

Trailer Towing Safety Pilot Training Course



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Trailer Towing Safety Manual

1. Background

In the process of conducting fieldwork, EPA personnel may need to utilize a trailer to transport boats, mobile laboratories, and other field related equipment such as all-terrain vehicles (ATVs). Towing a trailer requires driving skills that exceed those needed to operate a motor vehicle alone. As a result, personnel who are required to tow trailers in the course of their duties should have training in these special skills and should understand fundamental defensive driving techniques useful when operating a tow vehicle and trailer. For this reason, the EPA ORD has developed this manual and associated training course.

2. Objectives

The manual is designed to provide EPA and contractor personnel with fundamental safety awareness and best practices associated with trailer towing. The objective is to familiarize course participants with the fundamental concepts of towing safety and outline the issues associated with operating a motor vehicle while towing a trailer. The manual also addresses types of towing hitches and equipment, the pre-trip inspection, load securing and balancing methods, and basic defensive driving techniques.

In the training course, each of the issues addressed in the manual will be reviewed and discussed in an open forum. The training course emphasis will be on driving safety while towing, how to safely and properly hitch a trailer, and defensive driving while towing. In this course, students will also have the opportunity to work “hands-on” with actual trailers and associated equipment, as well as practice basic tow vehicle/trailer maneuvering principles under controlled conditions.

The manual and instruction course are intended to provide the basics that, along with practice, will enable EPA and contractor personnel to safely operate tow vehicles and trailers.

3. Types of Trailer Hitches

A critical component to towing a trailer is the hitch attaching the tow vehicle to the trailer. Figures 1 through 3 show various equipment mounted on trailers. Trailer hitches are available in three types of hitches : weight-carrying hitch, weight-distribution hitch, and fifth wheel (or gooseneck) hitch. The major difference between these types of hitches is the way they are connected to the tow vehicle and the way they distribute the weight of the trailer. The following provides a comprehensive review of the differences in the trailer hitches.



Figure 1. 19-Foot Boat on a Trailer with an A-Frame.



Figure 2. An All-Terrain Vehicle (ATV) on a Specially Constructed Flat-Bed Trailer.



Figure 3. A Mobile Laboratory Equipped with its Own Trailer.

3.1. Weight-Carrying Hitch/Weight-Distribution Hitch (Conventional Hitches)

These two types of hitches are similar in the way the trailer is hitched to the tow vehicle using a ball mount and coupler. The difference is in the way the two hitches distribute the weight of the trailer at the hitch, known as the tongue weight, to the tow vehicle. This ball and coupler type of hitch is used on a wide variety of tow vehicle and trailer combinations. These types of hitches consist of a ball attached to the rear of the tow vehicle and a coupler (socket) at the tip of the tongue or A-frame attached to the front of the trailer. This hitch is commonly used on recreational and boat trailers, and is the most common type of hitch used on EPA vehicles for towing mobile laboratories, boat trailers, and flat bed trailers .

The weight-carrying hitch is mounted to the back frame of the tow vehicle resulting in the tongue weight to be solely placed on the back axle. This is a simple and common hitch but is limited in the stability of the hitch while towing.

The weight-distribution hitch is designed to distribute the tongue weight to all axles of the tow vehicle, which will help stabilize the trailer and prevent swaying while towing. A weight-distribution hitch can be used for trailers with heavier loads since the tongue weight is distributed between all axles of the tow vehicle.

3.2. Parts of the Weight-Carrying and Weight-Distribution Hitch

Figure 4 shows the parts of a weight-carrying hitch. Each of the individual components is further reviewed below.

3.2.1. Receiver

The receiver is the part of the hitch fitted to the tow vehicle. Typically, the receiver is welded and/or bolted to the rear frame of the tow vehicle. The design of the receiver will determine whether the hitch is a weight-carrying or weight-distribution hitch.

3.2.2. Draw Bar (Ball Mount)

The draw bar (also called ball mount) is a separate piece of equipment that slips into the hitch receiver, and is locked in place with a hitch pin. This draw bar provides a place for the hitch ball to be mounted. For load distributing hitches, spring bars (see 3.2.5) are also attached to the draw bar. Figure 5 shows a draw bar and hitch ball with their individual capacities stamped directly on the equipment.

