March 2019 | Volume 12 | Issue 1

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## Keep the Fuel Flowing

## Nissan Sectioning Repair Tips

## Starting with the Starter

## Fluid Advancements

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# Contents

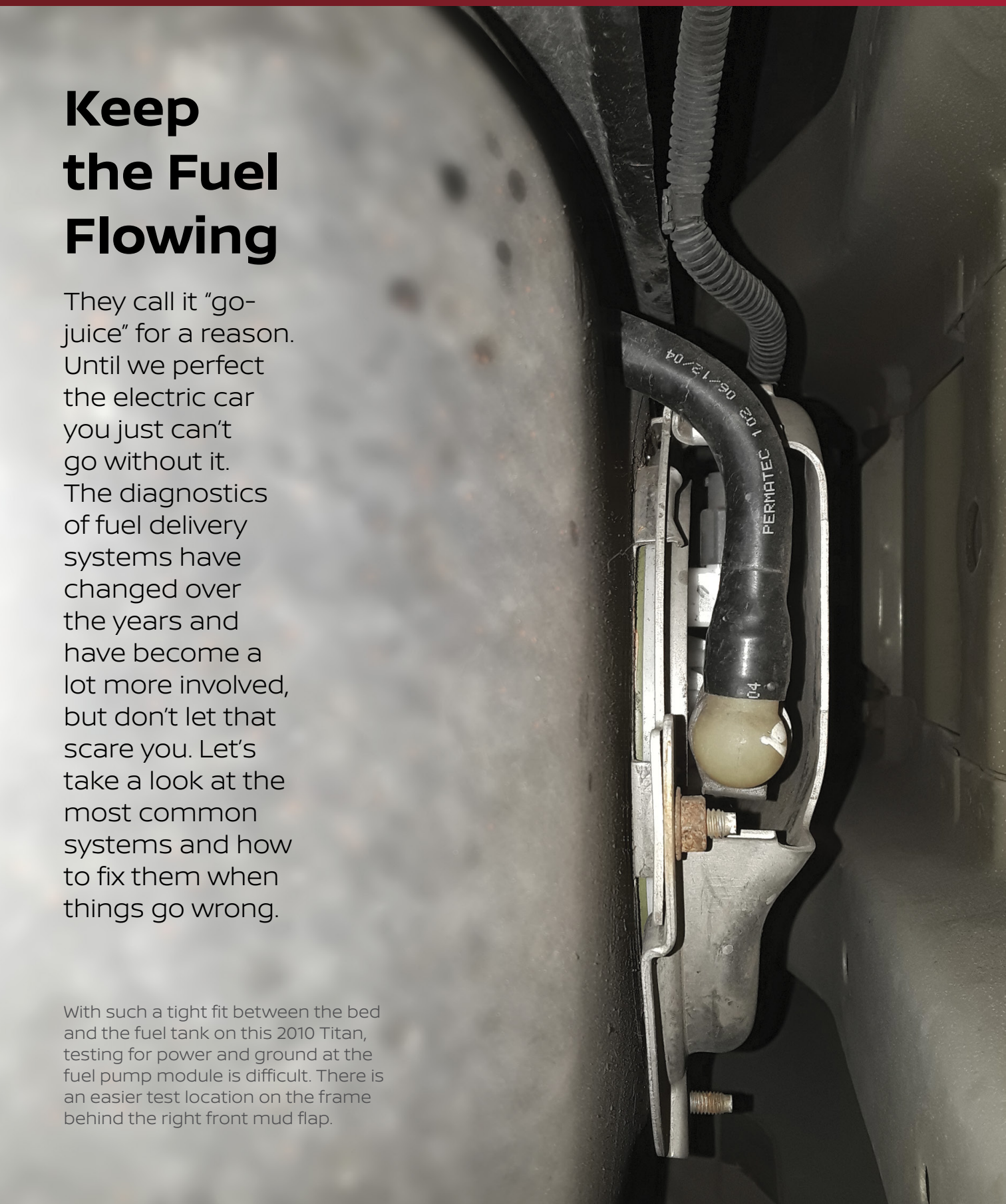
## Features



## Departments

# Keep the Fuel Flowing

They call it "go-juice" for a reason. Until we perfect the electric car you just can't go without it. The diagnostics of fuel delivery systems have changed over the years and have become a lot more involved, but don't let that scare you. Let's take a look at the most common systems and how to fix them when things go wrong.




With such a tight fit between the bed and the fuel tank on this 2010 Titan, testing for power and ground at the fuel pump module is difficult. There is an easier test location on the frame behind the right front mud flap.

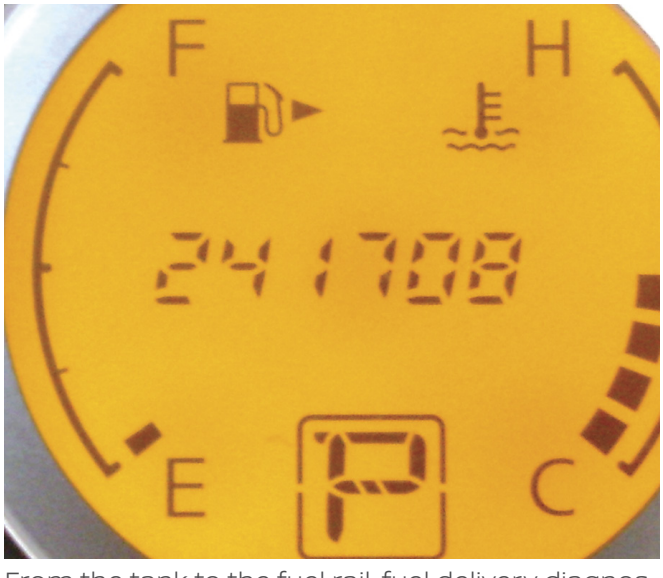
As the technology of the internal combustion engine increases, so does the need to get a reliable supply of fuel to the powerplant. This is the story of increasing pressures. Back in the days of the carburetor-equipped Datsun, all that was needed to supply the fuel was about 4 psi. Basically, all the fuel pump had to do was get the fuel from the fuel tank to a tiny little fuel tank on the side of the carburetor known as a float bowl.

With the introduction of throttle body fuel injection in the late 1970s, and even the early 1980s for Nissan pickups, we saw pressures rise to 35 psi so that an electronically controlled fuel injector on the throttle body could quickly deliver a charge of fuel on demand. These systems were used well into the 1990s, but were eventually phased out in favor of the multi-port fuel injection system. With a separate injector for each cylinder, the charge of fuel had to be delivered even faster, so the fuel pressure was increased once again to about 50 psi.

The next stage is the most dramatic jump in pressure yet. With pressures in excess of 2,000 psi, Direct Injected Gasoline, or DIG for short, is Nissan's contribution to the race for better engine efficiency. Just as the name suggests, this system injects fuel directly into the cylinder while the engine is building compression. The reason for the high pressure is that the fuel has to squirt into the cylinder against compression pressure in an extremely fast manner to get the fuel in there before the spark plug fires.

With advanced computer-controlled fuel injectors and an engine-mounted high pressure pump, the injector can fire multiple times per stroke to cool the piston before compression, then inject more fuel just as it fires. It sounds like a real fancy way of doing what fuel injection has been doing all along, but the end result is a dramatic increase in the amount of energy that can be extracted from the same amount of fuel.

As fuel delivery systems advanced, so did the components needed to make them work. About the only thing that stayed the same is that they all have fuel tanks, but even then we've switched from metal to plastic. Carbureted engines typically use a fuel pump mounted to the engine, driven by an eccentric attached to the camshaft.



From the tank to the fuel rail, fuel delivery diagnostics should start with a glance at the gas gauge. Sometimes the only tool you need is a gas can.

It's not just a clever, hip name for an engine. The acronym DIG. (Direct Injected Gasoline), sometimes referred to as GDI, means high technology and even higher fuel pressures.

A fuel filter will usually be in-line between the fuel tank and the pump and is a great place to start looking if fuel starvation is expected.

With the introduction of fuel injection, the fuel pump was moved into the gas tank and is operated with electricity controlled by relays and, ultimately, the ECM. A fuel filter is mounted between the tank and the fuel rail or throttle body to keep any particles out of the injectors.

Another important addition is the fuel pressure regulator. In older systems the fuel pressure regulator is mounted on the end of the fuel rail and has the return line to the fuel tank connected to it. It's controlled by a vacuum hose connected to manifold vacuum. As engine load is increased, manifold vacuum decreases and the pressure regulator, in turn, increases the fuel rail pressure, providing more fuel for the increased load.

On a returnless system the fuel pressure regulator is part of the fuel pump module and maintains pressure from the pump to the fuel rail. This change does more than simplify the fuel delivery system; it also decreases the extra heat introduced to the fuel tank by cycling fuel through the engine on a continual basis. Less heat in the tank means less fuel vapors to deal with. The DIG system uses fuel delivery similar to other fuel injected vehicles until the fuel gets to the engine. At the engine there is a mechanically driven high-pressure pump to deliver the extra pressure needed to overcome the engine's compression.

There is a point that is often overlooked when working on gasoline powered vehicles. Gasoline is extraordinarily dangerous. Just like you wouldn't risk working on an air bag without following the proper safety procedures, you shouldn't work on the fuel system without taking precautions. On any service that involves opening the pressurized fuel system, Nissan recommends releasing the fuel pressure prior to performing the repairs. Check the service manual for the particulars on the system you're working on.

Typically fuel pressure is released by removing the fuel pump relay or fuse and running the engine until it stalls. Then continue to crank the engine a couple of times to ensure that all remaining pressure is purged from the fuel lines. When opening connections, use a rag to catch any gas that spills. Any fuel that misses the rag and ends up on the engine should be cleaned up before attempting a startup.

Since these fuel systems run at such high pressures, some leaks in the system can actually spray fuel. Although it's not that common, and though most leaks tend to be seeping or slow dripping leaks, a spraying fuel leak is one of the most dangerous conditions you can have in the automotive industry. Any time you can smell fuel from the outside of the vehicle it is critical that you identify where the smell is coming from first just in case it is a dangerous leak.

Most often leaks will be small drips or seeping from the o-rings in the connections, rail mounted fuel pressure regulators, or fuel rail dampers. These should most certainly be resolved as a priority and, as a policy, vehicles with known fuel leaks should not be driven.

Many Nissan vehicles use a fuel pressure damper on the fuel rail as a means of stabilizing

This is a fuel pressure damper in a Titan V-8. Failures are often manifested as fuel leaks. No matter how minor the leak, replace the failed damper and make it a priority.

