, producing light. This type of light source is referred to as **incandescent**.

- A variation on this type of light is the **halogen** light bulb. Utilizing pressurized halogen gas and tungsten filaments, halogen bulbs provide more light in a smaller package than typical incandescent bulbs.
- Other light sources emit light energy due to electronic bombardment which "excites" the material until it glows or fluoresces. Heat is not produced with this type of light production. These sources are known as **luminescent**. Examples include neon signs and fluorescent lights.
- **LED** (Light-Emitting Diodes) are beginning to replace incandescent bulbs in many applications because of their smaller size, lower power requirements and longer life. When a threshold voltage is applied to a diode, this has the effect of exciting the electrons. When these electrons cross a junction and combine with surplus electrons, photons are emitted, thus producing light. LED lights are used in radios, calculators and in some Dominion marker lights.

### Measuring light

The amount of light (intensity) given off by a certain light source is measured in candles (or candelas). One **candlepower** used to be the amount of light given off by a carefully constructed real wax candle. Today's researchers use high-tech equipment to define candlepower as one sixtieth of the light intensity of one square centimeter of a perfectly black object at the freezing point of platinum. It's still equal to the light intensity of a single candle, but there's no wax buildup. Candlepower is still used to define and classify many lights.

## Functional Lights

Numerous truck designs, applications and state, national and international trucking regulations make it hard to specify the types or sizes of lights needed for every situation within this limited space. However, the following chart summarizes the basic lights required on vehicles in the United States and Canada according to lighting regulations from FMVSS 108 (United States) and CMVSS 108 (Canada).



## LIGHTS REQUIRED ON ALL VEHICLES

CHART KEY	LIGHT	LOCATION	HEIGHT	NO. OF LAMPS	COLOR
1	Headlamp <i>(not required on trailer)</i>	Front	22" - 54"	2 or 4	White
2	Tail Lamp (E)	Rear	15" - 72"	2 or more	Red
3	Turn Signal Lamp (E)	<ul style="list-style-type: none"> <li>• Front <i>(not less than 4" from low-beam - SAE J 588e)</i></li> <li>• Rear (A)</li> </ul>	<ul style="list-style-type: none"> <li>• 15" - 83"</li> <li>• 15" - 83"</li> </ul>	<ul style="list-style-type: none"> <li>• 2 or more</li> <li>• 2 or more</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red or amber</li> </ul>
4	Hazard Lamp (E) <i>(same lamp as turn signal)</i>	<ul style="list-style-type: none"> <li>• Front</li> <li>• Rear</li> </ul>	<ul style="list-style-type: none"> <li>• 15" - 83"</li> <li>• 15" - 83"</li> </ul>	<ul style="list-style-type: none"> <li>• 2 or more</li> <li>• 2 or more</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red or amber</li> </ul>
5	Stop Lamp (E)	Rear	15" - 72"	2 or more	Red
6	License Plate Lamp	Rear, at license plate	No requirements	1 or more	White
7	Side Marker Lamp <i>(not required on truck-tractor)</i>	<ul style="list-style-type: none"> <li>• Side near front</li> <li>• Side near rear</li> </ul>	<ul style="list-style-type: none"> <li>• 15" minimum</li> <li>• 15" minimum (B)</li> </ul>	<ul style="list-style-type: none"> <li>• 1 each side</li> <li>• 1 each side</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red</li> </ul>
8	Back-Up Lamp <i>(not required on trailer)</i>	Rear	No requirements	1 or more	White
9	Rear Reflector	Rear	15" - 60"	2 or more	Red
10	Side Reflector <i>(not required on truck-tractor)</i>	<ul style="list-style-type: none"> <li>• Side near front</li> <li>• Side near rear</li> </ul>	<ul style="list-style-type: none"> <li>• 15" - 60"</li> <li>• 15" - 60"</li> </ul>	<ul style="list-style-type: none"> <li>• 1 each side</li> <li>• 1 each side</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red</li> </ul>
11	Intermediate Side Lamp <i>(if vehicle overall length is 30' or greater)</i>	Side near center <i>(not required on truck-tractor)</i>	15" minimum	1 each side	Amber
12	Intermediate Side Reflector <i>(if vehicle overall length is 30' or greater)</i>	Side near center <i>(not required on truck-tractor)</i>	15" - 60"	1 each side	Amber
13	Parking Lamp <i>(only if vehicle is less than 80" wide)</i>	Front <i>(not required on trailer)</i>	15" - 72"	2 or more	Amber or white
<b>Lights Required on Vehicles 80" or Wider (E)</b>					
14	Identification Lamp	<ul style="list-style-type: none"> <li>• Front, spaced 6" - 12" on center <i>(not required on trailer)</i></li> <li>• Rear</li> </ul> <i>(not required on truck-tractor)</i>	<ul style="list-style-type: none"> <li>• As high as practical (C)</li> <li>• As high as practical</li> </ul>	<ul style="list-style-type: none"> <li>• 3</li> <li>• 3</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red</li> </ul>
15	Clearance Lamp	<ul style="list-style-type: none"> <li>• Front, at widest point</li> <li>• Rear, at widest point</li> </ul> <i>(not required on truck-tractor)</i>	<ul style="list-style-type: none"> <li>• As high as practical</li> <li>• As high as practical (D)</li> </ul>	<ul style="list-style-type: none"> <li>• 2</li> <li>• 2</li> </ul>	<ul style="list-style-type: none"> <li>• Amber</li> <li>• Red</li> </ul>