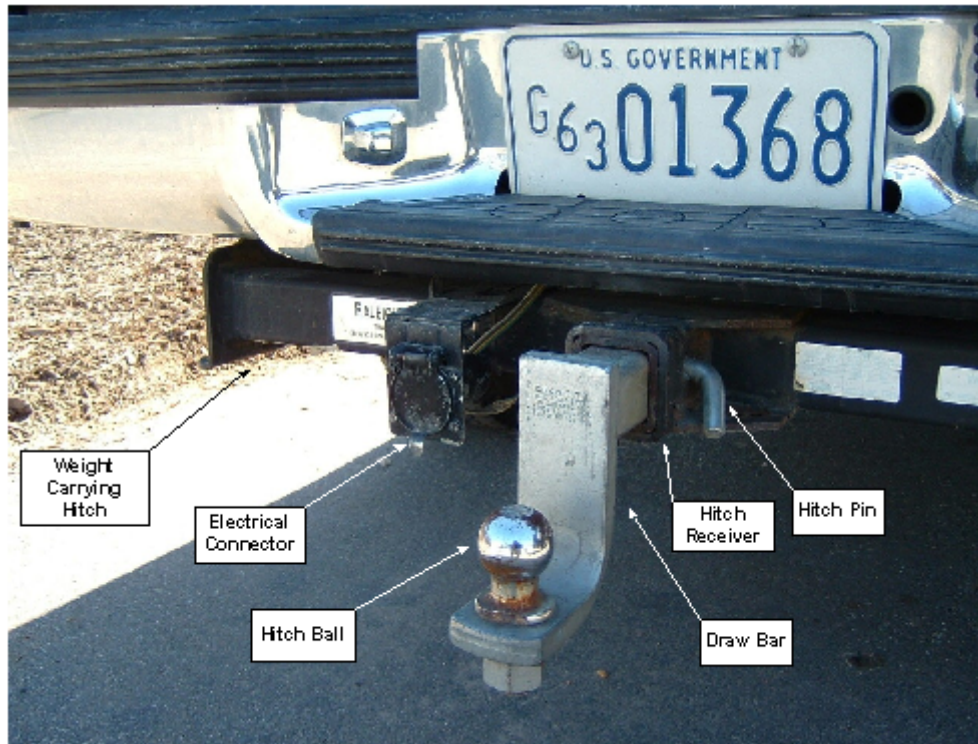


Figure 4. Weight Carrying Hitch Components.



Figure 5. Draw Bar and Hitch Ball with Carrying Capacities.

3.2.3. Hitch Ball

The hitch ball is the part of the hitch that physically connects the trailer tongue to the tow vehicle. The hitch ball receives the coupler from the trailer tongue to make the connection. Hitch balls are available in various sizes from 1½ inch to 2½ inches and must be selected based on the size of the trailer hitch coupler. If a hitch ball is too large for the coupler, the two simply will not fit. If a hitch ball is too small for the coupler, the ball and coupler may separate during trailer transport, causing the trailer to detach from the tow vehicle.

3.2.4. Tongue

The front of the trailer that hitches to the tow vehicle is known as the tongue. When determining the trailer weight load on the hitch we must determine the tongue weight. Figure 6 shows a typical tongue and all the components associated with it.

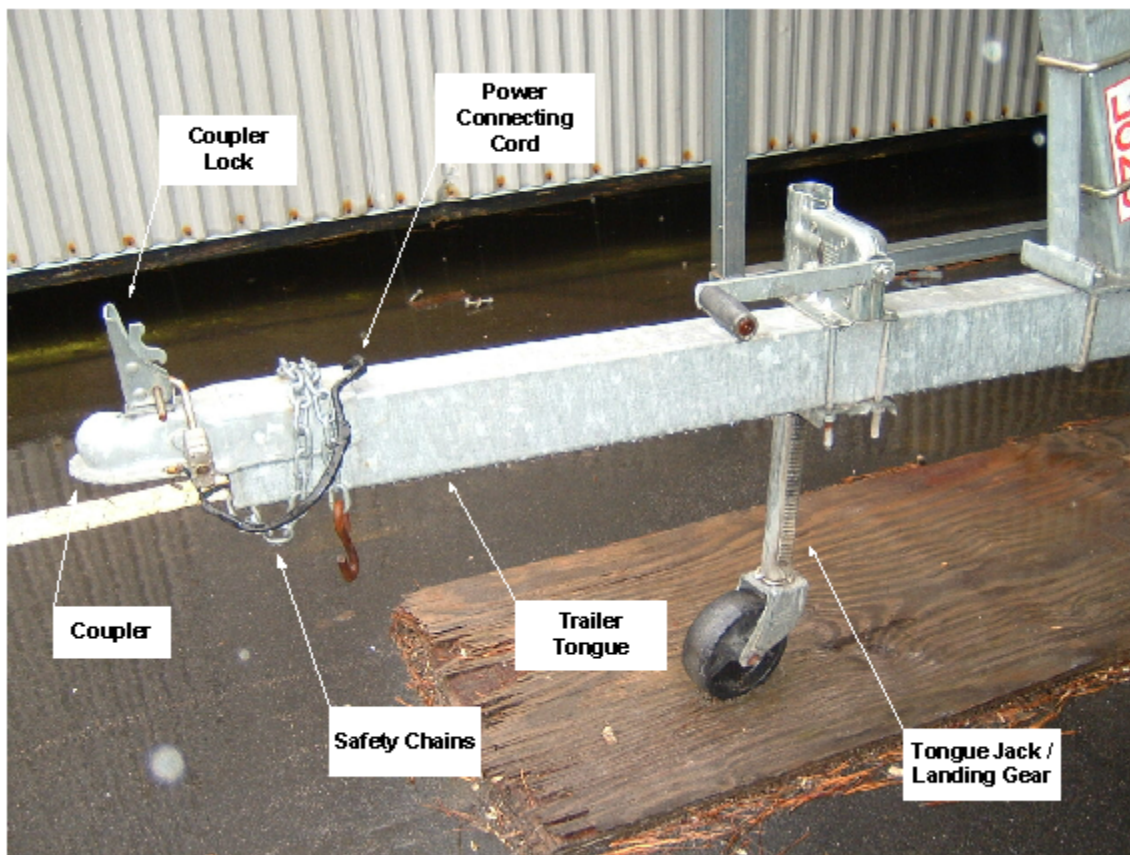


Figure 6. Conventional Trailer Tongue and Accessories.

