Diagnosing Suspension Problems

Our coach suspension system with Level Low is a wonderful system. Using our air springs (air bags) which provide the comfortable ride as we travel down the highway as the core of the system, Prevost engineers have designed the Level Low system to serve another purpose. That Level Low system is the means by which we can raise or lower our coach at three points so the chassis sits level even though the ground under the bus is not level.

Think of the system as a tripod. We can raise or lower the front, the left rear or the right rear. Raising the front only does not change the side to side tilt. But it does assist in front to rear leveling. Raising or lowering the left or right side changes the side to side tilt, and also affects the front to rear leveling. If a coach is on a campsite that is low in the front and right the coach could be leveled by first lowering the rear on both sides, and then raising the right hand side until the side to side tilt is level. The next step is to raise the front enough to level the coach front to rear. If the system is tight (as intended) with no air leaks the coach will remain level for long periods of time. When the coach is to be driven the system switch can be placed in the driving or road position and the coach will raise or lower at the three positions, front, left rear and right rear, so the coach may no longer be level, but it is parallel to the ground and at the correct height for driving.

The explanations are simple, but to accomplish what was previously described involves a number of valves and electric switch controls. Further, while the basic system operation is similar for all Prevost coaches, there are variations in the system logic that were design upgrades by Prevost, but also changes made by converters to add features to the Level Low system such as fully automatic leveling.

It is not the intent of this article to provide detailed information on all the variations, but to offer the diagnosis methods to use to diagnose a generic Prevost Level Low system that might have issues. Absent from this article will be information about or procedures for every system and variation. But with the information contained here an owner should be able to systematically be able to diagnose a problem, or offer guidance to a mechanic unfamiliar with the complexities of the Level Low system.

The types of problems that can be anticipated are relatively few and despite the number of valves, fittings and air paths zeroing in on a problem is generally easy. One way to keep the system logic easy to understand is to not think of it as a complete system but to understand there are two system designs within the overall Level Low system. One design is the front that merely goes up and down, or is set at the driving or ride height. The second design is in the left rear or right rear and encompasses up and down, or setting at ride height. The difference between the front and the rear
systems is the rear design also contains a function in which the tag axle can be lifted.

The problems encountered are typically that the coach will not go to the ride height, or it will not go up or down at any of the three positions when commanded. Also included will be problems we call the leans, in which the coach droops in the front or side to side after a short time period. Since the most critical function of the suspension system is to maintain the ride height position when the coach is going down the road that is where the problem diagnosis will begin.

Before we begin to explore problems it will be important to understand the components that are going to be discussed and where they are located. The control for the pneumatic system will be via a manifold located on the rear wall of the steer compartment and on that manifold will be five solenoid valves, electrically operated by manual controls or converter installed automatic controls. A photo of the solenoid valves and manifold is shown later in this article.

The solenoid valves will send pilot air signals to various Norgren spool valves located in various locations through the coach. Two of them may be seen (although not easily due to various air hoses and electrical wires on the back wall of the steer compartment, slightly inboard and below the previously mentioned solenoid valve manifold. Others are located in several locations beneath the coach and the diagrams used as illustrations in this article show approximate locations. The final components will be the ride height valves that are mechanically operated via a lever arm that is attached to the axles or suspension cradle to maintain a given air bag inflation height. The last and central component is the air spring or air bag. This component can be inflated to maintain a height suitable for driving, or if desired can be inflated to raise another 4 inches (approximately) or deflated to be lowered approximately 4 inches.

FAILURE TO GO TO RIDE HEIGHT. This is not an uncommon issue, and it is likely the single most important problem to correct. Let’s start by seeing what happens when the leveling system switch is in the drive or road position and the engine is running.

As soon as you turn on the key (system aired up) the third solenoid valve down on the solenoid valve stack located on the rear bulkhead of the steer compartment is opened because electrical power from the leveling system controls at the driver’s position energizes the valve coil. Air passes through that solenoid valve and causes three five port Norgren spool valves to shift so auxiliary system air passing through the ride height valves (3) pass through the five port Norgren valves supplying or exhausting air in the air springs as required to position the coach at the correct driving or road height.
DRIVING POSITION OR DRIVE HEIGHT CIRCUIT ENERGIZED

With the pilot air through the center solenoid valve opening a path through the five port Norgren valves the only height control functioning is the three ride height valves. Lets explore some failure modes and what may be wrong.