**CHART NOTES:**

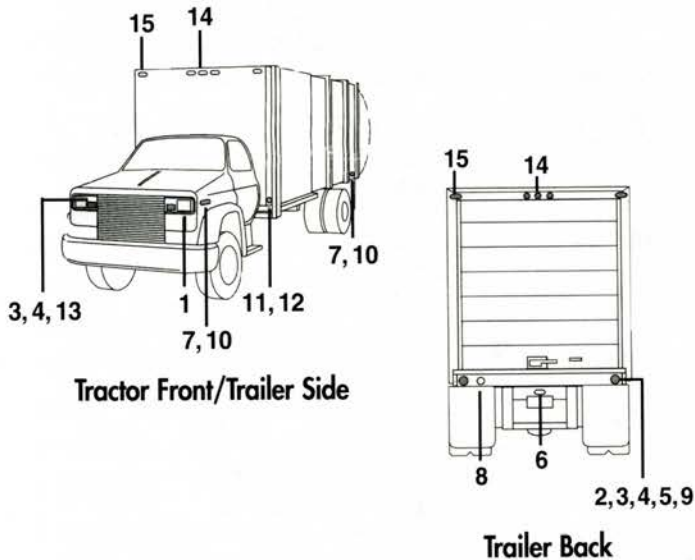
- A) Not required on truck-tractor if front turn signals are double-faced and visible from the rear.  
 B) 60" maximum on rear of trailers 80" or wider.  
 C) Front identification lamps can be mounted on either the top of the body or on the cab's roof above the windshield.

- D) Rear clearance lamps need not meet the requirement that they be located as high as practical when the rear identification lamps are mounted at the extreme height of the vehicle.  
 E) Original equipment requires a minimum of 11.625 in.<sup>2</sup> (75 cm.<sup>2</sup>) of effective, projected luminous lens area on vehicles 80" (2.032 mm) or wider.

NOTE: Any specific state or provincial regulations are not included in above chart. Each lamp assembly must be secured permanently to a fixed portion of the vehicle.

## Light Locations

The previous chart specified types of lights, quantity, color and certain lighting regulations necessary for most trucks. You can use the number code found in the "Chart Key" column of that chart to locate the lights on the diagrams below.



## Light Part Numbers

The type and function of a light, its color and location are important. However, the specific part number or "interchange" equivalent is necessary to recommend the exact part to your customer.

Dominion parts catalogs are excellent sources to help you in this endeavor whether you're looking for OEM replacements or interchange parts. Charts listing sealed beam specifications and replacement lens applications are also available.

## Heavy-Duty Construction

Dominion Automotive uses high-quality, durable materials suitable to the application. Where required, all lamps meet FMVSS 108 and CMVSS 108 regulations.

### Lights and design

To reduce bulb failure due to shock and vibration, many Dominion lamps are now available in the new

SHOCK-FREE® design. In shock absorption tests, these new lamps provide 450 percent improvement (per SAE-J577 test). This reduced shock and filament vibration can significantly lengthen bulb life and provide greater reliability. Check your parts catalog for specific lamps now available in the SHOCK-FREE design.

Dominion also offers LED lighting in many standard sizes of sealed lighting systems. LED is more immune to shock and vibration and produces less heat.

### Materials

- All Dominion lamps are available in a variety of shapes and sizes with precision optic acrylic and/or polycarbonate lenses. These materials will withstand more physical abuse than traditional plastics.
- Lamp housings are available in materials such as impact-resistant plastic, armor-type steel, die-cast aluminum or die-cast zinc.
- Metal housing finishes may be either enamel or chrome-plated.
- Parts subject to corrosion including the junction box are constructed with a corrosion-resistant molded cover and housing.