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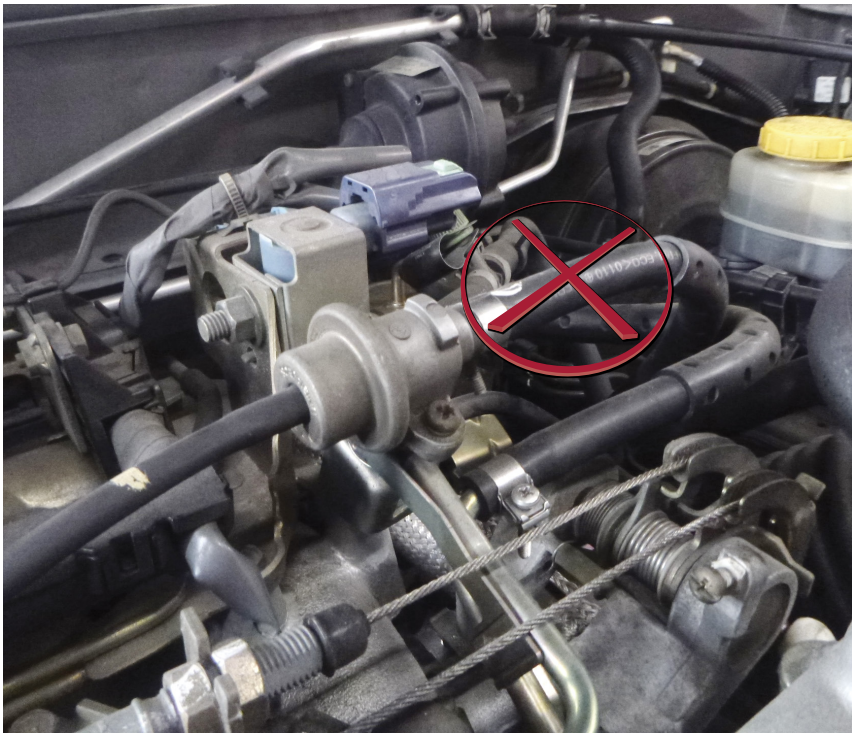
the fuel pressure. It works much the same way as the anti-hammer devices in your home plumbing system work. Some have suggested removing them as a preventive measure to prevent their eventual failure, and leakage. Don't do it. They help smooth the fuel pressure to the injectors, and removing them can cause everything from misfires to even some reports of fuel injector failures due the extra hammering stress.

On another safety note, fuel system leaks in the direct injected gasoline fuel system pose a much more serious danger for the technician servicing them. If a fuel leak is suspected, keep your hands away from the engine. The intense fuel pressure can not only cut you, it can literally inject fuel into and under your skin.



Making absolutely sure you connect to the pressure line and not the return line is step one in checking the fuel pressure. The hose connected to the pressure regulator is on top and easy to get to, and also the wrong one.

Recognizing a leak, besides the obvious smell of gasoline, might present as an extended cranking time when starting, or a slightly rough idle immediately on start-up. Fuel leaks are rare as Nissan designs this system to be safe, but ultimately your safety isn't an odds game. When in doubt, take the time to be sure.

Identifying a fuel delivery problem usually isn't all that tough. Leaks are smelly and a lack of fuel means the engine isn't running. Some of the more subtle issues might be something like an extended cranking time on cold soak start-up, or a loss of power under full throttle operation. A fuel pressure gauge will give you a solid start in which direction to look. When connecting a fuel pressure gauge look for the service port, a threaded connection that looks like a tire valve stem, and use that whenever possible.

Unfortunately, many Nissan vehicles don't have these easy connections. They will, however, have easily accessible hose connections. Keep in mind that a lot of Nissan systems in particular will have similar pressure and return hoses. Connecting to a return line will definitely lead you down the wrong path diagnostically speaking.

Take the example of a turn of the century Altima 2.4L. The fuel pressure regulator is right on top and easy to get to. That would be the return line to the fuel tank and connecting your gauge there won't help. Just below it is the pressure line. There are two easy ways to be sure you've got the right line. First, remember that if the pressure regulator is on the fuel rail it's on the return side. Second, spring type hose clamps are not used for high pressure fuel lines. If the connection is secured with an external hose clamp it will be held with a screw and make contact all the way around the hose.

Whenever you have a fuel pressure gauge connected, Nissan recommends checking the connections for leaks every 3 minutes when the engine or fuel pump are running. A good rule of thumb is to be diligent enough about fuel spills that you don't smell any fuel during your diagnostics. This may not be completely possible, but keep in mind, the stronger fuel you smell the more used to the smell you get, and thus the greater chance of missing a leak.

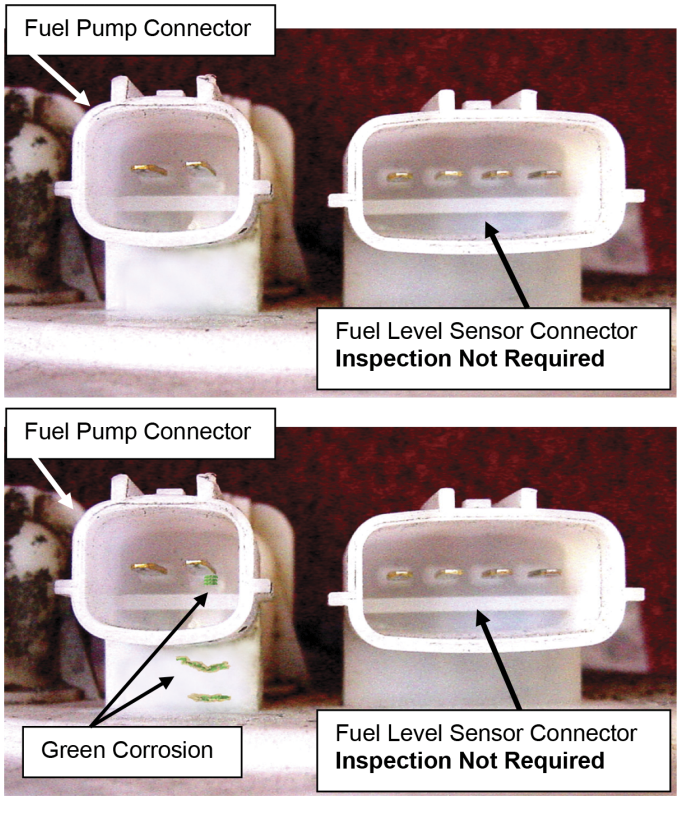
It also doesn't hurt to mention to a co-worker if you smell fuel walking past their bay. You never know, they may not be aware of it.

Fuel pressure can give your diagnosis a direction in many ways. An intermittent or "jumpy" pressure reading might indicate an empty fuel tank. As the tank runs dry, the fuel pump sucks air, causing the fuel pressure to change erratically. Just add a gallon of gas to confirm your hypothesis. Remember, the fuel gauge is not a bulletproof system. It doesn't have to be correct. Just because it's pointing at a quarter tank doesn't mean it can't be out of fuel. Poor grounds and corroded connections can alter the gauge readings. A gallon added to the tank takes a lot less time than pulling the tank down to verify.

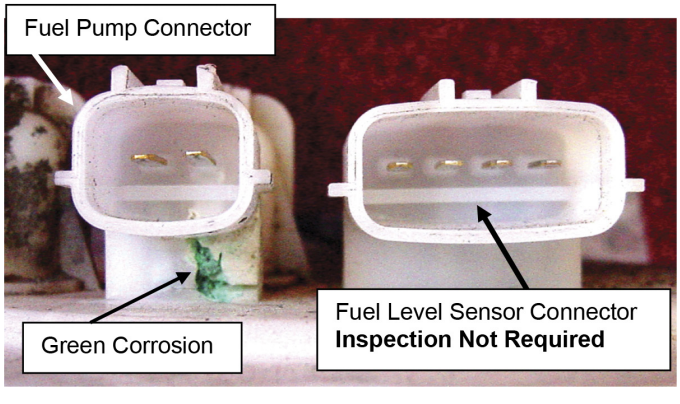
If you've decided to test for fuel pressure or return at the tank, there's no need to trace down the lines. The spring type clamp is used on the return and the screw type clamp is used on the pressure line.

When fuel pressure is simply absent, verify you have fuel pump operation. Can you hear the fuel pump come on when the key is turned to the On position? If not, verify power to the pump module. If you have power and ground to the pump and it's not coming on, you know the fuel pump module is coming out for inspection. One of the nice things about Nissan vehicles is that their fuel pumps very rarely fail. You will, however, find that certain models in certain climates can develop corrosion in the connections in the module, especially in climates that use salt on the roads.

Fuel pressure will often be at the center of an extended cranking situation on cold startup.

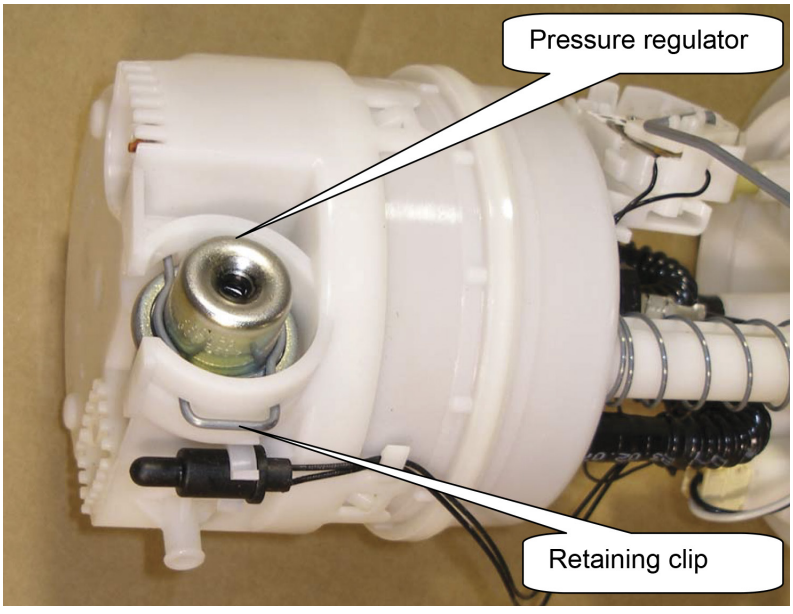



Any damage or corrosion in the fuel pump module means a replacement of the entire unit is called for. See TSB NTB04-062c in regard to 1999 to 2003 Frontiers and Xterras for the whole procedure and some helpful protectants to apply to prevent any future failures. (Top-Left: OK (No Green Corrosion), Bottom-Left: NG (With Green Corrosion), Bottom: NG (With Green Corrosion).)



Before the engine is started, the fuel pump will be activated for a few seconds to make sure the fuel pressure is at its peak when the engine cranks. This little bit of run time isn't enough to completely fill the fuel lines, it's only there to make the pressure right. If the fuel is allowed to bleed back out of the system overnight, that 3 second burst isn't enough to make the engine fire up in a timely manner.

The 2007 to 2009 Nissan Versa has a known issue with the original fuel pressure regulator in the tank (since this is a returnless system). TSB NTB07-094a gives a great description of how to test for and repair the issue. The test is simple enough. If the pressure drops lower than 29 psi after 30 minutes of engine shut down, the fuel pressure regulator has failed and is leaking down too much. There is a replacement available that isn't prone to the same failure. In other vehicles a little more diagnosis may be needed to confirm the regulator as the failure. Other possible causes might include a failed check valve in the fuel pump (in a return type system), an external fuel leak, or even a leaking fuel injector.



In the 2007 to 2009 Versa a failing fuel pressure regulator can lead to extended cranking times. The repair is installation of an improved pressure regulator that installs in less than an hour.

Unfortunately, many failures in the fuel delivery system will be in failures on the control side. From fuses to relays and even ECM issues, the electronic side of the fuel system can present a daunting diagnostic challenge.

Use the divide and conquer method by testing for power and ground at the fuel pump module first. With many Nissan cars and SUVs there is relatively easy access to the fuel pump module from the top under the back seat, or even in the trunk area thanks to cleverly installed inspection covers.

Checking for power supply at the fuel pump is relatively easy. Some exceptions to this are in the Frontiers and Titans. There are no access holes in the truck beds to get to the fuel pump. Typically, there are other connectors on these vehicles you can test at that don't require removing the tank. On the late 2000s Titan, for example, there is a connector in the chassis harness behind the right front mud flap on the frame. Simply check out the wiring diagram to confirm the wire colors for the fuel pump, back probe the connection and verify that the pump is getting power. This does leave one glaring possible failure point, and that's the wire harness between the connector on the frame and the connector at the tank. Simply test again when the fuel tank is down if a fuel pump problem is indicated.

Aside from the normal, mundane corroded connectors, small leaks, and failed regulators, take into consideration that basic maintenance and human error do get forgotten and do cause problems. Is the fuel in the tank actually fuel? Has the fuel filter been changed, ever? Does this model even have a fuel filter?