3.2.5. Coupler

The coupler is the part of the trailer tongue that physically connects to the hitch ball. Couplers are equipped with a sliding collar that will securely attach the coupler to the hitch ball to prevent the hitch from detaching. Once this sliding collar is in place a coupler pin is inserted to prevent the collar from releasing.

3.2.6. Sway Control Device

A sway control device is an additional connection between the draw bar and the trailer tongue. The sway control device functions just as it is titled, preventing the trailer from swaying while towing. Larger trailers are often equipped with a Sway Control Device that is designed to lessen the pivoting motion between the tow vehicle and trailer.

3.2.7. Spring Bars

For trailers with multiple axles, Spring Bars (also called load-leveling bars) are often used to distribute the tongue weight among all axles of the tow vehicle and trailer with a weight-distribution hitch.

3.2.8. Safety Chains

As a safety measure, the tow vehicle and trailer are also connected by two safety chains. The safety chains prevent the trailer and the tow vehicle from becoming completely separated if the hitch fails. The chains cross under the trailer tongue in an “X” pattern to form a saddle that prevents the tongue from dropping onto the road in the event that the hitch connection is broken. It should be noted that these safety chains should have enough slack to permit sharp turns, and that **a trailer cannot be towed by the safety chains alone.**

3.2.9. Emergency Brakes

Trailers that exceed a loaded weight of 1500 pounds are often required to be equipped with an emergency braking system that is activated upon an unexpected release of the trailer from the tow vehicle. The last part of the hitch system is a cable connection from the tow vehicle to a breakaway switch located on the trailer tongue. With the cable inserted into the breakaway switch, the trailer brakes are released. If the cable becomes detached from the breakaway switch due to a failure at the hitch the trailer’s brake is automatically activated. This will allow the driver to bring the tow vehicle and detached trailer to a safe and controlled stop. Figure 7 shows the control box, breakaway switch, and electrical wiring for a typical emergency braking system.

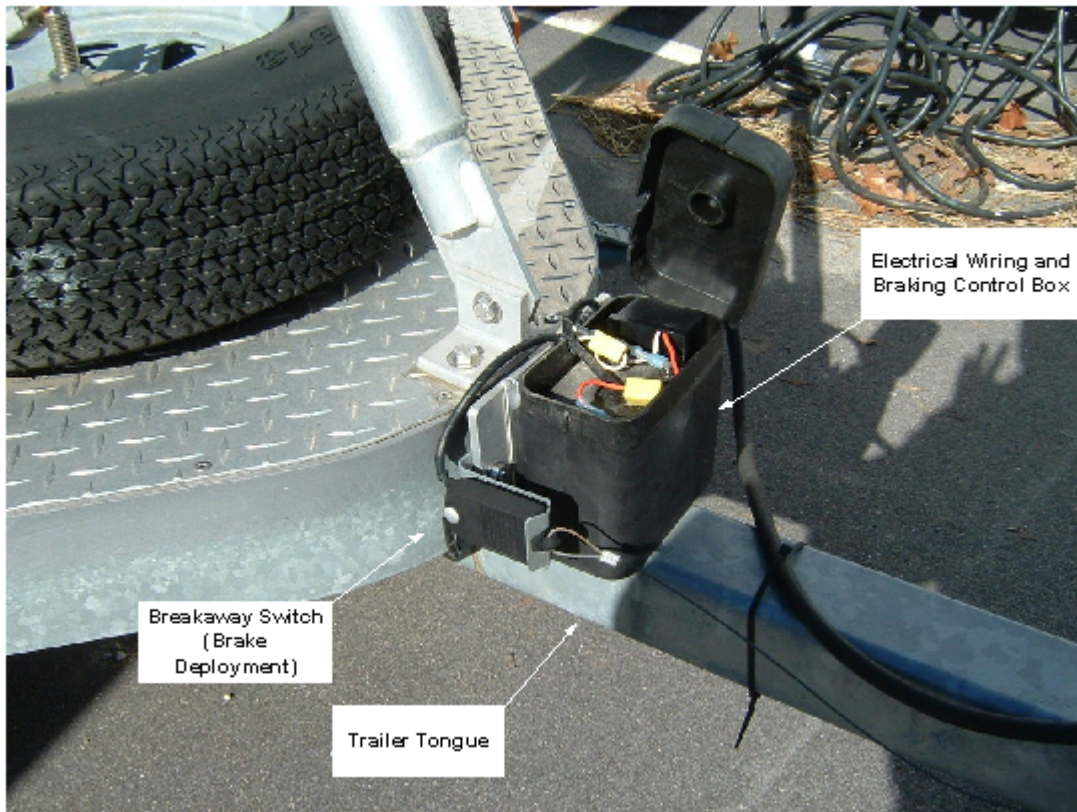


Figure 7. Trailer Emergency Braking Control System.

3.3. Fifth-Wheel Trailer Hitches

Fifth-wheel trailer hitches are used for heavy trailers or loads that cannot be handled by a conventional hitch. Not as much attention needs to be given to balance, hitching procedures and weight restrictions for fifth-wheel trailer hitches because they are inherently very stable (which is why they are used for heavy loads and livestock). The fifth-wheel trailer hitch occupies the center of a truck bed with the hitch pin located just in front of the center-line of the tow vehicle's rear axle. Because of this configuration, two disadvantages are noted:

1. Only trucks can be used to tow fifth wheel trailers (an SUV cannot properly tow a trailer with this type of hitch).
2. A large portion of the truck bed space is not available when towing a fifth wheel trailer.