## Other Lighting Needs

When recommending new lamps or replacement parts to your customers, be sure to suggest the following electrical items they may need during outfitting or repairs.



### Wire and cable

The specific gauge and total length of cable your customer needs will depend on the application, operating conditions and electrical load to be carried. It's important to recommend the proper cable gauge to prevent unnecessary candlepower loss attributed to voltage drops. To determine gauge and length, calculate the following:

- Determine the distance from the battery to the most distant electrical unit in the circuit and figure the length of cable needed.
- Calculate the maximum candlepower to be used by all lights in the circuit and the approximate ampere load in the circuit.
- Use the "Primary Wire and Cable Guide" located in most Dominion parts catalogs. Once you've calculated the length, candlepower and amperes needed, the recommended gauge can easily be located on that chart.

Both single and multiple conductor cables are available from Dominion in a variety of gauges, sizes and colors. All are constructed from the highest quality materials and feature multi-stranded 100 percent copper conductors plus corrosion, heat and chemical-resistant jacketing which resists heat up to 194 degrees F (90 degrees C).

### Loom and tubing

Loose wires can be a nuisance and a safety hazard. To control these wires, Dominion offers a complete line of loom, tubing and accessories. These help contain and protect wires from heat, abrasion and chemicals. They are available in plastic, fiber, vinyl-coated and convoluted

loom. Using loom fittings, your customer can branch or merge wire bundles to create a "neat" installation and protect his system from moisture and corrosion.

You should also recommend the regular use of a high-quality, anti-corrosion dielectric grease compound such as the Truck-Lite<sup>®</sup> NYK Corrosion Preventive Compound to further protect against corrosion on major connections.

### Terminals and connectors

Dominion offers a complete line of terminals and connectors in both insulated and non-insulated styles to meet most every heavy-duty electrical requirement.

- PVC insulated terminals and connectors are designed to be anchored with one quick crimp to provide a strong, rigid plastic insulating sleeve that can't slip off, fracture or unravel.
- Nylon insulated terminals provide excellent crimp strength and vibration resistance.
- Heat shrink solder terminals and connectors from Dominion offer an innovative design that combines a solder and sealed wire connector to provide an electrically and environmentally sound connection.

### Much more

In addition to the items above, your customers may also need fuses, electrical tools, terminal blocks, circuit breakers, toggle switches, push-pull switches, multi-position switches, junction boxes, flasher receptacles and headlight connectors. All these items and more are available through Dominion Automotive.

## STARMASTER SUMMARY

### Dominion Automotive

#### YOUR CUSTOMER GETS...

The right part for the right application

Reduced shock and filament vibration, lengthened bulb life and greater reliability

Tough lenses able to withstand more physical abuse than traditional plastics

Terminals and connectors suited for any job or application

#### BECAUSE OF...

- Concise and accurate OEM and Interchange parts number charts available for all parts specialists
- New SHOCK-FREE design now available in many Dominion lamps
- Precision optic polycarbonate materials
- Complete line of PVC insulated terminals and connectors
- Nylon insulated terminals
- Heat shrink solder terminals and connectors



## STARMASTER REVIEW

When you have read this section of the workbook, complete the review below. Read each question and mark your answers on the answer page at the back of the workbook. Then send your completed review to the Western Star Training Center for evaluation.