With the increase in technology, external fuel filters are becoming a thing of the past. Unfortunately, that leads many technicians to forget that some cars have them and they do get plugged. Also, people putting bad gas and fluids classified as "other" into their fuel tanks is still happening. Water, diesel fuel, and various other fluids will still pour down the filler neck, so don't forget to check a fuel sample.

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# Making the Cut

## Nissan Sectioning Repair Tips

The determination as to which structural components are permitted to be sectioned differs among different Nissan models. Dig into the Nissan Body Repair Manual for accurate, current and model-specific sectioning procedures.

Collision impact force propagates throughout the vehicle, creating a combination of visible and hidden damage. This may include some or all of the following: bending, twisting, crushing, sagging and side-sway.

When a structural component is out of specification in any of three dimensions: vertical, lateral (sideways), and longitudinal (front-to-back), you have only two options.

## Sectioning, or full assembly replacement?

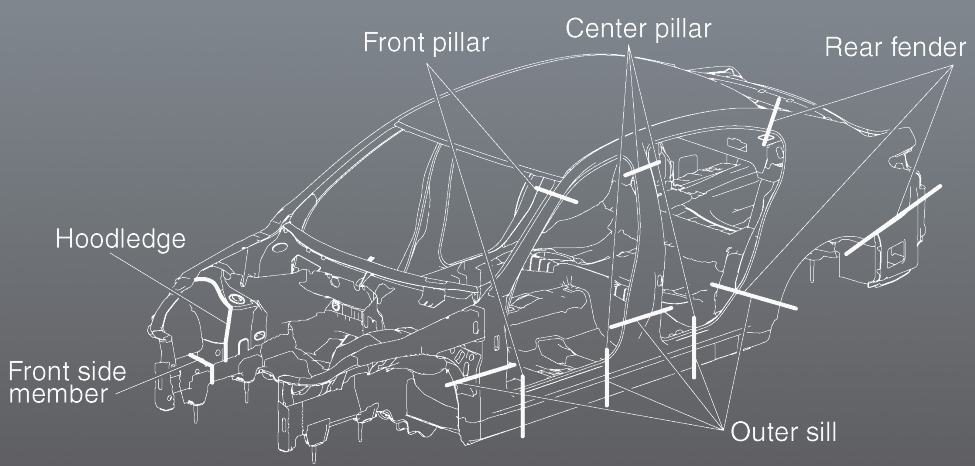
1. Assembly panel replacement – Cut out the assembly at the factory welds and replace the complete panel.
2. Partial panel replacement (sectioning) -- Replace only the damaged parts. Cut and replace part of the panel if full assembly replacement is very labor-intensive and costly, and only when damage is confined to a portion of the part.

Sectioning of structural components is permitted in a limited number of areas and only in specific locations. The determination as to which components and which areas can be sectioned varies based on body structure, material strength, part shape and other factors affecting how the vehicle responds to collision impact.

Body pillars, frame rails and other structural components may be sectionable on one Nissan model but not another. Where partial repair is permitted, the Body Repair Manual for that year and model shows the cut location (or area) measured from a reference point specified on the component.

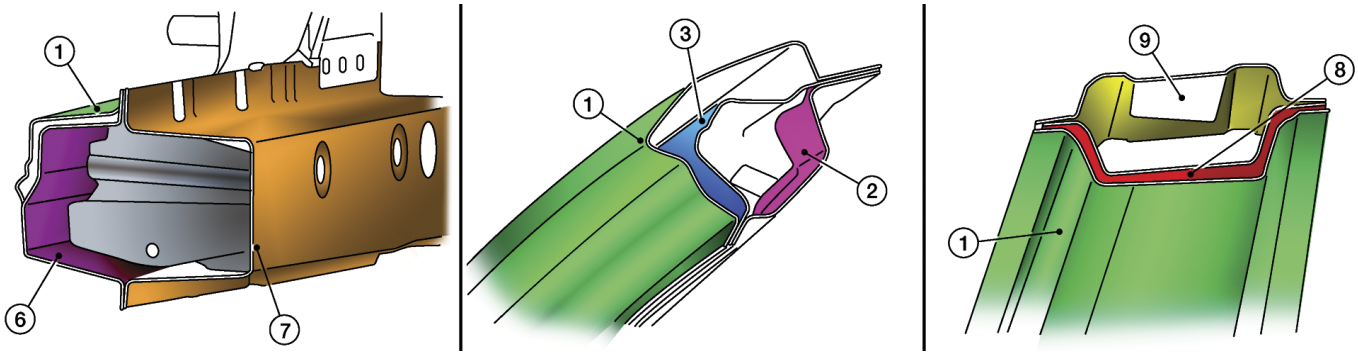
## Plan benefits

Planning your repair based on knowledge of which parts can be sectioned and which will be replaced as a complete assembly is invaluable. It helps you write an accurate estimate, develop a more thorough parts ordering list, improve cycle time, and restore the vehicle to its pre-accident condition.




The sectioning locations marked on this image are general suggestions only. Partial repair of key structural components may or may not be allowed depending on the vehicle model's body structure, the component's material type and strength, the part's shape and internal structure (ducting, complex support, or baffles, etc.), and other factors.

Left: Restoring the shapely lines of the beautiful Nissan GT-R requires knowledge of which collision-damaged components can or cannot be sectioned.




These images show how various structural components on one Nissan model – the 2017 Murano – feature significantly different multilayer construction that affects which parts can be sectioned. The image on the left is a portion of the sill below the B-pillar. It shows the body side outer panel (1), and the inner sill (7), both of which are regular steel and can be sectioned, and the outer sill reinforcement (6), which is 980 mPa UHSS and cannot be cut. The center image is of a portion of the upper front pillar. It shows the body side outer panel (1), the upper front pillar reinforcement (3), and the upper front pillar inner plate (2). The reinforcement cannot be sectioned. The image on the right is of the upper portion of the center B-pillar. It shows the body side outer panel (1), the center B-pillar reinforcement, and the center pillar inner (9). Both the center pillar inner and the center pillar reinforcement on the 2017 Murano feature 980 mPa UHSS and thus cannot be sectioned. (Color added for reference only; may not be to scale.)

## Multilayer construction

Many Nissan structural assemblies contain multiple layers of plates, with different material composition and performance objectives determining which can or cannot be sectioned. A typical structural assembly may have an outer plate that is regular steel that can be sectioned, and a reinforcement that is UHSS and cannot. Structural assemblies designed to handle high stress loads may include multiple layers of reinforcement and permit sectioning of some plates but not all.

## Why some parts cannot be sectioned

A few things that make sectioning less likely to be allowed for a given panel include:

1. The component contains reinforcement made of UHSS. The high-strength material loses a significant amount of its impact resistance at the point where it is cut and welded back together.
2. The part contains internal ducting or baffles. Complex internal structures are impossible to restore to full strength after being cut.
3. Damage occurred in an area that is part of a crumple zone, or that must absorb a high amount of impact force to prevent it from passing into another component. If the concentration of stress is more likely to overwhelm a welded joint than a solid panel, the component should not be sectioned in that area.

Complete assembly replacement is undesirable. If removal and replacement of the complete component requires excessive labor time, sectioning may be recommended. Additional reinforcement of the new joint may also be specified.

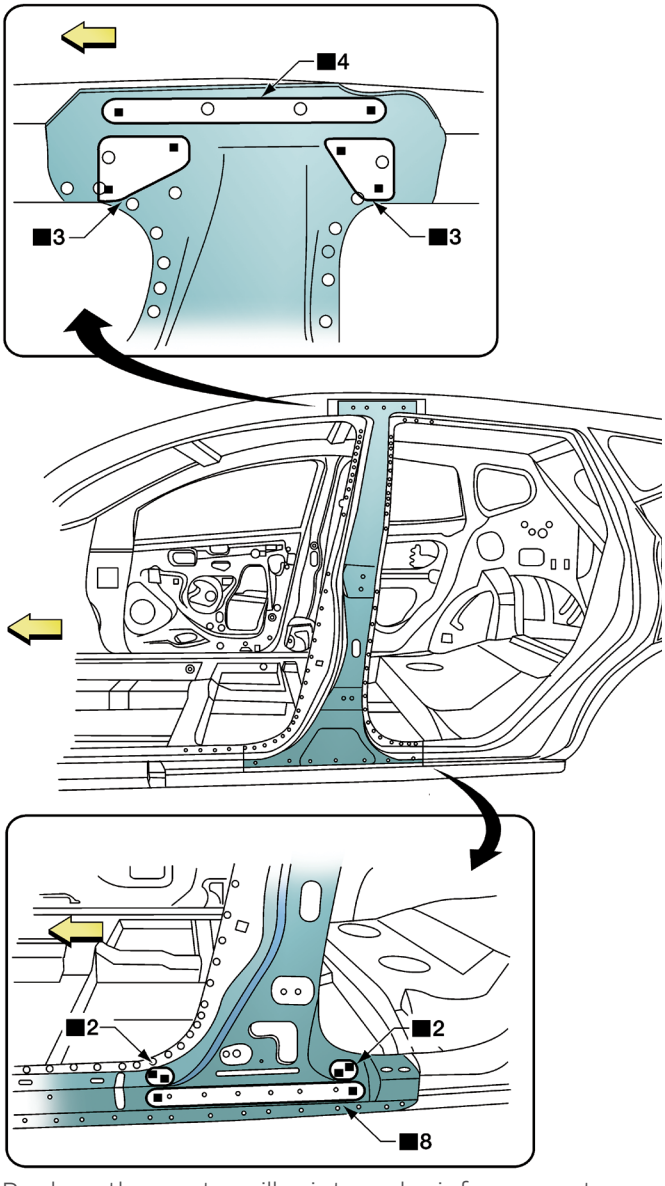
Sectioning that is allowed for a part on one model may not be permitted for the same component on another Nissan. The front pillar reinforcement on one model may be made of UHSS, while on another model it may be made of a traditional steel that can be sectioned.

The model year also affects whether partial repair is an option for an assembly or plate. A structural component of a newer vehicle may be made of UHSS, while that part on an older version of the same Nissan model may be constructed of traditional steel and is permitted to be sectioned.

## Strength and sectioning

The strength of steel is measured in megaPascals (mPa). High strength steel is used extensively in automotive bodies and ranges from 440 mPa to 979 mPa. Ultra high strength steel is used in many vehicle structural components and rates from 980 mPa and up.

Use of heat on UHSS structural parts is not recommended as it may reduce the component's crash resistance. Nissan requires replacement rather than partial repair for key structural components such as side member and center pillar reinforcements. Even if repair is permitted for the component, do not heat HSS or UHSS parts above 550 degrees C (1,022 degrees F). Temperatures above 550 degrees C alter the configuration of atoms in the steel and weaken the component.



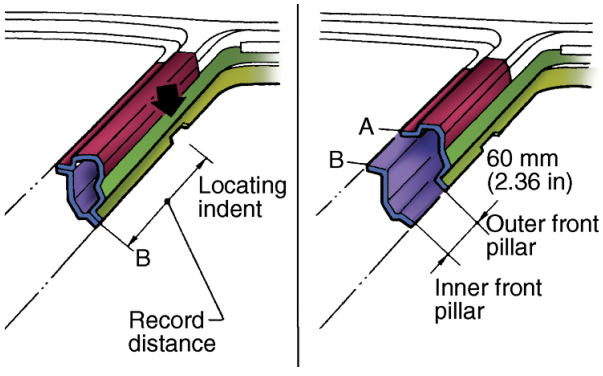

Replace the center pillar internal reinforcement as a complete assembly on the 2017 Murano (or other Nissan models). It is made of 980 mPa UHSS and loses strength if repaired by the heat of welding. (Color added for reference only; may not be to scale.)