The hitch weight of fifth-wheel trailer hitches is usually around 20 percent of the trailer weight. Fifth-wheel trailer hitches are typically rated for up to 15,000 pounds of gross trailer weight.

3.4. Parts of a Fifth-Wheel Trailer Hitch

Fifth-Wheel Plate - Unit that contains hitch plate, plate jaws, and handle (mounted in the truck bed).

Handle - The device used to release or lock the plate jaws.

Hitch Plate - "Wheel" that allows the trailer to rotate.

Pin - The connecting device attached to the fifth-wheel trailer (designed to fit into the plate jaws mounted in the truck bed).

Pin Box - Structure attached to the bottom front section of the trailer frame (the pin is attached to the bottom).

Plate Jaws - This device holds the pin.

Side Rails - Support rails that are bolted to the tow truck bed (supports the fifth-wheel hitch).

4. Tow Vehicle

4.1. Wheels

4.1.1. Tires

Tires on your vehicle must be of the proper size and correctly inflated for the load. All tires (including the spare tire) on the vehicle should be of the same size, type, and construction. All tires must be free of punctures, cuts, and excessive wear.

4.1.1.1. Inflation

Under-inflation reduces fuel economy and load carrying capacity, and may cause control problems. Under-inflation is a major cause of overheated tires and blowouts. Over-inflation increases tire wear, affects handling, and can also result in blowouts. To ensure that all tires are properly inflated, tire pressure should be regularly checked when the tires are cold. When inspecting tires for proper inflation, one must remember that tow vehicle tires may require a higher tire pressure due to the additional tongue weight when towing trailers. The preferred method for checking tire pressure is to measure the pressure with a tire pressure gauge. Other quick and easy methods, especially for trailers with multiple axles, is to hit the tires with a tire iron and listen for differences in the sound. Also, while fueling the tow vehicle, feel each tire with bare hands to determine if the tire is warm. Warmer tires are an indication of low air pressure.

Tire fires, which can be caused by running on a flat tire, are a danger on vehicles equipped with dual tires and are very difficult to put out, so tires should be frequently and thoroughly inspected for wear.

4.1.1.2. Tire Tread

Tire tread is essential for proper vehicle control, and should be checked often. Uneven tire treads can lead to vehicle control difficulties, and excessive tread wear can lead to tire blowouts.

4.1.2. Wheel Rims

Wheel rims must be free of cracks, dents, bends, and rust. Wheel fasteners (lug nuts) should be checked for adequate tightness. Wheels should be properly balanced to ensure vehicle stability.

4.2. Mirrors

Proper mirrors are essential to towing so the driver can be aware of surrounding traffic and assists in backing a trailer. When towing trailers, the vision from a standard (inside windshield-mounted) rear view mirror is typically limited by the front end of the trailer. Therefore, side-mounted left and right hand rear view mirrors must be relied upon. The driver should check the mirrors frequently when driving to observe for traffic conditions surrounding the vehicle, which may help the driver to avoid last minute maneuvers and surprises. Additionally, properly positioned rear-view mirrors are essential for backing a vehicle with a trailer.

Side-mounted rear-view mirrors should be as large as practical, with a separate convex mirror mounted at the bottom of the side mirror. Position the side-mounted rear-view mirrors as wide apart as possible for maximum rear vision. The mirrors should be adjusted so that the inside edge of the mirror is further out than the outside edge of the trailer. The trailer's rear wheels should be visible in the convex mirrors to check for correct tracking. If the side view mirrors on a tow vehicle cannot provide a view of at least 200 feet to the rear of the vehicle, special "extended" side view mirrors must be temporarily installed on the tow vehicle. Extended side view mirrors are also required when the trailer width exceeds the width of the tow vehicle.

4.3. Braking Systems

As with any vehicle, the proper operation of the tow vehicle's braking system is essential for vehicle control. Typical braking distances increase dramatically with the addition of a trailer and its contents in tow. Periodic inspection and maintenance of the vehicle braking system shall follow the automobile manufacturer's recommendations at a minimum. Reference the manufacturer's recommendations for brake selection.

Trailers are equipped with separate brakes that should be considered a continuation of the tow vehicle's brake system. The trailer brakes are integrated into the tow vehicle brakes

and activate in combination with the tow vehicle brakes. In the event that a trailer is separated from its tow vehicle, it is essential that the trailer be equipped with a braking system that is activated upon separation from the tow vehicle. Several states require a separate braking system and breakaway switch for a trailer with a loaded weight of more than 1,500 pounds. There are two main types of trailer braking systems, each of which is outlined below:

Electronically Controlled Brakes:

These brakes provide both automatic and manual control for trailer brakes, and require that the tow vehicle be equipped with additional electrical wiring and a control box in the tow vehicle that can activate the brake system either automatically or by the driver of the tow vehicle. When the tow vehicle brakes are applied, an electric current energizes a magnet for each brake, which moves an actuating lever to activate the trailer brakes in proportion the rate of deceleration. When the tow vehicle brake pedal is released, the magnet is de-energized, and the trailer brakes are released.