- 1. The type of light produced when electrical current is forced through a fine metal filament is referred to as \_\_\_\_\_.**
  - a. fluorescent
  - b. LED
  - c. incandescent
- 2. \_\_\_\_\_ lights are smaller in size, have lower power requirements and a longer life than other commonly-used types of light.**
  - a. Neon
  - b. LED
  - c. Luminescent
- 3. Using the chart titled "Lights Required On All Vehicles," what color side reflectors are required on the side near the rear?**
  - a. amber
  - b. red
  - c. white
- 4. Based on the truck lighting diagrams, what lamps or lighting functions are combined and noted as "2, 3, 4, 5, 9?"**
  - a. license plate lamp, stop lamp, side reflector, rear reflector, parking lamp
  - b. tail lamp, turn signal lamp, hazard lamp, stop lamp, rear reflector
  - c. intermediate side lamp, back-up lamp, stop lamp, tail lamp, parking lamp
- 5. Based on the truck lighting diagrams, what lamps or lighting functions are combined and noted as "3, 4, 13?"**
  - a. headlamp, turn signal, identification lamp
  - b. turn signal lamp, side marker lamp, hazard lamp
  - c. turn signal lamp, hazard lamp, parking lamp
- 6. The new SHOCK-FREE® lamp design reduces shock and \_\_\_\_\_ to significantly lengthen bulb life and provide greater reliability.**
  - a. filament length
  - b. filament vibration
  - c. bulb power
- 7. When recommending wire or cable to your customer, calculate the length, candlepower and amperes needed, then use the "Dominion Primary Wire and Cable Guide" chart to find the appropriate \_\_\_\_\_.**
  - a. gauge
  - b. color
  - c. loom
- 8. \_\_\_\_\_ can be anchored with one quick crimp to provide a strong, rigid plastic insulating sleeve that can't slip off, fracture or unravel.**
  - a. Nylon insulated terminals
  - b. Heat shrink solder terminals
  - c. PVC insulated terminals and connectors
- 9. The regular use of a dielectric compound protects major connections against \_\_\_\_\_.**
  - a. voltage overload
  - b. corrosion
  - c. high-speed impact
- 10. Metal lamp housing finishes available from Dominion include:**
  - a. impact-resistant plastic and armor-type steel
  - b. enamel or chrome-plated
  - c. LED and incandescent

*Dominion Automotive and SHOCK-FREE are registered trademarks of Dominion Automotive Group Inc. Truck-Lite is a registered trademark of Truck-Lite Co., Inc.*

## Trucks Stop for Bendix Air Brakes

Which is most important: Generating enough power to start and run a truck, or stopping a truck? Ask any driver after he's come through Wolf Creek Pass in Colorado or as he descends toward Vancouver on the Coquihalla Highway and he'll definitely have an answer for you.

Being able to stop when and where necessary is definitely at the top of any driver's priorities. And a Bendix air brake system from AlliedSignal is the best answer to any braking question. For over 60 years the Bendix name on heavy-duty truck air brake systems and components has meant reliability and durability for all original, after-market new and aftermarket remanufactured products.

## Air and Pressure

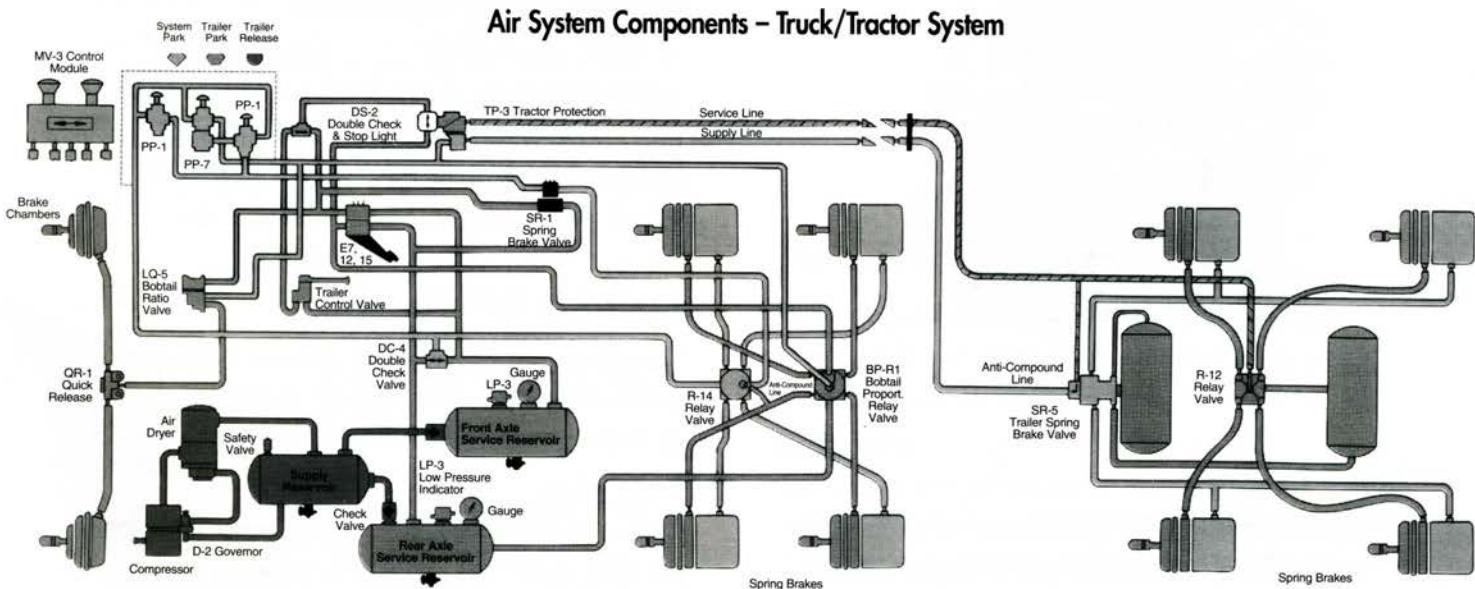
The study of air and other gases is called "pneumatics." These studies have proven that air has its own weight.