Cutting and re-joining parts made of UHSS (980 mPa or higher) create a new part that may be weaker than the component it replaces. Even if it is comparable in strength to the original component it may, in a collision, not offer the crumple zone performance specified by Nissan engineers. If a structural part or reinforcement made of UHSS is damaged, replace the part.

The "Fundamentals" section of the BRM includes charts that show the tensile strength of structural components, whether they contain aluminum, and other factors affecting which repair methods best apply. Check there if in doubt about whether or not a part is UHSS, HSS, or made of a material that cannot be sectioned or partially repaired.

## Locating the cut

If sectioning is permitted for a given component, the Body Repair Manual specifies an area on the part where you can section and re-join it to the vehicle. The area may be narrowly defined so as to avoid reinforcements or other internal supports having complex angles or baffles. The specification may locate a sectioning cut in a place where it has the least impact on the crumple zone performance of the

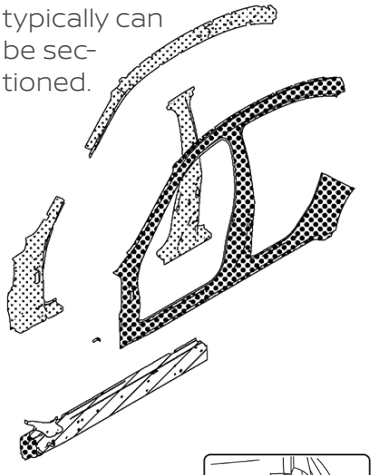



This image shows hypothetical cut locations for a front pillar on a model for which Nissan permits sectioning. Refer to the Body Repair Manual to get model-specific cut point locations. Write down the distance from a locating indent on the component. Cut this same distance from the locating indent on the replacement part. In this example, offset the cut to the outer plate 60 mm (2.36 inches) above where you will cut the inner panel. This creates a stronger joint than if you make both cuts in the same location on the component. (Color added for reference only; may not be to scale.)

repaired component. It may also be positioned or restricted in size so it reduces the possibility of heat damage or spot welding stress affecting nearby components.

Body construction and materials can differ from model to model and change for the same model over time. Thus the same component on different vehicles may differ on whether or not it can be sectioned. Refer to the Body Repair Manual for the vehicle year and model and follow its specifications to the letter.

Cutting UHSS and HSS panels with a torch (gas) is not recommended, as the heat will weaken areas surrounding the cut. Use a saw instead. If torch cutting is the only option (due perhaps to a restricted access location), allow a minimum of 50 mm (1.97 inches) margin around the cut line.

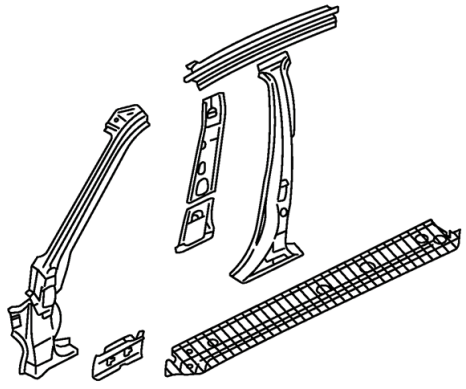


The integral type outer body service panel features a one-piece outer skin that is often made of traditional steel and typically can be sectioned.

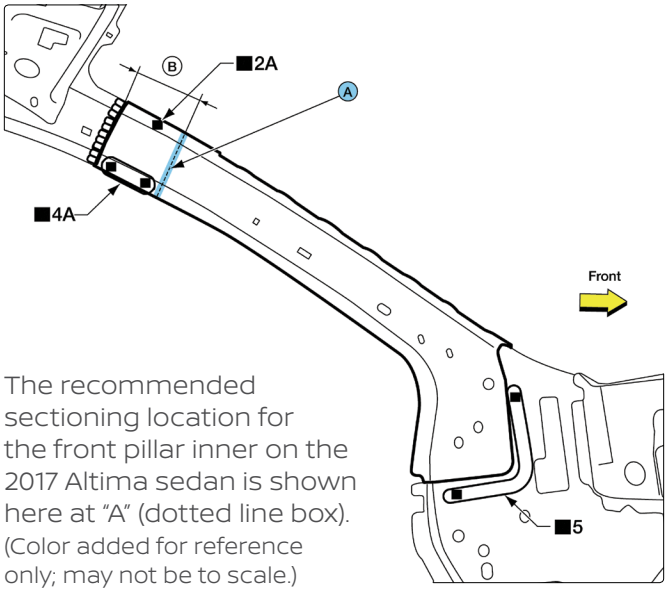
## Service panel sectioning

Nissan offers two types of outer body side assemblies as service panels for use in collision repair. One is an integral type comprised of a one-piece outer panel plus smaller, separate reinforcement plates that together form an inner support structure. The second is a separate type in which the outer panel consists of a series of individual parts that join together to form a whole.

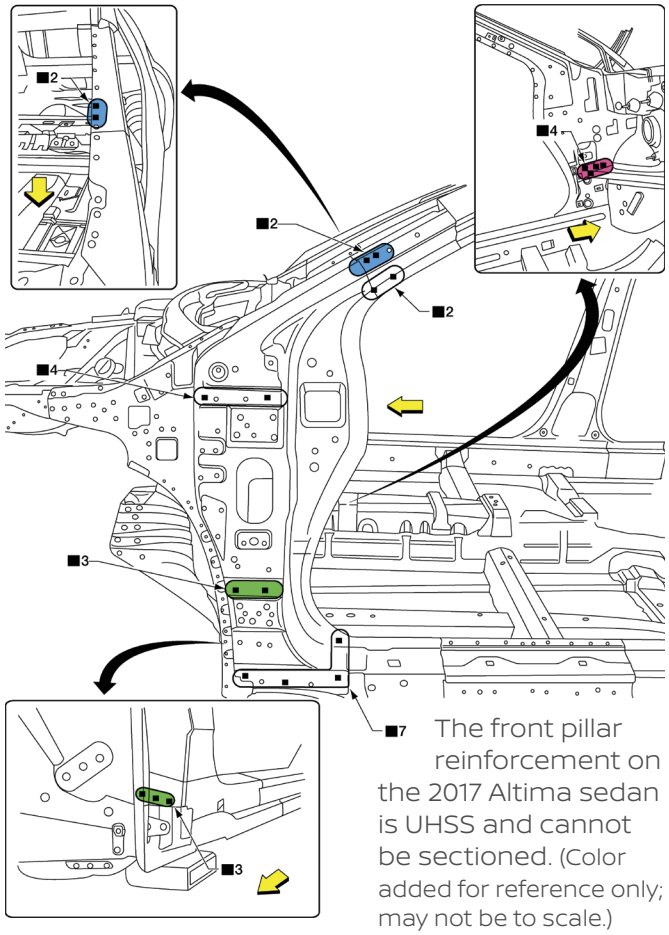
In either the integral or separate type, various components may be made of different materials or material strengths in mPa. Nissan may permit



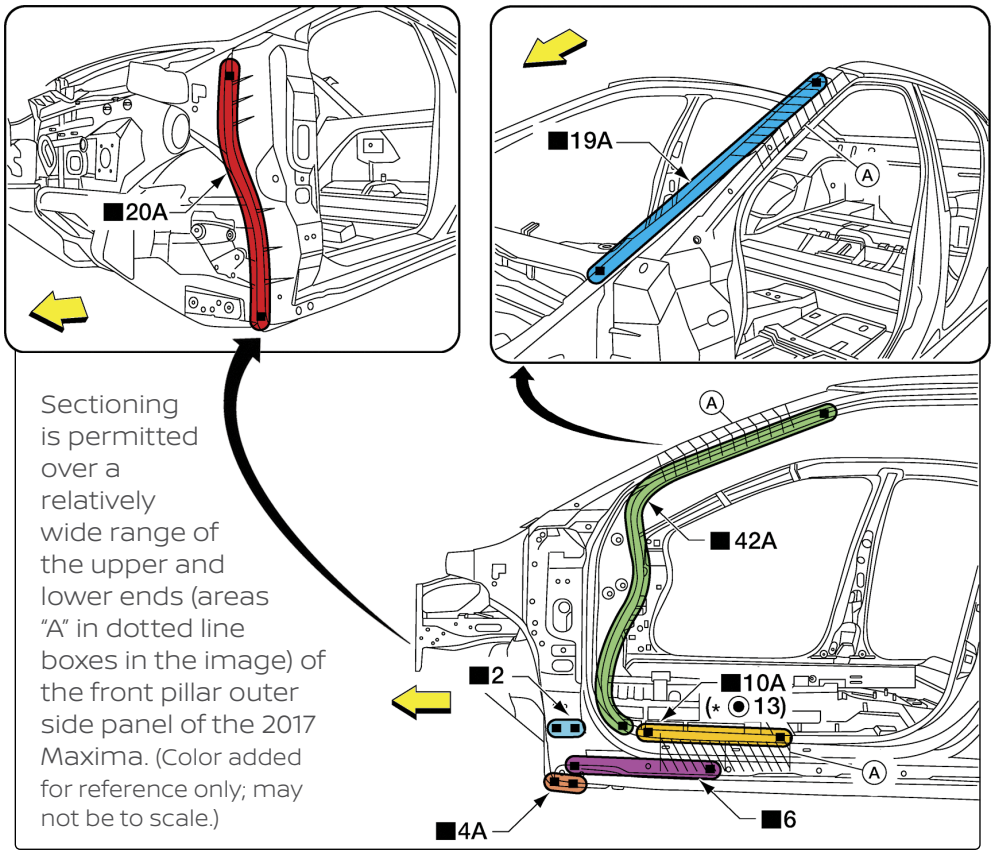
Nissan offers the separate type outer body service panel as an assembly of individual components which can be purchased together or separately.



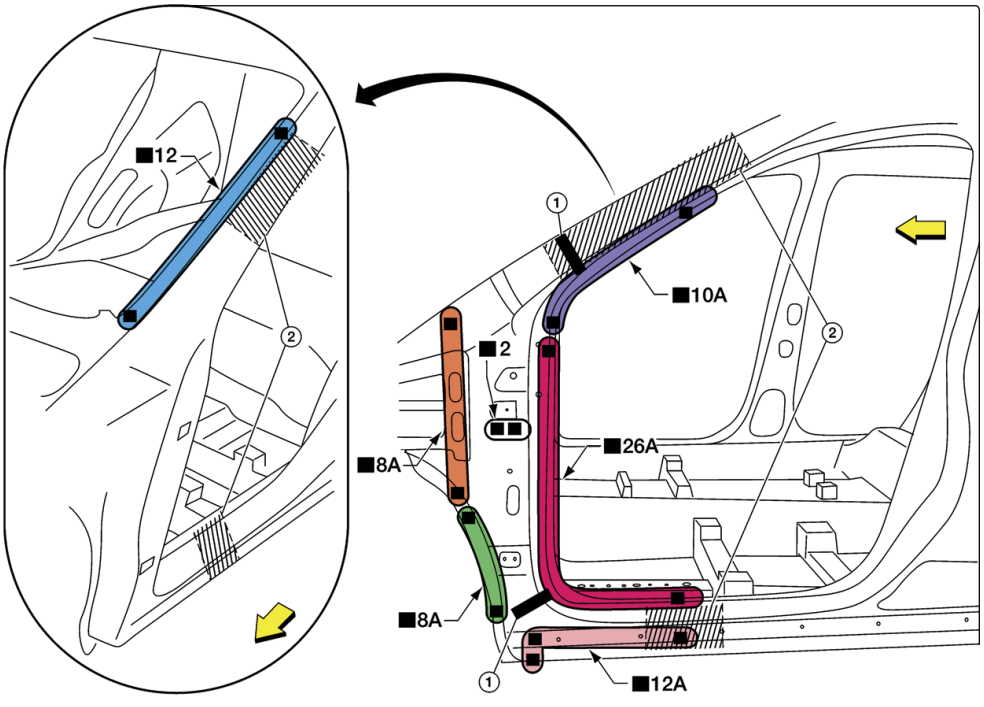

The recommended sectioning location for the front pillar inner on the 2017 Altima sedan is shown here at "A" (dotted line box). (Color added for reference only; may not be to scale.)