NOTHING HAPPENS. You start the bus, make sure the system control is set for the road or driving position, and the coach which is not at ride height doesn’t move. Whether the coach is down low or up high, or is low on one corner and high at another corner is unimportant. Nothing happens. At this point verify the third solenoid valve down (or up) is getting electrical power. You can do this by listening for a click or using a volt meter. If you think it is getting power and have verified that make sure it is opening the valve. If there is any doubt swap that valve coil with any other coil of the same voltage in the stack making sure to keep the wires where they belong at their respective positions.

Once the center solenoid valve operates as intended the coach should move toward the ride height at the front, left rear and right rear.

The problem was likely a failed center coil.
THE COACH GOES TO THE RIDE HEIGHT AT TWO OF THE THREE POSITIONS. This also happens, but not as frequently. The previous problem relating to a failed solenoid valve coil was because that coil is always energized any time the coach is running. Hence that coil has the most frequent failures. But when the solenoid valve in the center position is functioning properly but the coach will not go to the driving or road height at the front, or left rear or right rear then the suspicion shifts to the operation of the five port Norgren valve at that respective position or the ride height valve

The ride height valve arm is attached to the suspension cradle or axle. If the arm has become disconnected or if the valve has failed in some manner it may not provide or exhaust air to bring the air bag height to the height required for driving. If in doubt the arm can be operated manually to raise or lower the coach at that position. Use caution however because working on the suspension in any way can cause the chassis to drop. Make sure you never place any part of your body beneath the coach or between potential pinch points. Also be aware Prevost uses time delay ride height valves and instant acting ride height valves. Know which you are moving manually so you can anticipate a delay or instant reaction.

The valves and the system are susceptible to damage from moisture in the auxiliary air system. If the coach has had water entering the valves that could contribute to valves that fail to shift internally when commanded, failing to open the path to the ride height valve. Verify the five port Norgren is getting pilot air to the air actuator. If air pressure is present, determine if the spool is shifting to open the path from the ride height valve to the air bags.

It is not beyond reason to find moisture that has resided in the system for long time periods has corroded the aluminum within the Norgren valve preventing the actuator from moving. I have seen aluminum corrosion sludge slow down valve actuation or completely prevent valve actuation.

It is unlikely the third down solenoid valve will function properly yet all three five port Norgren valves will fail to shift at the same time. It might be possible, especially if a poorly maintained bus has not been operated for a long period of time, but unlikely.

Obvious, but needing to be recognized is an air leak that prevents sufficient pressure from being delivered to the air bags so the coach can be raised as required to the driving height. A leak of that significance is likely going to be easily heard.

To cement your understanding of what valves are a part of the ride height command and how they come into play review the diagram above noting that once the third solenoid valve shifts the five port Norgren valves the air path to the air bags is straight through the Norgren valves from the ride height valves. Any problems with
coming to ride height are going to be associated with the switches in the drivers area, the third solenoid valve, the five port Norgrens, or the ride height valve unless the problem is associated with lack of air pressure which is a whole different topic.

FRONT HEIGHT ADJUSTMENT, UP OR DOWN. This problem is specific to the switches at the drivers position, the top two solenoid valves or the three and five port Norgren valves in the steer compartment.

FRONT SUSPENSION RAISED

In the diagram above it can be seen when the front is to rise the selector needs to be in the “front” position and the “up” button depressed. This sends power to the top two solenoid valve coils which when opening the valve shift the three and five port Norgren valves to open a path from the auxiliary air supply thru the three port valve, the five port valve and into the front air bags.
FRONT SUSPENSION LOWERED

This command only activates the second solenoid valve down, which in turn shifts the five port Norgren valve to direct air from the air bags to the normally open port on the three port Norgren valve. With both diagrams available for review let's examine some things likely to go wrong.

NOTHING HAPPENS, EITHER DIRECTION

This failure mode requires the diagnosis to consider what components are common to a total failure to manually raise or lower the front of the coach. As can be seen by looking at both diagrams there appear to be only three components common to both up and down commands, The selector switch that is used to choose the front position is the primary potential failure point. Verify that voltage is reaching the top two solenoid valve coils and the second solenoid valve down is functioning. If those two items check out, consider the five port Norgren valve may not be shifting internally.

COACH DOESN’T RISE, AND LIKELY DROPS WHEN THE UP COMMAND IS SELECTED.

This may be a failure of the selector switches and power to the top two solenoid valve
coils has to be verified. If power is at the coils, verify the coils have not failed and they and the valve are functioning. If that solenoid valve operation is verified consider the three port Norgren valve has not shifted and instead of passing auxiliary system air to the five port Norgren valve, it is exhausting air from the air bags because it is in the normally open position.