At sea level and under normal conditions, the pressure of air can be measured at 14.7 p.s.i. (pounds per square inch).

In air brake systems, air is forced, or compressed, into a smaller space than it normally occupies. This elevates the pressure of air within the system to facilitate air brake operation. Despite the fact that outside air has pressure, the air pressure in an air brake system is expressed on a scale beginning at zero.

## Creating and Controlling Air Pressure

Several components make up the air brake system on a tractor and a tractor and trailer rig. The illustration below shows the basic components and their relation to each other.

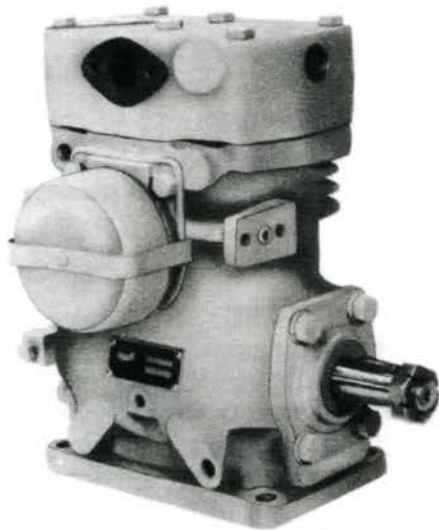


## Air compressor

Powered by the truck engine, the air compressor takes in surrounding air and converts it to compressed air. This compressed air provides the energy for the air brake system and is stored in the supply reservoir.

Bendix compressors are available in several sizes and mounting configurations to meet a wide range of vehicle needs. All reciprocating-type compressors feature automatic inlet and discharge valves and an unloading mechanism.

The TU-FLO 501 series air compressor, often used in Western Star Trucks, is a 2-cylinder compressor and uses pressurized engine oil for lubrication and water for cooling.



## Governor

The governor controls the compressor and governs, or regulates, the amount of air pressure in the supply reservoir.

The Bendix D-2 governor is an adjustable piston-type valve available in various pressure settings. It can be direct-mounted to the compressor or remote-mounted. It is also available in weatherproof and high temperature versions for special installations.

## Air dryer

Air and water enter and leave the compressor and governor during normal operation, but too much water or contaminated air can cause air line freeze-ups. A Bendix air dryer utilizes a replaceable desiccant material to remove 100 percent liquid and solid contaminants and 95 percent water vapor from the compressor discharge air before it reaches the air brake reservoirs. This means only clean, dry air is supplied to the air brake system.

## Reservoirs

A typical dual air brake system uses several different reservoirs to supply and store compressed air. Basic reservoirs include the supply reservoir, the rear axle service reservoir and the front axle service reservoir. The reservoirs also provide a location where air, heated by compression, can be cooled and water vapor condensed.

The specific size of the reservoir (and the volume of compressed air) is determined by truck manufacturers to provide an adequate volume of air for use by the braking system and auxiliary control devices.

All Bendix reservoirs are built in accordance with SAE J-10-B specifications and are available in various sizes in both single and double compartment design configurations. They are certified per FMVSS 121 (United States) and CMVSS 121 (Canada) regulations.

## Applying Air Pressure

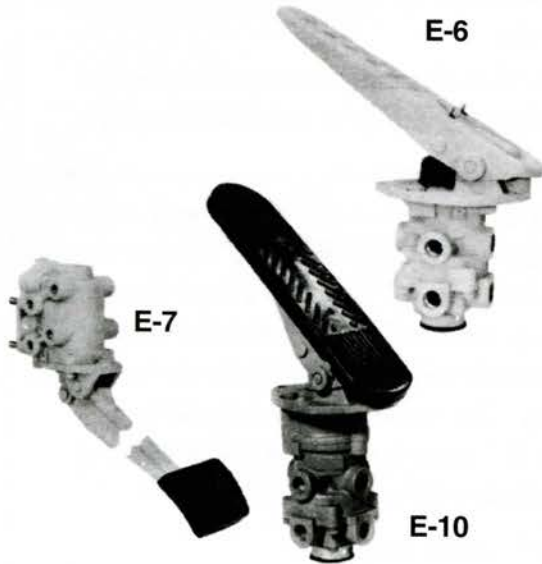
Compressing air, governing air pressure, cleaning air and storing air are all very important functions of an air brake system. But how does all this air stop a truck?