The front pillar reinforcement on the 2017 Altima sedan is UHSS and cannot be sectioned. (Color added for reference only; may not be to scale.)




Sectioning is permitted over a relatively wide range of the upper and lower ends (areas "A" in dotted line boxes in the image) of the front pillar outer side panel of the 2017 Maxima. (Color added for reference only; may not be to scale.)




The outer panel of the front pillar on the 2017 Nissan Rogue can be sectioned at the upper and lower ends (encircled "2" in the diagram). Urethane foam (encircled "1" in the diagram) is placed between the Rogue front pillar's inner reinforcement, which you cannot section, and the outer panel, which can be sectioned. (Color added for reference only; may not be to scale.)

sectioning of individual components from each outer body side assembly type if they are below 440 megaPascals (mPa). Always refer to the Body Repair Manual for procedures and specifications that are applicable to the vehicle model and year that you are repairing.

## What's in a name?

The front pillar on a 2017 Altima sedan has at least two support plates: one called a "reinforcement" and the other labeled "front pillar inner." The reinforcement cannot be sectioned, while the pillar inner can.

TIP: In at least one location in the BRM, the instruction refers to the front pillar inner as an "inner reinforcement." Check the BRM section entitled "Fundamentals" to confirm that you are looking at the correct part. This applies to any Nissan model for which you need clarification of structural part names. The Fundamentals section for each model includes a list of body component parts. It shows illustrations of each key structural part, with the correct name next to each part number.

## Similar assembly, different cars

Never assume that because a part on one vehicle looks similar to

one on another model, it can be repaired in the same manner. For example, the front pillar areas of the 2017 Nissan Maxima, Murano and Rogue do not have the same sectioning options.

## MIG plug welding or spot welds?

The Body Repair Manual often specifies MIG plug welding to replace factory spot welds, but that is the last resort when access is only available on one side of the joint. Although not explicitly stated in the manual, Nissan prefers the use of spot welding instead wherever two-sided access to the joint or flange is possible. Spot welding minimizes the spread of heat beyond the immediate weld location, reducing the chance of weakening surrounding areas.

Use resistance spot welding instead of plug, seam, or torch welding for HSS or UHSS panels. Do not use gas (acetylene torch) welding as it creates a lower strength weld joint.

Note that spot welds on HSS and UHSS parts are harder than those of regular steel panels. When cutting spot welds out of a HSS or UHSS panel, use a low speed high torque drill (1,000- 1,200 rpm) to make cutting easier and help drill bits last longer.

Normal MIG welding is good for use on plate thickness of 2 mm (0.079 inch) or more. Additional types of MIG welding more appropriate for use on thinner plate thicknesses include short arc and pulse welding. Short arc welding requires less heat than the regular MIG process and is thus good for use on plate thicknesses as thin as 1 mm (0.04 inch). Pulsed Arc welding features a low pulse waveform that creates a stable weld puddle penetration and bead shape while maintaining a low heat profile. Pulse welding makes it easier to create finely detailed weld bead patterns.

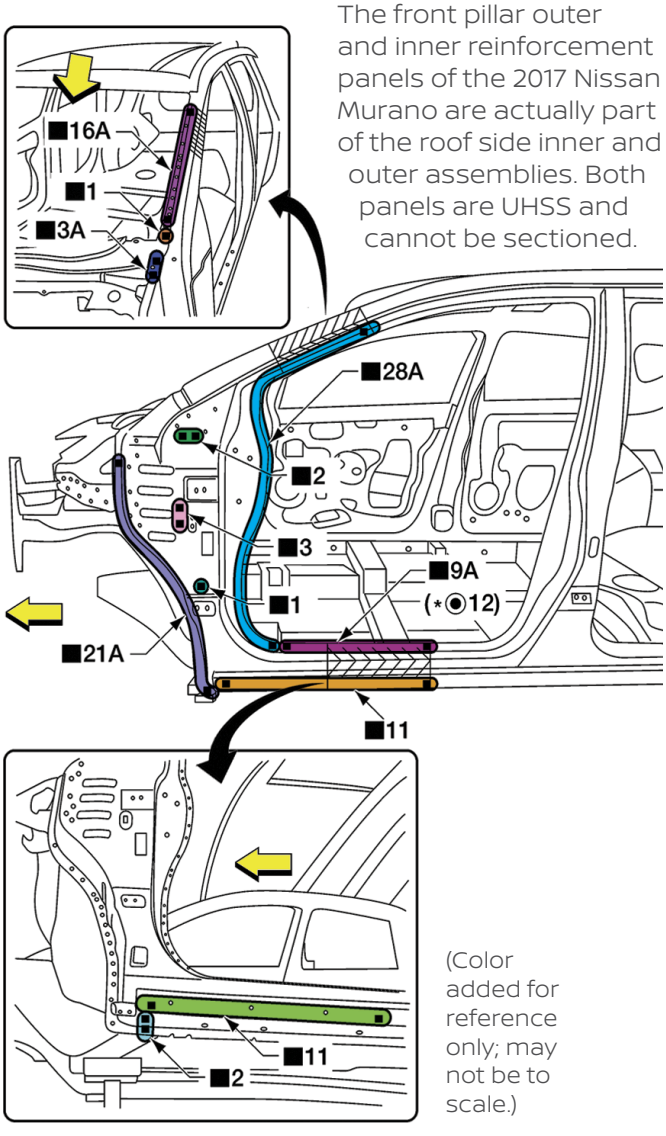
Combine the thicknesses of the two upper panels to use as the upper panel thickness when calculating the plug hole diameter, current, and voltage (or using a lookup chart) for MIG plug welding a three-plate joint.

Tack weld the joint at approximately 10 mm (0.39 inch) intervals to hold it securely until you complete the butt weld. NOTE: Remove aluminum oxides and magnesium oxides generated at tack weld locations. Not doing so before you start the butt weld results in a weak joint.

## Planned success

As you develop your repair plan you must research the vehicle construction and identify which damaged assemblies have subcomponents made of materials that cannot be cut without reducing their strength or intended crumple zone performance.

Always check the Body Repair Manual for the Nissan model you are repairing to determine which damaged components can be sectioned and which must be replaced as a complete assembly. Having this information at the blueprinting stage helps ensure not only a safe repair, but also helps you develop an accurate estimate, order the correct parts, and improve cycle time.



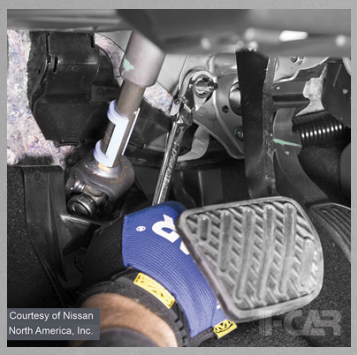

The front pillar outer and inner reinforcement panels of the 2017 Nissan Murano are actually part of the roof side inner and outer assemblies. Both panels are UHSS and cannot be sectioned.

(Color added for reference only; may not be to scale.)

# Nissan LEAF® Collision Repair Training from I-CAR®

Take the Nissan LEAF® Technologies & Repair Considerations class from I-CAR to learn about sectioning structural components, working with ultra high strength steel, repairing Advanced Driver Assistance Systems, and more.

The 2018 LEAF features a variety of different steel types including Ultra High Strength Steel (UHSS) for collision energy management and ultimate occupant protection. The Nissan LEAF Technologies & Repair Considerations class (course #NI007E01) from I-CAR goes beyond part sectioning and replacement considerations. It covers safety precautions when working around the LEAF's high-voltage batteries, wiring, and power management systems, and the disconnect steps you'll use to protect yourself and sensitive electronics.




The Nissan LEAF features the e-Pedal, allowing drivers to control both acceleration and braking systems using only the accelerator pedal when activated. The class reviews its functions and repair considerations.


If removed or replaced, you must calibrate the Intelligent Cruise Control Distance Sensor (mounted in the front grille) after installation.

Nissan recommends using the OEM scan tool CONSULT III Plus to perform pre- and post-repair diagnostic scans and calibrations.

The course explains how to read Nissan repair diagrams to learn what you can or cannot section, how to sequence welding steps for assemblies with multiple components, and whether a plug weld or spot weld is appropriate. The class also explains camera aiming, sensor calibration, and other post-repair procedures that are required to reset the LEAF's many Advanced Driver Assist System (ADAS) technologies.

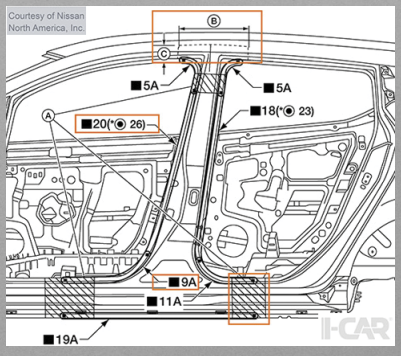
The class lists which components cannot be heated, straightened, or repaired. You'll learn the symbols that indicate which parts to section as well as where to cut.

You'll learn Nissan codes that differentiate between a spot weld and plug weld; how to tell the number of layers or plates in a joint; how many welds to make for a given component or assembly; and symbols for other collision repair procedures or parts.

If you remove a camera or any related part, including windshield glass, front grille, door mirror, mounting brackets, or other hardware, you must perform a calibration, also called a camera-aiming adjustment. If you replace the camera itself, conduct a read and write configuration to ensure that it can accept instructions from, and send data to, the control module. You'll need Nissan's CONSULT III Plus to perform any calibration or read and write configuration.

The I-CAR LEAF class helps repair professionals understand and interpret the service manual, such as by providing video instruction on performing a post-repair calibration of the Distance Sensor for Intelligent Cruise Control® (ICC). The video shows detailed steps for positioning and setup of the front and rear targets, mounting and aligning the laser measuring assembly, and confirming that measured values are within specified ranges.

If the ICC calibration fails, a Nissan Service Manual troubleshooting chart offers assistance. By showing possible causes from that ICC calibration failure chart, and what service procedures resolve each different problem, the I-CAR class helps teach you to diagnose common problems. This class demonstrates Nissan's commitment to providing training on the latest vehicles and their technologies to ensure safe and proper repairs back to manufacturer specifications.




The class walks you through locating the appropriate placement and number of spot and/or plug welds in the service manual. The red highlighted box pointing to the vertical center of the pillar indicates that this area requires either 20 plug welds or 26 spot welds. If the flange is accessible from both sides, Nissan prefers spot welds to limit heating this UHSS component.

# Starting with the Starter

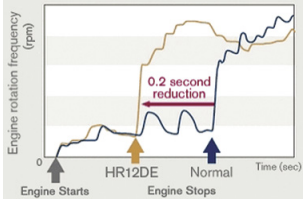
Step one; start the engine and allow to idle... It won't start? Now it's time to start with step zero, starting with the starter. From batteries to connectors, through the corridors of the battery cables and even the ever-controlling ECM, starter diagnosis isn't the same old procedure it used to be. It now requires more advanced diagnostics and a few cool new tricks. Let's take a look at modern and classic starting circuit diagnostics.