COACH IS UP, BUT WILL NOT LOWER. This is most probably a failure of the second down solenoid valve or its coil, or the failure of the five port Norgren valve to shift and open an air path. A review of the diagram will show the only two pneumatic parts involved are the second down solenoid valve and its coil and the five port Norgren valve. If this failure occurs it is unlikely the coach will rise in the front if commanded, unless the problem is solely electrical, with the down switch being the probable culprit.

This is a good example of why diagnosis of Level Low suspension system problems require verification of power at the solenoid valve coils as a first step.

REAR HEIGHT ADJUSTMENT, UP OR DOWN. Since the left and right suspension systems in the rear are identical with the exception of their respective solenoid valves and selector switch positions, the description of the systems operation is the same. For ease of understanding only the left rear suspension will be discussed.

In the diagrams below it can be seen the components that control the raising and lowering of the left rear are the selector switches at the driver position and the top and bottom solenoid valves. The forth solenoid valve down, or second up from the bottom is the RH side solenoid valve.

The top solenoid valve in all cases is the “control” valve and it is common to manual “up” operation of all three suspension positions. It is not used in any of the “down” operations of any of the three systems.

Like the front suspension system an up command begins with the selector switches which in turn open the top and bottom solenoid valves which in turn shifts the three port solenoid valve in the front steer compartment and the five port Norgren valve for the left side located on the bulkhead in front of the drive axle. That supplies air pressure to raise the three rear air bags.

In the diagram note that the three rear air bags are tied together so they share the same internal air pressure. More about this later.
LH REAR SUSPENSION RAISED

You will note that in the air line between the two drive axle air bags and the single tag axle air bag is a valve. That is a three port Norgen valve that in its normal position maintains an open path between all three rear air bags on each side. The purpose of that valve in that position is only to shut off the air path between the tag axle air bag and the drive axle air bags, and to exhaust tag axle air bag air so the tag axle lifting device can lift the tag axle. That pair of three port Norgen valves will function any time the tag axle lever is in the raised or lift position. The two valves are in the suspension system, but are independent of it controls and operations.

For purposes of this article disregard their presence. They do however come into play when discussing leak detection as will be explained later.
LH REAR SUSPENSION LOWERED

Like the front suspension controls, lowering the rear involves the lower solenoid valve on the manifold only as a control device to lower the LH rear by directing air through the open five port Norgren valve to the normally open three port Norgren valve in the front steer compartment air is exhausted and the rear will lower.

NOTHING HAPPENS, EITHER DIRECTION

This failure mode requires the diagnosis to consider what components are common to a total failure to manually raise or lower the front of the coach. As can be seen by looking at both diagrams there appear to be only three components common to both up and down commands, The selector switch that is used to choose the LH rear position is the primary potential failure point. Verify that voltage is reaching the top and bottom solenoid valve coils and the bottom solenoid valve down is functioning. If those two items check out, consider the five port Norgren valve may not be shifting internally.

COACH DOESN’T RISE, AND LIKELY DROPS WHEN THE UP COMMAND IS SELECTED.
This may be a failure of the selector switches and power to the top and bottom solenoid valve coils has to be verified. If power is at the coils, verify the coils have not failed and they and their respective valves are functioning. If that solenoid valve operation is verified consider the three port Norgren valve has not shifted and instead of passing auxiliary system air to the five port Norgren valve, it is exhausting air from the air bags because it is in the normally open position.

COACH IS UP, BUT WILL NOT LOWER. This is most probably a failure of the bottom solenoid valve or its coil, or the failure of the five port Norgen valve to shift and open an air path. A review of the diagram will show the only two pneumatic parts involved are the second down solenoid valve and its coil and the five port Norgren valve. If this failure occurs it is unlikely the coach will rise in the left rear if commanded, unless the problem is solely electrical, with the down switch being the probable culprit.

To diagnose problems on the RH side focus on the fourth solenoid valve down or the second up from the bottom. Other than that the diagnosis of problems follows the recommendations above.

SUMMARY. I have found diagnosis of suspension problems requires a methodical approach and for me that starts with ruling out electrical problems which means verifying the involved solenoid valves are getting voltage at their coils. Once that part of the diagnosis is out of the way I just follow the pressurized air, from the solenoid valves to the respective actuators on each Norgren valve, and then from the auxiliary air supply to and through the valves that function to make the coach go up, down or to road height.