## Brake valves

The control point of a truck air brake system is the foot-operated brake valve. The driver applies and releases pressure on the brake pedal to signal and activate the air brake system.

Bendix brake valves are available in various mounting configurations and, generally, are either floor or firewall-mounted. Actuation of the valve can be by treadle, pedal, or lever/linkage. All brake valves are designed to

provide a gradual means of applying air in the 5 p.s.i. to 80 p.s.i. range with the capability of delivering full reservoir pressure.



Slack adjuster models are available in various arm configurations, lengths and spline types and are designated by a number which represents maximum torque rating (i.e. a Type 20 unit is rated for a maximum of 20,000 inch-pounds of torque).

Manual and automatic slack adjusters perform the same functions, although an automatic unit can make adjustments for lining wear. The Bendix "Sure Stroke" unique design monitors brake lining wear to brake drum clearance and eliminates the possibility of over-adjustment.

The ASA-2 is designed to fit most truck/tractor and trailer applications, while the ASA-3 is intended for use where linkage interference is a problem. The ASA-4 is identical in appearance to the ASA-2, but is primarily intended for use with the Bendix air disc brake.

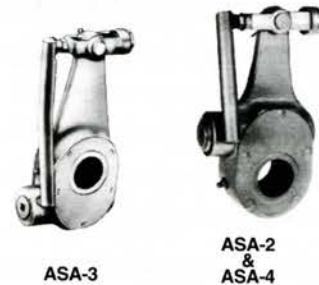
### Brake chamber and actuator

Brake chambers are located by the wheels on a tractor or tractor/trailer configuration. As the driver applies pressure on the brake valve to activate the air braking system, compressed air is released into the brake chamber. The brake actuator push rod activates the slack adjuster to convert compressed air into a mechanical force.

Brake chambers are available in several sizes to provide a wide range of output forces. The size and relative power output of a brake chamber is specified by its name. For example, a Type 20 has a 20-square inch area for air pressure to act on.

### Slack adjuster

The slack adjuster forms the final link between the truck air system and the cam brake in the wheel. The slack adjuster multiplies and transfers the linear force developed by the brake chamber into a rotational force (torque). This actuates the brake camshaft which begins to force the brake shoes into contact with the brake drum. When brake application is released, the actuator push rod returns to the release position, the cam shaft rotates back and the brakes are released.



## Air Safety

Various control and safety valves are utilized within the air brake system to provide protection to the brake system itself and to the driver.

### Safety valve

This safety valve protects the air brake system from excessive air pressure build-up. It should be installed in the same reservoir to which the compressor discharge line is connected. Bendix safety valves are available in adjustable (ST-1) and non-adjustable (ST-3) styles, in various pressure settings and with either 1/4" or 3/8" m.p.t. (male pipe thread).



### Low pressure indicators

In the event that air pressure is below a safe minimum for normal operation, an air-pressure-operated, electro-pneumatic switch provides warning to the driver. The low pressure indicator is available in various pressure settings, is not adjustable, and is generally used in conjunction with a dash-mounted warning lamp or warning buzzer (or both).

### Quick release valve

When the driver releases his foot from the brake pedal, the whole braking process and air compression cycle is reversed. The air reverses its flow so it can exit back through a control device. However, the use of a quick release valve allows air to exhaust much more quickly and lets the driver return the truck to normal speed sooner.

## Bendix Remanufactured Exchanges

Many air brake components, including compressors and governors, are available to your customers in remanufactured equivalents. Extensive charts comparing OE part numbers and Reman part numbers are available in AlliedSignal Bendix parts catalogs.

Here's a quick hint to help you identify an original or remanufactured compressor:

- A nameplate is attached to the crankcase of all Bendix compressors. It displays the model, piece number and serial number.

- A nameplate with a black background denotes a new/original equipment compressor.
- A nameplate with a red background designates that the compressor is a Bendix remanufactured/replacement unit.

## Maintenance Parts and Kits

Besides the major air brake system components discussed here, there are numerous parts within each component plus additional switches, valves, and tubing that can be repaired or replaced. In many instances, maintenance kits are available that include a complete assortment of parts routinely inspected and replaced during periodic servicing. One maintenance kit designed for the TU-FLO 501 air compressor contains the following items to service the unloader field:

- unloader piston complete (2)
- unloader plunger (2)
- plunger guide (2)
- unloader spring saddle (1)
- unloader spring seat (1)
- unloader spring (1)
- strainer gasket (1)

For a complete list and description of maintenance kits, see your AlliedSignal Bendix Parts Catalog.