It seems like such a simple task to accomplish; make a switch turn on a motor to get that engine cranking. For most of our automotive history that's pretty much all that was involved. A switch to turn the power on to a high amperage DC electric motor to make the engine crank. The driver would completely control the duration of the starter operation and could almost supernaturally feel when the engine was supposed to start and surely notice when it didn't start exactly when it should.

With simplicity of control comes room for error. An extra-long cranking time would inevitably devolve into a ritualistic dance of mashing the accelerator pedal and praying over the steering wheel. And if the engine starts, then any possible problems are quickly forgotten.

Fast forward to today. With the simple push of a button, all judgment is removed from the driver's consideration. There is no question. If the engine doesn't start, something has gone horribly wrong.

It's this kind of advancement that acts as a double-edged sword. The old way of turning the engine over was so simple to understand and diagnose that even the weekend shop hand could have a go at it and probably find the solution in short order.




Saving gas using idle stop technology has to be without inconvenience, and that means getting the engine started faster. With the Nissan HR12DE 3-cylinder engine that means half the cranking time.

Opposite Page: The automotive industry is changing the paradigm. Turning a big old heavy key is way too much effort these days. Pushing a button? Now that's an easy way to start a car. What could possibly go wrong?

Starter circuits didn't change from the first Datsuns imported to the US in the 1950s until the mid-2000s. Basically there is a keyed switch powering a relay powering the starter. Add in a park/neutral switch or clutch pedal switch for safety and that's about it.

With the advancements in push button starting, hybrid technology, anti-theft systems, and automatic idling-stop systems, diagnostics will take much more knowledge and, most likely, an advanced scan tool. We now have to consider components like the brake pedal switch, body control module, integrated power control module, steering column, anti-theft system, and even the key fob. Now nearly all types of failures in the old system are still possible in the new systems, with the addition of many new ways for the system to fail. On the other hand, Nissan has made massive strides in improving the designs of the systems so that problems are much less likely than ever before.

One of the more interesting developments is idling stop technology. Simply put, this system kills the engine when you don't need it at a red light. The idea is that the engine won't use fuel if it isn't running. There is a trade-off in that the engine will have to be started many more times in an average commute, adding more wear and tear to the starter and engine.

To compensate, Nissan has improved the durability of the starters and made the engine bearings more durable against startup damage. Another consideration is that the system can't be obnoxious. When the green light comes on the car needs to move seamlessly. To that end, engineers have reduced starting time dramatically. When the brake pedal is released the engine will crank in less than half a second and start as quickly as 0.2 seconds in the case of the new Nissan 3-cylinder engine, the HR12DE. That's roughly translated into less time than it takes to get your foot from the brake to the accelerator. Of course, this system is

almost completely computer controlled with the exception of a driver override option, making it an effective feature without being obtrusive.

In the push button ignition system, one issue that can really get you scratching your head is when you push the start button, and nothing happens. The first instinct is to inspect the starting circuit and battery, or even popping the button out of the dash to test it, all because we assume the system functions the same as an ignition switch.

The button, however, is simply an input device. The failure is almost always in how the BCM responds to the button press and what other factors it's taking into consideration before energizing the ignition and starter. Paying attention to what happens on the dash can give you the first clue to a possible answer. If the display continues to indicate, you should press the brake pedal to start the car and if your foot is firmly on the brake pedal we now have a different symptom to diagnose.

In the 2007 to 2010 Nissan Altima there is a known failure in the stop light switch that prevents the BCM from recognizing the brake pedal position. In such cases a TSB and installation of an improved switch design can resolve the issue. Most any model with a push button ignition can have switch failure cause a no-cranking condition. You can confirm the brake signal is getting to the BCM with a scanner and data stream to be certain, but simply verifying that the brake lights work may give you your answer faster.

Another failure we are seeing with the push button start is in a safety feature that can sometimes malfunction. With the removal of the actual ignition key we also removed the ability to mechanically lock the steering wheel. An electronically controlled locking mechanism in the steering column was adopted to fill the gap. Since this system is integral in the ignition system, a failure in the lock mechanism or steering column control module can cause a no-crank condition.

In this case the steering lock position is not correctly relayed to the BCM and IPDM, so it defaults to an off or locked position. Often this will be accompanied by erratic steering column lock functionality. In such instances you can tell the lock is partially engaged but it's not really locked all that well.

Although the steering column lock module can fail on its own, aftermarket devices (for remote start, alarms and such) connected to the system have been known to cause these kinds of failures. Diagnosis for this condition is going to start with a Consult III Plus or other scanner that can communicate with the BCM when the ignition is off. Stored codes for steering lock failures are likely going to point you right to the problem.

Several systems all have to work together, each doing their part to get the engine to crank when it's supposed to. In early systems the ignition switch would send voltage through a neutral safety switch or clutch pedal position switch, then power the starter solenoid and the engine would crank. With the introduction of the relay, the system gets a little more advanced in that we now have multiple conditions that have to be met for the starter to engage.


Although not labeled very clearly, this is the main relay connection for the starter. The center pin, number 7, is the direct line to the starter solenoid. Applying battery positive to this terminal will activate the starter and verify that this half of the circuit is working.

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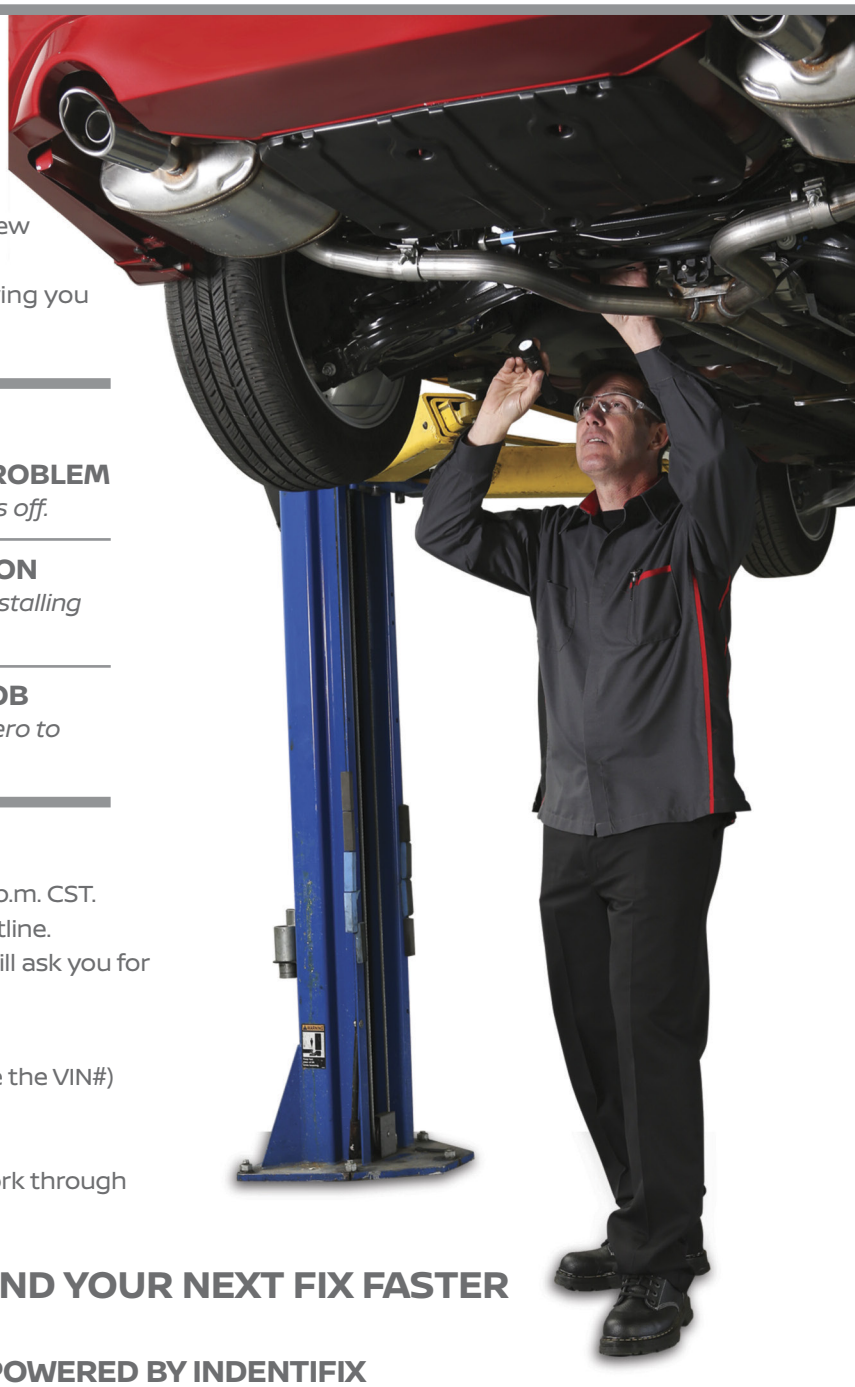

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A Nissan Repair Specialist will call you back to work through your issue.

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### NISSAN INSTALLER REPAIR HOTLINE POWERED BY INDENTIFIX

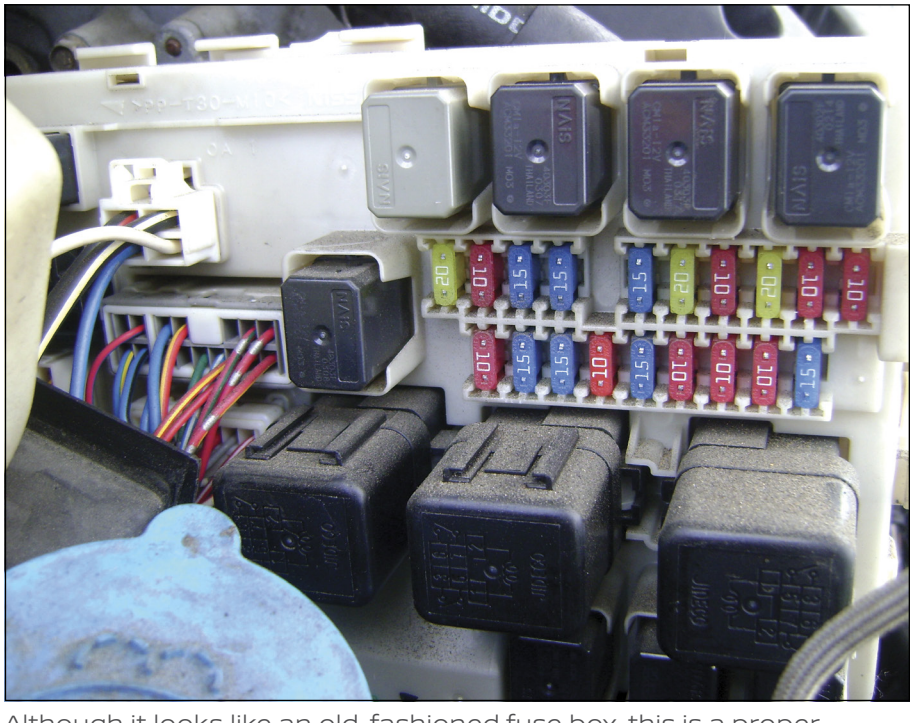
Let's take the example of the 2000 Nissan Maxima. A relay labeled as the "park/neutral position relay" in the wiring diagram (Inhibit/ clutch interlock in the relay box) is the main control relay for the starter. Neither the relay, nor the signals to it, are computer controlled with the exception of the anti-theft module supplying battery positive to the control side of the relay.

In a much appreciated move, Nissan engineers designed the relay with the actual wiring diagram printed right on the relay. What's more, it's actually labeled with the same pin identification numbers as the service manual wiring diagram. Following the wiring diagram, you can quickly identify which signal is missing to get the starter to engage. For example, pin 7 is the direct wire for the starter solenoid. By applying battery voltage to this pin, the starter should engage (making sure the transmission is in Park or Neutral of course). In one step, and with minimal labor, you've eliminated half the possible causes of your no-crank condition and you're in the right place to test the other half.