Surge (hydraulic) Brakes:

Surge brakes are an independent braking system that is activated by a surge coupler and master cylinder located at the junction of the hitch and the trailer tongue. When the tow vehicle applies its brakes, the trailer's natural forward momentum places stress on the surge coupler, which applies pressure against the master cylinder, in turn activating the trailer brakes. The amount of pressure applied to the master cylinder is directly proportional to the amount of pressure applied to the trailer brakes. Once the tow vehicle has placed a pull on the surge coupler, pressure to the master cylinder is removed, and the trailer brakes are released. An independent hydraulic system is used for braking power.

Note: The hydraulic system of the tow vehicle should never be directly connected to the hydraulic system of the trailer.

Because surge brakes cannot distinguish between braking and trailer backing, a surge brake system should be equipped with either a free backing mechanism, or a reverse solenoid wired to the tow vehicle's reverse lights to vent brake pressure while the tow vehicle and trailer are in reverse.

4.4. Lighting System

A properly operating lighting system is necessary for trailer towing safety, especially during night or inclement weather. The lighting system of a tow vehicle consists of headlights, fog lights (optional), tail lights, rear brake lights, and turn signals. The light system must be regularly checked to ensure lights are not burned out and operate properly. It is illegal to operate a vehicle if lights will not illuminate or operate properly. Burned out lights must be replaced, and improperly operating lights must be repaired immediately.

Trailers are equipped with a separate lighting system that is considered a continuation of the tow vehicle's lighting system. The lighting system of a trailer typically consists of

taillights, rear brake lights, turn signals, and running lights. The lighting system for trailers is powered by a connection to the tow vehicle's electrical system (see Section 4.5).

4.5. Wiring System

A wiring system is needed to power the trailer brake system and trailer lighting systems in coordination with the tow vehicle. To do this, usually a four-way power connector is hooked up to the tow vehicle's electrical system (see Figure 4). In some cases, a seven-way connector is used to supply more connections. When connecting a trailer to a tow vehicle, one must ensure that the signals on the electrical connector of the tow vehicle match those of the trailer. When making the connection between the tow vehicle and the trailer, ensure that there is sufficient length in the electrical cable to allow for the trailer to pivot without breaking the connection or damaging the cable.

5. Performing a Pre-Trip Safety Inspection

Before the start of a trip involving trailer towing, a visual pre-trip safety inspection shall always be conducted, regardless of the length of the trip. The safety inspection should thoroughly evaluate the tow vehicle, trailer, and hitch to ensure everything is in proper operating order. Additionally, the load weight and distribution on the trailer should be inspected. The checklist provided in Appendix A is a tool that can be used to assist in the visual safety inspection, and each checklist item should be reviewed and deemed satisfactory before a trip is undertaken. If issues are found during the pre-trip inspection, corrective action must be completed before the trip can be taken. For this reason, it is recommended to conduct the pre-trip safety inspection well in advance of the planned departure, so that no surprise inspection issues delay or prevent a trip from taking place.

6. Loading a Trailer

It is difficult to overload a boat on a trailer because space tends to limit the amount of weight. Space, not weight, is the main loading concern. With boats, the weight (and distribution of that weight) is inherently controlled so long as the boat is properly loaded onto the trailer each time it is used. On the other hand, trailers used to move equipment and mobile laboratory trailers are very capable of being overloaded. With loose loads, there is always the possibility for improper weight distribution, and the way a trailer is loaded can have a major impact on how the vehicle handles and how much the tires wear. The results of overloading can be serious, with problems ranging from tire failure to poor vehicle handling. Appendix B provides a Vehicle-Trailer matching checklist for component compatibility and safety, which must be followed when towing a trailer.

6.1. Trailer Load Ratings

Trailer manufacturers provide load ratings on certification tags at various points inside or outside the trailer. The certification tags are usually placed on the front left-side exterior wall of a travel trailer. Boat trailers usually have this information near the hitch in the front of the trailer. EPA personnel who tow trailers should know where to locate this

information on the trailer they will tow and should review this information regularly so they are familiar with the load ratings. At no times shall these load ratings be exceeded.

To determine the weight of a trailer, the Gross Trailer Weight (GTW) and the Trailer Tongue Weight (TTW) must be measured. The best method to weigh a loaded travel trailer is to drive the trailer to a commercial platform scale. To find a local public weighing station, look in the yellow pages of your local telephone directory under "Weighers-Public".

To obtain these two weights, the following protocol should be followed:

1. Position the loaded trailer on a scale so that the hitch coupler reaches beyond the scale, but the trailer tongue jack sits on the scale.
2. Block the trailer vehicle wheels, unhitch the tow vehicle, and obtain a weight rating. This is the GTW.
3. Place a support under the hitch coupler (beyond the scale) at a height where the trailer is level and raise the trailer tongue jack. Note this weight.
4. Calculate the TTW by taking the value obtained in Step #3 and subtracting it from the GTW.

Multiple sources recommend that the TTW be approximately 10 to 15 percent of the GTW. Following this recommendation will ensure that a proper portion of the trailer's weight is distributed to the trailer's front axle and onto the tongue. If not enough weight is placed on the trailer tongue, the trailer may sway. If excessive weight is placed on the trailer tongue, essential weight may be removed from the front wheels of the tow vehicle, which may result in a loss of the vehicle's steering and braking control. Exceeding the hitch weight can also cause a trailer to "dive" during braking where the force at the hitch increases downward during braking. Adjusting the load toward the back of the trailer, beyond the trailer axle, to meet the hitch weight limit can lead to an unstable condition. TTW values for larger trailers may be limited by the capacity of the tow vehicle and hitch. In such cases, the use of a weight-distributing hitch is recommended. Weight-distributing hitches are attached to the tow vehicle and are designed to distribute the tongue weight between the front axle and rear axles of the tow vehicle. The strongest weight-distributing hitch is rated for a maximum hitch weight of 1200 pounds. Most passenger car suspension systems cannot handle that much weight and the trailer should be towed with a pickup truck, compatible sports utility vehicle, or van.