# STARMASTER SUMMARY

## Bendix Air Brakes

### YOUR CUSTOMER GETS...

The right Bendix air compressor for his truck

Clean, dry air supplied to the air brake system

Rid of over-adjustment brake problems

Convenient air brake system maintenance

### BECAUSE OF...

- The wide variety and sizes of Bendix air compressors to fit various mounting configurations
- Bendix air dryers which utilize a replaceable desiccant material to remove liquid and solid contaminants plus water vapor
- Bendix "Sure Stroke" design slack adjuster which monitors brake lining wear to brake drum clearance
- Numerous Bendix maintenance kits which contain parts most generally required to complete minor service work



# STARMASTER REVIEW

When you have read this section of the workbook complete the review below. Read each question and mark your answers on the answer page at the back of this workbook. Then send your completed review to the Western Star Training Center for evaluation.

1. At sea level and under normal conditions, the pressure of air can be measured at \_\_\_\_\_.
  - a. air has no weight
  - b. 17.4 pounds per square inch
  - c. 14.7 pounds per square inch
2. Compressed air provides the \_\_\_\_\_ for the brake system and is stored in the supply reservoir.
  - a. motivation
  - b. energy
  - c. desiccant
3. According to the air system component diagram, the governor is connected between the \_\_\_\_\_.
  - a. brake chamber and compressor
  - b. compressor, the supply reservoir and air dryer
  - c. compressor and the safety valve
4. According to the air system component diagram, the QR-1 quick release valve allows air pressure to escape between the \_\_\_\_\_.
  - a. rear brake chambers
  - b. brake chambers and compressor
  - c. front two brake chambers
5. Three basic reservoirs used to supply and store air in a dual air brake system include the \_\_\_\_\_ reservoir, the rear axle service reservoir and the front axle service reservoir.
  - a. air dryer
  - b. supply
  - c. quick release
6. The control point of a truck air brake system is the \_\_\_\_\_.
  - a. compressor
  - b. foot-operated brake valve
  - c. quick release valve
7. The \_\_\_\_\_ forms the final link between the truck air system and the cam brake in the wheel.
  - a. slack adjuster
  - b. brake valve
  - c. supply reservoir
8. A Type 20 brake chamber has a \_\_\_\_\_ square inch area for air pressure to act on.
  - a. 200
  - b. 20
  - c. 20,000
9. The Bendix "Sure Stroke" \_\_\_\_\_ monitors brake lining wear to brake drum clearance to eliminate the possibility of over-adjustment.
  - a. air dryer
  - b. slack adjuster
  - c. brake chamber
10. A black nameplate on a Bendix air compressor crankcase denotes:
  - a. a remanufactured/replacement unit
  - b. nothing significant
  - c. a new/original equipment compressor



# ANSWER SHEET

Please record answers for all reviews on this answer page. After you have completed this page, either remove from book (or make a copy of this page) and fax to the Western Star Training Center at 816-891-7576. If you have any questions, please call 1-800-704-1105.

Date: \_\_\_\_\_/\_\_\_\_\_/\_\_\_\_\_

Name: \_\_\_\_\_  
(Please Print)

Dealer Name: \_\_\_\_\_

Parts & Service Dealer Code: \_\_\_\_\_

City: \_\_\_\_\_ State/Prov.: \_\_\_\_\_ Zip/Postal Code: \_\_\_\_\_

Dealer Phone: (\_\_\_\_) \_\_\_\_\_ Dealer Fax: (\_\_\_\_) \_\_\_\_\_

Please circle the correct answers below:

## CHARGING SYSTEMS

- 1. A B C
- 2. A B C
- 3. A B C
- 4. A B C
- 5. A B C
- 6. A B C
- 7. A B C
- 8. A B C
- 9. A B C
- 10. A B C

## LIGHTING SYSTEMS

- 1. A B C
- 2. A B C
- 3. A B C
- 4. A B C
- 5. A B C
- 6. A B C
- 7. A B C
- 8. A B C
- 9. A B C
- 10. A B C

## AIR SYSTEMS

- 1. A B C
- 2. A B C
- 3. A B C
- 4. A B C
- 5. A B C
- 6. A B C
- 7. A B C
- 8. A B C
- 9. A B C
- 10. A B C

Y1-Q4



# SELLING BY ASKING QUESTIONS

What is selling? Simply defined, selling is the act of finding out what your customers' needs are and doing your best to help satisfy those needs. And you find out what those needs are by asking questions.