This is a prime example of why to use genuine Nissan replacement parts. The relay has an accurate diagram imprinted right on the unit with numbers that match the service manual wiring diagram, and each pin on the bottom of the relay is clearly marked. This is a great example of "Testing made easy" by Nissan.

Moving forward in the generations, the starter circuit gets much more involved. Each control module has its own function in the starting process. The BCM sends the signal to the IPDM to activate the starter relay, the TCM sends the signal to the BCM that the transmission is in Park/Neutral, the IPDM directs the power through the starter relay to the solenoid, and the solenoid on the starter supplies the motor with current to crank the engine.

More advanced systems work on basically the same principle, with added modules sending information to the IPDM and BCM until all the signals needed are present. This is how we end up with a failing brake light switch

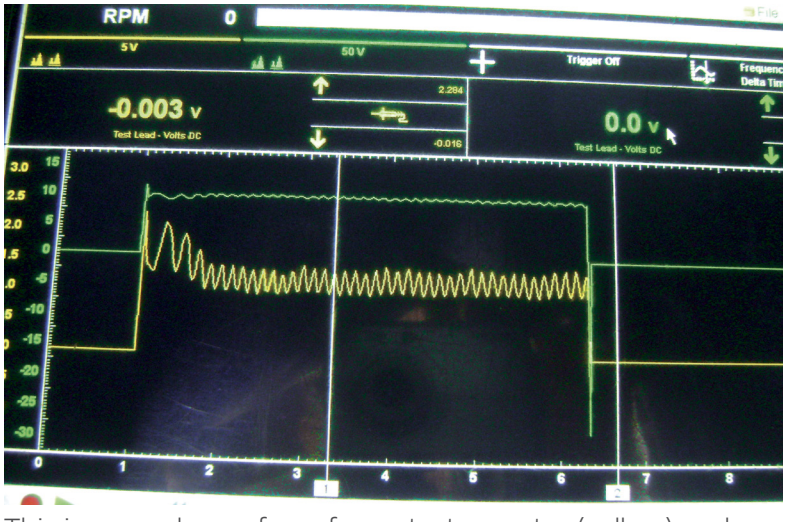


Although it looks like an old-fashioned fuse box, this is a proper control module. After receiving the command from the BCM, the IPDM (Intelligent Power Distribution Module) is responsible for sending power to the starter solenoid. Use caution when testing, as any shorted circuit could lead to a costly repair.

preventing the starter from cranking. The major benefit to the system working this way is that we can communicate with the BCM and determine exactly what signal is missing.

On the engine side of the IPDM or relay box a whole other set of safety precautions should be taken with any starting system diagnosis. The amount of torque and amperage going through these starters is astounding. With modern gear reduction starters, 90 amps on a no-load bench test is normal. Even the tiny 1.8L Sentra starter without gear reduction can still draw over 50 amps, and that's not even counting the drag of the engine and start up amperage. That's also enough amperage to melt an 18 AWG wire and open the fuse in your multimeter instantly if testing is not conducted properly.

When the shop manual says "disconnect the negative battery cable," it's not kidding. The main power supply cable from the battery to the starter is not protected by a fuse and is capable of delivering enough power to really hurt you, melt the cables, or weld a wrench to a body panel. Testing amperage is very useful and should be done with an inductive amp probe only. Checking the integrity of the starter amperage waveform with a graphing multimeter can identify failing windings by an erratic "hairy" pattern even when the starter sounds like it's working well.



This is a good waveform for a starter motor (yellow) and solenoid (green). Each peak represents a single cylinder on its compression stroke.

The same caution must be considered when addressing a dead battery. If time permits you should always charge the battery separately as opposed to jump starting or boosting a battery just to get the vehicle running. In some vehicles, especially hybrids, the 12 volt battery is the AGM type (Absorbed Glass Mat). Nissan recommends that AGM batteries only be slow charged. Because jump starting vehicles is relatively common it is sometimes not given the cautious attention it deserves. Accidentally connecting a booster battery (or worse another vehicle) backwards, even for an instant, can cause devastating damage to the electrical system, fuses, fusible links and even damage various control modules, especially the intelligent power distribution module.

Jump starting hybrids isn't all that different than on non-hybrids, and can be even easier and safer in a lot of cases. Take the Nissan Altima hybrid for example. The 12 volt battery is under the trim panel in the trunk of the car. Fortunately, there is a connection under the hood that can be accessed without the added risk of hydrogen gas built up by a nearby charging battery. If you're not sure about the connections, stop and look it up. The approved jump-starting connections are easy to find in the service manual and also in the owner's manual. Just remember, in any hybrid, orange marked cables are off limits. Don't touch them.

Don't forget to keep it simple to start with. The noise you hear when you turn the key should give you a pretty good idea where you need to look. If you hear a rapid ticking coming from the engine you need to start by checking for adequate voltage at the battery and starter. You should expect somewhere around 10 volts while cranking and higher than 12 volts when not cranking. In particularly cold climates not only are battery failures commonplace, but so is corrosion on the battery connections and ground points, either of which can keep a starter from cranking.

After the battery is confirmed adequate with a load test, a good test to

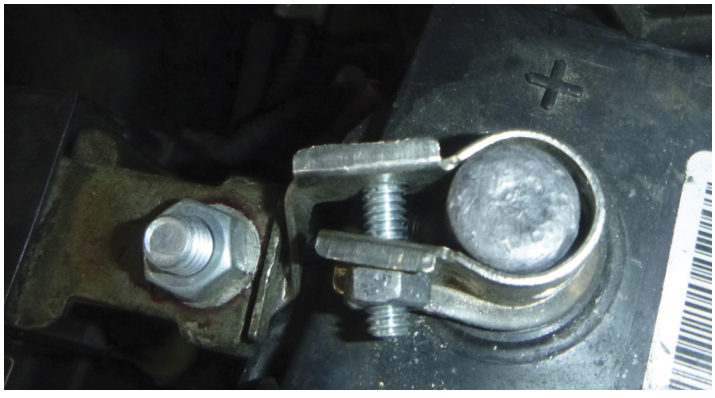
verify that your battery cables and connections are good is called a voltage drop test. Connect a multimeter negative lead to the starter end of the battery cable and connect the positive end to the positive battery terminal, then crank the engine and watch for a reading of less than 0.5 volts. Any more and you know you have excess resistance in the wire. Then repeat the same test for the ground side. Resistance can hide in wires and connections that look good.

Once the power supply and cables are confirmed, take a moment to make sure the engine will actually turn over by hand. Replacing a starter only to find out the engine is seized is not a mistake you want to make. If you have access to test the starter directly with a power probe, energize the solenoid with battery voltage. If there is still no cranking, it's time to take that starter out for a good old fashioned bench test.

If you've never done this test before, be advised that the torque in these starters is impressive. Secure it in a vise, snug but certainly not crushing the starter case, or just strap it down to keep it from jumping off the work bench. Connect a known good 12 volt battery with the ground to the starter case and power to the battery cable connection on the solenoid. Then, using a power probe or jumper wire, energize the switch connection of the solenoid (sometimes called terminal "S"). If all you get is a clicking from the solenoid, the test is over, that starter is toast.

Even if the starter turns on the bench, test the current the starter is using. Gear reduction starters can pull up to 90 amps, and non-reduction models about 2/3 of that. There are standards available for each application in the service manual if the readings appear close to failure. Also note any unusual noises. It shouldn't sound like a blender, just a smooth, powerful electric motor. The gear should thrust out when the starter first engages and stay engaged firmly until the power is removed. Any signs of weakness mean it's time to replace that starter.

The starting system can present a very frustrating system failure for your customer, as it leaves no leeway for their busy day. In today's world of overbooked schedules, a funny noise in the suspension will often be ignored and a squeaky belt will frequently be put off, but a failure to start can leave anyone from a business executive to a soccer mom in a panic. Being efficient in your diagnosis and getting your customer back on the road ASAP will go much further in these desperate situations. A quick solution will make you the hero and may earn you a customer for life. Taking the time to learn and understand the starting systems is a great way to increase your value as a technician as well as keeping our society on the move.



Cheap battery terminals are readily available and often installed poorly. Just because a cable end is new doesn't mean it was installed right or that the battery terminal under it was cleaned.

Activating the starter manually on the vehicle is as easy as applying power to the solenoid at the switch connection (the Phillips head bolt here). Use all due caution as this will, if everything's working right, crank the engine immediately.

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Feature

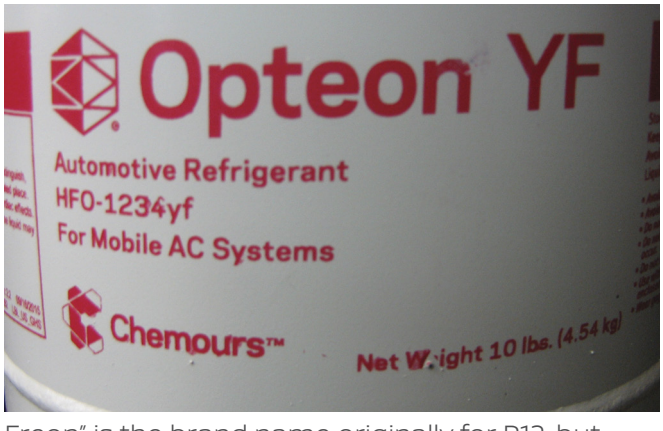
# Fluid Advancements:
## R-1234yf and Dynamic Oil Change Intervals

Environmental considerations are essential to Nissan's research and development efforts. In order to reduce the harmful effects on the environment from inevitable refrigerant leakage, Nissan HVAC systems will incorporate a new HFO refrigerant called R-1234yf. Additionally, to reduce unnecessary oil changing, Nissan has introduced an intelligent oil control system to advise drivers on a suitable oil change interval based on their unique driving circumstances.

## The evolution of refrigerants: CFCs to HFCs to HFOs

One of the major challenges for those of us in the automotive repair industry is to remain up to date with the constant changes in fluid chemistry, diagnostic procedures, and systems engineering. With the introduction of every new design, there is always the question: "Why the change?"

These days, just about everyone knows that CFC (Chlorofluorocarbon) refrigerants were banned because they depleted the Earth's ozone layer. The emergency phase-out of CFCs spurred a rapid transition to HFC (Hydrofluorocarbon) refrigerants that no longer contribute to ozone depletion.




Freon" is the brand name originally for R12, but is commonly used to refer generically to any refrigerant. Is "Opteon" as cool of a name?

However, HFCs still have high GWP (Global Warming Potential) partly because they remain suspended in the atmosphere for years. Even though R134 does not deplete the ozone, with a GWP of 1430, each unit will contribute the equivalent of 1,430 units of carbon dioxide to global climate change over its life in the atmosphere. For comparison, R12 has a GWP of 10,300 and an atmospheric lifespan of about 100 years! Considering it is inevitable that refrigerant in all types of systems will leak out, this is a significant problem.

Therefore, for the American markets, the EPA requires that all 2021 model year vehicles use refrigerants with low GWP. There will not be restrictions on the production or import of R134 itself, so older systems will not need conversion, and refrigerant canisters should remain easy to source.

Nissan will meet emissions requirements using HFO (Hydrofluoro-olefin) refrigerant R1234yf, also known as Opteon. The GWP for R1234yf is four (4.0), with an atmospheric lifespan of only a few days. Considering the similar performance and design characteristics to existing R134 systems, R1234yf is a logical upgrade.