6.2. Tow Vehicle and Hitch Tow Capacity

Both the tow vehicle and the hitch have weight capacities that affect the safe handling of the vehicle. Tow vehicle load ratings are often found on the driver's side doorframe of the tow vehicle. At no time shall the Gross Combination Weight Rating (GCWR) of the tow vehicle be exceeded. The GCWR includes the total weight of the tow vehicle, passengers, cargo, and a fully loaded trailer. The tow vehicle also has Gross Axle Weight Rating

(GAWR) limits (front and rear). These are the weights that the front and rear axles of the tow vehicle can carry. The payload and hitch weight must be divided evenly between the axles to conform with the maximum axle weight limits and to avoid oversteering problems. The following five weights can determine if the weight of the tow vehicle is distributed evenly:

1. The entire vehicle with all wheels on the scale
2. Front axle with only the front wheels parked on the scale.
3. Rear axle with only the rear wheels parked on the scale.
4. Left side with only the left front and back wheels on the scale.
5. Right side with only the right front and back wheels on the scale.

These five weights help to determine if the vehicle weight is distributed properly.

Springs, wheels, axles, and tires are all affected by overloading. Tire failure can be disastrous when towing a trailer, especially at high speeds. Be very careful and pay close attention not to exceed the maximum inflation pressures stamped on the side of the tire of the tow vehicle and trailer (for passenger cars, trucks and vans, the recommended tire pressure can be found on the driver's side door frame). If this pressure is different from that stamped into the tire, use the vehicle manufacturer's recommended tire pressure on the driver's side door frame.

Tow loads must also comply with restrictions of the individual hitch components, such as the hitch itself, the tow ball, and draw bar. The Gross Trailer Weight should not exceed the maximum weight capacities of the tow ball rating or the hitch capacity. In addition to this, the tongue trailer weight should not exceed the maximum weight capacity of the draw bar tow rating.

6.3. Hitch Load Adjustment

By properly loading a trailer, the tongue weight will measure between 10 and 15 percent of the gross trailer weight. If the tongue weight is less than 10 percent, adjust the load by relocating materials toward the front of the trailer to increase the tongue weight.

When using a weight-distributing hitch, additional adjustments to the hitch will assist in distributing the weight properly. Be sure that the spring bars are rated high enough to handle the tongue weight of your trailer, plus a safety margin of at least 10 percent. Check for adequate rear suspension of the tow vehicle by verifying that the vehicle sits relatively level prior to hitching the trailer. Weight-distributing hitches are designed to distribute the hitch weight relatively evenly to all axles of the tow vehicle. The tow vehicle and trailer should be in a level position (attitude) in order for this hitch to function properly. The attitude can be checked by following the steps below:

1. With the tow vehicle loaded, measure the distance between the vehicle and the ground at reference points, which you can establish, in front and rear. Note the figures for later use.

2. Hitch the trailer and adjust the tension on the spring bars so the tow vehicle remains at roughly the same attitude (i.e., if the rear drops an inch after hitching, the front should also drop an inch).

3. Inspect the trailer to ensure that it is level. If not, the hitch ball should be raised or lowered, as necessary. Spring bars that are rated for more weight may be needed if the tow vehicle cannot be kept from sagging in the rear.

7. General Driving Safety

7.1. Safety Belts

Safety belts should be worn at all times by personnel while in the tow vehicle. The driver and all other occupants must be restrained in their seats with safety belts whenever the vehicle is in motion. In an accident, injury to the driver and passengers can be reduced if the seat belts are properly used. Legislation requires the use of safety belts in a majority of areas, however, they should be used regardless of regulations.

- Before departure, lock all doors to reduce the risk of ejection in the event of a collision.
- Never use one seat belt for more than one person.
- Never transport more people in the vehicle than the number of safety belts.
- Always adjust the seat belt for a snug fit, placing the shoulder belt over the shoulder and across the chest. Never place the shoulder belt under the arm, or behind the torso. Place the lap belt across the hips, as low as possible. Do not place the lap belt around the waist.
- Do not make adjustments to the safety belt to prevent it from automatically removing slack.
- To reduce the risk of injury in a collision, both the driver and passengers should properly wear their safety belts, adjust their seats as far back as possible, and remain upright in their seats.

7.2. Traffic Regulations

The driver of the tow vehicle must understand and obey all traffic laws. When towing trailers, the driver must acknowledge that some states have additional towing laws, and review each applicable states' towing regulations.

7.3. Vehicle Operation

When driving a vehicle, it is important that the driver is fully aware of traffic conditions and focused on the task of driving. Trying to locate various features of the vehicle will

divert the driver's attention away from driving. The driver should take time to familiarize themselves with the location and operation of various features of the vehicle, such as windshield wipers, wiper fluid, lights, speed control, transmission, and interior environment controls.