## "How can I help you?"

Asking a few basic questions can help you improve your sales efforts and enhance customer satisfaction in the following ways:

- 1. Asking questions helps you focus the conversation and establish the facts.** As a parts specialist, you are more aware of application specifics and necessary replacement parts criteria such as year and model numbers, voltage requirements, and even legal restrictions. Ask all the questions you need to enable you to recommend and sell the proper part. If you sell a customer the wrong part, he won't remember that he forgot to give you an important piece of information. He'll blame you for not asking him the right questions.  
*What's the year and model number of that truck? Is it 9-speed or 13?*
- 2. Asking questions helps you control the amount of time spent with each customer.** Friendly chit-chat does have a place in a sales conversation; it helps establish a friendly rapport and a personal connection between you and your customer. But if a customer begins to ramble, it's up to you to carefully guide him back to the important topic at hand ... the products he needs to purchase from you today. As a rule, the more time spent in idle chit-chat, the less likely a sale will occur.  
*You did say that was a '93, right?*
- 3. Asking questions allows you the opportunity to listen to your customer and identify other sales opportunities.** As discussed in our last training workbook, listening is a very effective sales tool. So when you ask your question, remember to actually listen to the answer your customer gives you and avoid unnecessary interruptions.  
*How's your truck riding?*
- 4. Asking questions allows you to gather opinions from the customer.** All customers have opinions that can be important to your sales efforts. These opinions could include the suspected reason for a specific part failure, his rationale for preferring one manufacturer over another or even the reason he prefers to buy his parts from you and your dealership.  
*How many miles did you get out of those brakes?*
- 5. Asking questions finally leads you to the end of the sale and the suggestion of related items.** After you have focused the conversation to gather all facts and opinions and properly identified your customer's needs, it is now time to ask for the sale and to suggest other necessary related items.  
*Is there anything else I can help you with today? Do you need any cable or connectors for those new lights?*

If you begin each customer inquiry with a question — "How can I help you?" — and follow through with appropriate questions until you know exactly what he needs, your customer will probably respond with greater trust and, ultimately, increased purchases.

# SUCCESS STORIES



## IF THE CUSTOMER CAN SEE IT ...

Marshall Cymbaluk, president of Motor Trucks Inc. in northwest Washington, is a firm believer and experienced practitioner of merchandising. "When we built our first new dealership facility in 1977, we put in approximately 1,800 sq. ft. of merchandise display area," he says. "Letting customers 'see' what we have to offer has always worked well for us."

A parts display area, Marshall says, is especially effective when counter men are busy with another customer since it allows waiting customers time to browse. "A guy may come in for a transmission gear, but after walking through the aisles, he may leave with a box of rags, strap tie-downs and some oil. We even provide over-the-arm shopping baskets; you'd be surprised how many people use them."

Related item merchandising also gets considerable attention at Motor Trucks dealerships. "It's important to display items in a logical sequence," Marshall says. "Put battery cables next to the batteries, filters next to the oil, and frame bolts next to the hitches. It does make a difference."

Since 1977, Motor Trucks has added two additional dealerships and the merchandise display area has increased in each one. With a fourth now in the final phase of construction, Marshall continues to put an emphasis on merchandising.

## MERCHANDISING IN ACTION

Mike Stoepfel, parts manager for Great Lakes Western Star in Toledo, Ohio, is a recent convert to the power of merchandising. "Until May of this year, we didn't place much emphasis on merchandising," he says. Then his Western Star RPSM held a POP (point-of-purchase) seminar at the dealership. The seminar included before and after videos, pictures and sales statistics of dealerships who had recently increased their merchandising efforts.

After the seminar, one of Mike's counter men erected a pyramid display of oil. Prior to the display Mike said they had sold approximately eight gallons a month. After the display, they sold 72 gallons during the month of July. "That was a significant increase in sales," Mike says, "and there was very little work put into it."

A new location in Monroe, Mich., is now getting Mike's attention. Utilizing a merchandising planning service now available through Western Star Trucks, Mike worked with a consultant to develop a strategic "plan-o-gram" of the entire parts and display areas. "He even helped us figure and purchase racking and display shelving," Mike says. "We're anxious to see the results."

**To submit a success story idea, call or write the Western Star Training Center at the phone number or address below.**

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1-800-704-1105

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