## More similarities than differences

Despite using a new chemical, R1234yf systems will look familiar to anyone experienced in working with R134. The compressor-condenser-evaporator loop is conceptually identical. The service method using vacuum and recharge-by-weight equipment is the same. The refrigerant and oil capacities are similar. The cooling performance characteristics are nearly identical. If you are already EPA section 609-certified, no additional certification testing or updating is required to work with R1234yf. The operating pressure ranges are similar, as outlined in the chart on the next page.

| | R-134a | | R-1234yf | |
|---|---|---|---|---|
| ambient temp: | Low (psi) | High (psi) | Low (psi) | High (psi) |
| 77F | 37-45 | 135-165 | 28-35 | 144-176 |
| 86F | 42-52 | 153-187 | 32-39 | 159-194 |
| 95F | 47-58 | 168-206 | 38-46 | 209-255 |
| 104F | 51-63 | 181-222 | 44-54 | 237-290 |

2018 Altima (R134) and 2019 Altima (R1234yf) AC high/low pressures. Information for operating pressures can be found using the ESM (Electronic Service Manual) through www.nissan-techinfo.com. Choose the "Trouble Diagnosis" button if given the option, and then VENTILATION, HEATER, AND AC > HEATER AND AIR CONDITIONING > BASIC INSPECTION > PERFORMANCE TEST > Inspection.

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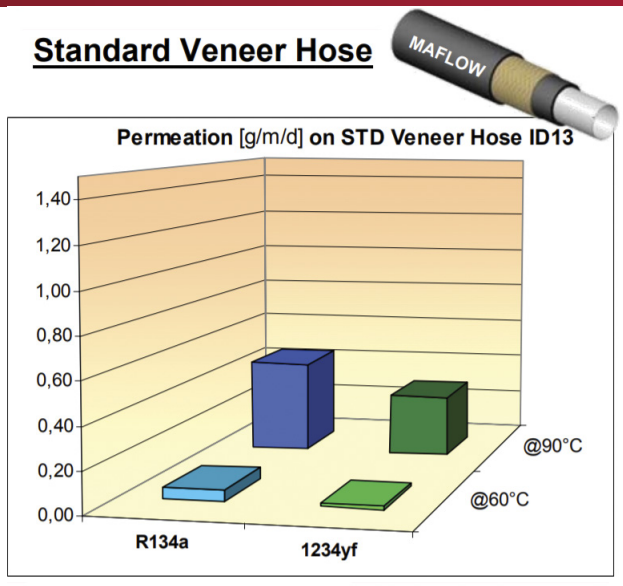
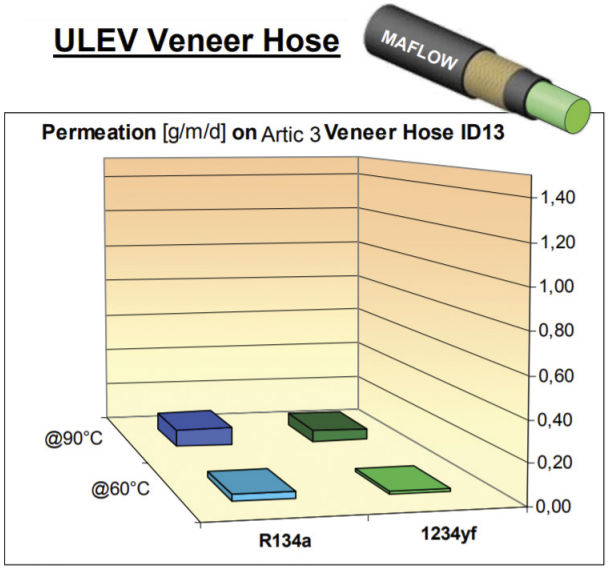
**Summary of Hot Plate Tests**

| | | Hot Manifold | | |
|---|---|---|---|---|
| | | 550°C Faint Red | 800°C Cherry Red | >900°C Orange |
| HFO-1234yf | Spray No oil | No ignition | No ignition | No ignition |
| | Premixed with air no oil | Not tested | No ignition | No ignition |
| | with PAG oil | No ignition | No ignition | Ignition |
| R-134a | Spray no oil | No ignition | No ignition | No ignition |
| | Premixed with air no oil | Not tested | No ignition | No ignition |
| | with PAG oil | No ignition | No ignition | Ignition |

*HFO-1234yf shows same flammability behavior as R-134a - Ignition due to presence of oil*

DuPont and Honeywell collaborated on the initial chemical engineering for R1234yf. The complete test results presented to the SAE World Congress can be found on the web at https://bit.ly/2Tj3gKK.




Not only concerned with tailpipe emissions, the LEV regulations aim to reduce permeation through the materials used in evap lines, fuel lines, and A/C lines.

In terms of safety and handling, R1234yf has an equivalent toxicity rating and similar acute toxicity levels to R134. However, R1234yf is considered a mildly flammable gas of the lowest classification (ASHRAE A2L). While direct open fire in a closed environment might cause ignition to R1234yf, the most common automotive scenario of a high pressure leak onto a hot exhaust manifold showed no greater risk of ignition than R134.

Given equivalent gas concentration, R1234yf has a slower rate of seepage through HVAC hoses than does R134.

## Practical differences between R134 and R1234yf

At a glance, these are the important differences between R134 and R1234yf refrigerants:

- The oil is not compatible.
- The recovery, recycle, and recharge machine is not compatible.
- Leak detection dyes are not compatible.
- The service fittings are not the same.

Admittedly, the first thing you might notice when servicing an R1234yf system is that your R134 machine fittings don't connect! This is

Dye is injected into a charged R1234yf system through the low side fitting.

precisely to prevent accidental contamination.

Compressors use PAG-46 oil specially formulated for HFO-1234yf. This can be purchased directly from Nissan using the part number "VC100yf," or through appropriate vendors of high quality lubricants. Some PAG oils for R1234yf are backwards-compatible with R134 systems. The reverse is not true. Even when a PAG oil is ISO46 (the correct viscosity), if it is not formulated specifically to work with HFOs, it will harm the system. When placed in "universal" or a non-R1234yf oil, the lower solubility of the refrigerant results in larger immiscible regions and improper vaporization. This behavior affects the oil circulation, resulting in insufficient compressor lubrication and lower thermal transferability. (Read more specifics from the UN's Energy Learning program here https://bit.ly/2tLbiNQ).

Likewise, dyes for R134 oils are different than dyes made for R1234yf oils. Dyes made for R1234yf are not backwards compatible with R134. Do not interchange leak detection dyes. (A complete leak detection kit compatible with R1234yf can be found on nissantechmate.com, search for "J-43926".)

Reference the vehicle's service manual for the specific amount of oil needed during repair procedures. Compressor oil capacity is similar between R134 (2018 Altima: 120 ml) and R1234yf (2019 Altima: 120 ml). Test results indicate mechanical wear tendencies inside compressors using R1234yf oil are comparable to those using traditional R134 oil.

Be aware that R1234yf systems are still highly susceptible to moisture contamination, and the PAG oils for this refrigerant are hygroscopic. Take care during service and repairs to limit exposure as you would when working with an R134 system.

## Cooling performance

For testing purposes, when an R134 system is flushed and filled with R1234yf without making any modifications, the performance output remains within 5 percent depending on the compressor. Typically, R1234yf is less performing. Therefore, with minor component optimizations, R1234yf performance can be improved to the expectations for R134.

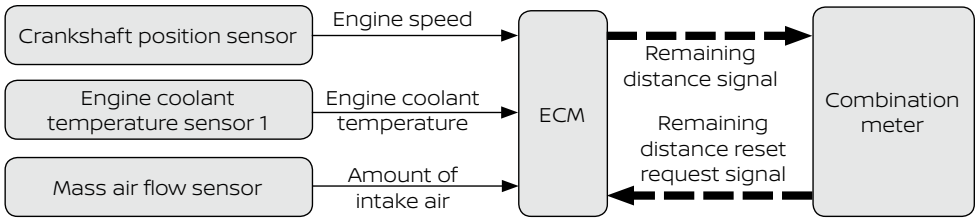
One such component is an internal heat exchanger (IHX), which is often found in stationary A/C systems but is less common in automotive applications. An IHX improves the performance of any refrigerant system, and is not unique to or required by an R1234yf design. The exchanger has two pipes or chambers: a smaller one that passes through a larger.

On the 2019 Altima, the IHX is bolted to the thermal expansion valve. As warm liquid refrigerant from the condenser enters the smaller chamber en route to the TXV, cold vaporized refrigerant exits the evaporator into the surrounding larger chamber. Heat transfers from the liquid into the gas, reducing the temperature of the liquid further below the condensation point. When this "sub-cooled" liquid refrigerant evaporates, it will take more energy (heat) to boil since its temperature is lower than it would have been without the exchanger. Thus, vent temperatures are reduced.

## Drawbacks

For most of us, the real drawback is the equipment and procurement cost required to support the new refrigerant. A gram of R1234yf at the time of writing is about 15 times more expensive than R134. Considering it's 350 times better than R134 for the environment, and that, without dramatic efforts to curb climate change, nobody will be around to complain, it's a

necessary inconvenience. Furthermore, as more vehicle manufacturers get on board with R1234yf, more chemical producers will compete on pricing to meet demands. By the time R1234yf systems need regular maintenance and repairs, the associated costs may be less.




The oil change interval calculation occurs somewhere in the black box, out of sight of prying mechanics' eyes.

Purchasing a new recovery, recycle, and recharge machine is another major investment in shop equipment. You can find the officially recommended Nissan-approved machine on nissantechmate.com. Search for "J-52405."

## The future is R1234yf. Prepare and certify for it

Nissan has made an informed engineering decision when transitioning away from R134 to R1234yf. According to ALLDATA, among 28 different auto makers, 48 percent of new car models shown in 2017 already have switched to R1234yf. That number is growing to meet environmental regulations. While other refrigerant systems may meet those regulations, for automotive applications, the clear winner is R1234yf. Be aware that in order to purchase the refrigerant at wholesale volume (more than 2 lbs), you or a technician at your shop must have section 609 certification.

## Reducing waste oil with intelligent oil change intervals


The processes of oil extraction, production, refinement, delivery, and recycling come at a great price to this planet. When oil is drained from an engine before its functional lifespan has ended, it is effectively wasted oil. According to a California Air Resources Board study, 83 percent of surveyed drivers qualify under "severe operating conditions" in their owners' manuals, and yet still 73 percent of all drivers were changing their oil more frequently than the manufacturer recommendation. (From a mechanic's perspective, this surprises me!) Nevertheless, it means that good oil is being wasted.

On Nissans equipped with OCS (Oil Control System), the ECM monitors the deterioration state of the engine oil. This is achieved by calculating the engine load, coolant temperature, and engine speed based on signals from the MAF sensor, ECT, and crank position sensor.

When OCS data indicates that the mileage is approaching the recommended calculated oil change interval, an alert is displayed on the driver information screen. The alert appears during the first IGN ON at around 1000 miles before due, then again around 600 miles, then five more times at 60 mile intervals from 300. Once the recommended change is reached, the alert language changes to indicate that the service is due every IGN ON.

## Working with the Engine Oil Data

As a technician, whenever you perform an oil change, you must manually reset the OCS data. The reset procedure is outlined in the Electronic Service Manual.

Conversely, after replacing the ECM, it is necessary to do an oil change since the OCS data will be lost!

## No substitute for a human

You may have noticed that there is no oil level sensor input to the ECM's oil deterioration calculation. That means the oil change interval calculation cannot factor any accelerated oil deterioration due to reduced oil volume. In a perfect world, all our customers would be regularly checking and topping their engine oil. In the real world, we all know how many of our customers actually do this. The OCS change recommendation should be another tool in the arsenal of responsible vehicle maintenance, but it is no substitute for the humble dipstick.

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