7.4. Trailer Operation

The driver of the tow vehicle should be familiar with the trailer they are towing. In addition to the pre-trip inspection, the driver should assess the trailer they will be towing, taking note of its weight, dimensions, and braking system. Obtaining the characteristics of the trailer before the trip is essential for the driver in order to properly determine distances associated with braking, passing and merging, as well as weight and clearance restrictions.

If the driver is unfamiliar with towing a specific trailer and/or load, they may want to practice simple maneuvering techniques in a controlled environment with few associated hazards. At this time, the driver can familiarize themselves with acceleration, braking (both tow vehicle and trailer brakes), lane changes, turns, and parking.

One issue that should not be practiced in the field is controlling trailer sway, which is explained below:

If a driver begins to experience trailer sway, they should initially respond by gradually applying the electronically-controlled trailer brakes with the control box inside the vehicle. If the trailer is not equipped with these brakes, the driver should apply the vehicle brakes as gradual as possible to achieve the desired speed until the swaying is eliminated. A better braking alternative may be to select a lower gear to slow down vehicle speed.

With regards to steering, the driver should attempt to control trailer sway by making a series of slight steering conditions as opposed to one radical turn, as such an action may amplify the trailer sway, which increases the risk of losing control and / or jack knifing.

If a sway repeatedly occurs during the trip, it may be the result of one, or a combination, of the following factors below:

- Excessive speed
- Excessive wind gusts
- Uneven load distribution
- Suspension problems
- Insecure trailer hitch or wheels

- Uneven tire inflations

To check for each of these factors, the driver should maneuver to an area where an inspection can be safely conducted. Trailer sway may be alleviated by implementing one of the following:

- Reduction in vehicle speed
- Slight increase in tongue weight
- Use of a sway control device
 - Friction bar - device that slides in and out and is activated by the relative motion of the tow vehicle and trailer. When the tow vehicle brakes or turns, the trailer weight compresses the friction bar which then compresses the trailer against the tow vehicle.
 - Dual cam sway control - usually used with large vehicles with heavy tongue weights. The cam action of this device is applied to the spring of the trailer which shifts the trailer weight forward and reduces sway. This device also adjusts for weight shifts, which allows the trailer to better follow the path of the tow vehicle.

8. Defensive Driving Techniques

Defensive driving requires all drivers to think ahead. This is even more important for towing a trailer than for drivers of passenger vehicles. The driver of a towing vehicle must be continually aware of the traffic around the vehicle because directional changes must be made slower than normal, and the trailer needs more space in traffic. If driving in unfamiliar areas, it is helpful to have a passenger to help with directions and read the maps. If traveling alone, pull over to the side of the road in a safe location or into a parking lot when it is necessary to read a map and figure out directions. It is a very unsafe practice to try to read a map while driving. Try to avoid travel during rush hour traffic, night, and adverse weather conditions.

8.1. Be Prepared

Listen to the local radio stations where you are traveling. Be aware of warnings for traffic slowdowns, accidents, or road construction, etc., and make plans to take alternative routes if conditions warrant. Always be on the lookout for road hazards (i.e. potholes, road obstructions, wildlife).

8.2. Prevention: Maintaining Safe Distances and Planning an Escape

To successfully avoid an accident situation, plan an escape. The first step a defensive driver must take is maintaining a space cushion around their vehicle and trailer. This open space around the vehicle and trailer is valuable in avoiding dangerous situations. One important technique is to keep a three second following distance from the vehicle ahead of you. Keeping your distance gives provides time to react and avoid a collision. Continually inspect the shoulder of the road and assess whether it looks firm enough and

wide enough to support the tow vehicle and trailer. The driver of a tow vehicle should be prepared for when vehicles attempt to pass on the right and move in front of them.

8.3. Signaling

Always use turn signals well before initiating a turn or course correction. This will communicate your intentions and upcoming maneuvers to other drivers so that they can be adequately prepared for them. Always be on the watch for other driver's signals, with the realization that not every driver will always signal well in advance of upcoming maneuvers.

8.4. Starting and Shifting

Start and shift (for manual transmissions) smoothly to prevent wear and tear on the hitch, drive train, and transmission systems.

8.5. Turning Patterns

The longer wheel base of a vehicle and trailer requires different turning patterns. Wider than normal turns must be taken at intersections to prevent sideswiping curbside items and the rear wheel from rolling over the curb. This means going further into the intersection before starting the turn and adjusting lane position to increase the turning radius.

Negotiating curves while on the highway can also be tricky. Keep the tow vehicle and trailer more to the center of the lane for right turns so the rear wheels will not move off the pavement. For a left turn or curve, steer more to the right of the lane to prevent the back of the trailer from tracking into the oncoming lane of traffic.

Some trailers, especially those carrying boats, have a high center of gravity. Turning corners and taking curves with these types of trailers must be done at slower speeds to prevent swaying. Begin to slowdown before entering the curve.

8.6. Trailer Backing

Backing a trailer can be the biggest challenge for inexperienced drivers. The most important item to remember is that the trailer will go in the opposite direction of the tow vehicle. It is helpful to have another person help you back the trailer. Two approaches for backing trailers are provided below:

1. Turn the vehicle's wheels to the right to make the trailer go left, and vice versa.
2. Put your hand at the bottom of the steering wheel. The trailer will go in the same direction your hand moves (moving your hand to the right will cause the trailer to go right, and vice versa).