There are some things to always be aware of. The system shown in the diagrams above is generic and the coach converter may have modified the Level Low system for their purposes. The system may vary because Prevost Car has made running changes to the Level Low system through the years. The only sure way to know you are looking at your exact Prevost system is to pull up the pneumatic diagrams specific to the coach serial number. They can be found on the Prevost Car web site through the maintenance section. http://motorhome.prevostcar.com/service/parts-service

While the Prevost system is 24 volts, some conversions may have some solenoid valve coils of 12 volts while others are 24 volts. This is important to know because if the third coil needs to be swapped out to make the valve work (what I consider one of the most common failures) if the other valves are 12 volt they will not help. In that case it is better to find out before a problem occurs and carry a spare. Realize Prevost parts may not have information about your specific Level Low system if your converter modified it.
I inserted this photo because so much of the diagnosis of problems starts with the solenoid valves and their coils where voltages and valve operation are checked. If the snap ring is removed the coil will slide off the solenoid valve post and access can be had to the electrical terminals to check for the presence of voltage or continuity through the coil.

The photo below shows the coil removed and the electrical connector removed from the coil.

When it is determined a coil is bad remember that if the other coils on the manifold are the same voltage as the defective one, you can trade coils to make the defective function operable. You just have to be certain the wire connections are to remain with their respective solenoid valves. In the case of a defective ride height coil replacing it with a good coil from another position (as long as voltages for the coils are the same) is a good emergency fix to be able to maintain ride height while driving until replacement coils can be available.

Do not attempt to drive with the ride height portion of the system malfunctioning.
THE LEANS......SOMETHING THAT HAPPENS TO EVERY COACH. As a coach ages an owner finds time is the enemy of every rubber or rubber like component. The Prevost suspension system is dependent upon many components made of rubber, or that use rubber parts to work properly. The air bags are rubber, and over time the rubber can develop cracks and leaks. The valves including the solenoid valves, the Norgren spool valves and the ride height valves all rely on rubber components to seal against leakage. But over time and possibly aided by poor system maintenance leaks develop.

As a coach approaches the time when leaks are noticeable because the bus is no longer level, but is leaning to the side or slopes to the front, it seems the leaks are more rapidly noticeable when it gets cold. But regardless of whether the cold brings on the leans or not, when the coach no longer will remain level for extended periods (defined as greater than 3 days) an owner is confronted with having to isolate and fixed the leak(s). As can be seen from the system diagrams from above, the coach has three individual suspension systems that are independent of one another but do share a few components. The shared components are outside of the individual systems so when a lean is noticed, its cause can be found usually within a relatively small number of components and fittings.
The key to understanding leak detection is knowing that when the key is off (unless a converter has installed a “key off” suspension leveling system) the air in a particular set of air bags is “locked” in those air bags by the closing of the Norgren five port valves.

When no air pressure is applied to the end actuators such as when supplied by opening one of the five solenoid valves on the steer compartment manifold there are no thru paths in the five port Norgren valve. That means air is locked in the air bags associated with that particular Norgren valve.

If the coach leans to the left for example, the only place air can leak from the three rear LH air bags is through a defective or leaky air bag, one of the fittings associated with the three LH air bags, through the three port Norgren valve between the drive and tag air bags, or though the five port Norgren valve. That is very easy to say. What is less easy is finding all but the most obvious leaks. To start with, a person looking for leaks has to get under the coach. NOBODY SHOULD EVER GET UNDER A COACH OR PLACE ANY PART OF THEIR BODY UNDER THE COACH OR BETWEEN PICH POINTS UNLESS IT HAS BEEN SUPPORTED UNDER THE CHASSIS SUPPORT POINTS.

Sometimes with some soapy water solution a person can find the leak within
minutes, but more often than not a small leak can avoid detection despite the numerous ways to locate leaks. But at least an owner can take comfort in knowing leaks will not require a full bus leak detection effort, but instead will require a concentration of efforts on the specific components in that portion of the suspension system which affects the way the coach droops or leans.

There are some things related to understanding leaks that will save time. Except on coaches whose system logic is such that air pressure is required to hold the three port Norgren valves between the drive and tag air bags open, (this applies to coaches prior to 95/96 that have not been modified) the auxiliary system and brake system pressures can drop to zero PSI and the suspension should not lose air. That will save a technician or owner many hours checking and fixing leaks not associated with the specific suspension section. Further, if conventional methods of leak detection fail to show leaks, including soapy water, your ears, a stethoscope, or an ultrasonic leak detector, Hector Duplichnen has created a design for a “bubbler” that will require chasing leaks one component or fitting at a time, but will identify leaks no other method will detect.

This article would not have been possible without the photos and diagrams provided by Hector Duplichnen who has created not only those items but a companion seminar giving a basic understanding of the Prevost Suspension System for owners and mechanics who need that understanding to be able to work on the system.

You may copy this article and retain it as a reference.

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