Sharp steering wheel corrections may cause the trailer to jack knife and may cause damage to the rear of the tow vehicle or the front of the trailer.

8.7. High Wind

Special care is necessary when towing a trailer in high wind conditions. Crosswinds are the greatest threat because they can push a large vehicle and trailer combination into another lane if the driver is not prepared. In most cases, decreasing speed is the best defense against strong winds. If heavy wind causes a trailer to begin swaying, the driver should first decrease speed by gradually applying the trailer brakes. If the trailer is not equipped with a separately-operable trailer brake, (electronically controlled braking system) use the vehicle brakes but do so as gradually as possible to achieve the desired decrease in speed. A better alternative to braking may be to use the engine to slow the vehicle by gearing down the transmission. It is important to not oversteer (try to avoid steering to control the sway) to bring a swaying trailer under control, as this will only amplify the swaying, making the situation worse. It is better to use a series of slight steering corrections as opposed to one radical correction. This will decrease the possibility of losing control and jack knifing. If the vehicle cannot be safely operated in high wind conditions, pull over and wait until the wind speeds decrease, parking in a position so that the tow vehicle and trailer are parallel to the wind. This practice will minimize the potential of wind born objects crashing into the vehicle and trailer.

8.8. Snow and Ice

If possible, the use of snow tires is highly recommended for driving in snowy and icy conditions. Always carry drive wheel and trailer wheel chains for additional support while traveling in snow or ice conditions. It is essential that the vehicle operator know how to put snow chains on. Chains are needed for both the tow vehicle and for one axle of a trailer. When towing a trailer on icy roads, go slowly, especially downhill. Use the lower gears of the vehicle to control the descent. Additional traction for the tow vehicle may be obtained by moderately releasing the tension of the load equalizing hitch. Always readjust the hitch after the icy road condition has passed or vehicle stability may be affected during normal driving conditions.

8.9. Steep Grades and Escape Ramps

Almost all uphill grades, regardless of severity, will cause the vehicle to slow down. The heavier the vehicle, the more pronounced this effect. Grades steeper than 6 percent are considered extreme and require special attention. On highways, steep grades will be indicated by signs that may also indicate the percentage of the grade. On smaller roads, there may not be any warning or signs indicating steep grades, so be aware of the general topography when driving. If driving in a mountainous region, be ready.

The steeper the grade, the longer the grade, and the heavier the load, the more it will be necessary to use lower gears to climb hills or mountains. When going down steep hills, gravity will tend to increase speed. The driver must select an appropriate safe speed, then use low gears to maintain the safe speed. Use the braking effect of the engine (lower

gears) as the principal way to control speed. The use of brakes on a long or steep downgrade is only a supplement to the braking effect of the engine. **Do not** ride the brakes to control speed during a steep descent, as this could cause the brakes to overheat, which could lead to brake failure at a very inopportune time.

Before entering a steep descent, slow the vehicle and shift the transmission to a low gear before starting down a grade. Once the vehicle is in the proper low gear, the driver should use the following proper braking technique:

1. Apply the brakes just hard enough to feel a definite slowdown.
2. When the speed has been reduced to approximately 5 mph below the "safe" speed, release the brakes. The application of brakes should last for about three to five seconds.
3. Release the brakes, and when the speed has increased to the "safe" speed, repeat steps 1 and 2. This allows the brakes to dissipate heat between pumps.

When ascending or descending a steeply-graded multiple-lane highway, avoid driving in the fast lanes. Stay in the far right lane while climbing a steep grade if the trailer cannot maintain the legal speed limit. It would be better to drop to a lower gear and slow down rather than pass slow trucks and tie up the faster lanes because the vehicle does not have enough power.

Escape ramps have been built on many steep mountain grades, and are used to stop runaway vehicles safely without injuring drivers and passengers. Escape ramps use a long bed of loose, soft material (pea gravel or sand) to slow a runaway vehicle, sometimes used in combination with an incline. Know where escape ramps are located on your route. Signs show drivers where ramps are located. If it is necessary to use an escape ramp to stop a vehicle when the brakes have failed, try to slow the vehicle first by engine-braking (down-gearing). If in an automatic vehicle, this option is unavailable. When the vehicle hits the ramp, the steering wheel will be difficult to control—hold tightly and keep the front wheels pointing straight ahead. If the vehicle begins to veer off of the ramp, do not oversteer to correct as this may cause the trailer to jack-knife. Use the slightest steering corrections necessary to bring and keep the vehicle under control.

8.10. Narrow Roads

When driving a slow-moving vehicle on a two-lane highway or road where passing is unsafe, and five or more vehicles are following, pull to the side of the road when it is safe to do so to let the vehicles pass. Special "turnout" areas are sometimes marked on two-lane roads, especially in hilly or mountainous areas. Try to stay to the right of the lane so the vehicles behind you can see ahead.

8.11. Dirt or Unpaved Roads

Remote sites must often be accessed by dirt or gravel road. Pay close attention to the signs posted and observe their warnings. If a sign prohibits trailers, do not use that road as there may be a hazard such as rocks, low trees, or washed-out sections of the road ahead that only a 4-wheel drive vehicle can handle safely.

8.12 Road Hazards

In the process of operating a tow vehicle, a driver may come across a wide variety of road hazards such as potholes, road debris, and wildlife. The best precaution to avoiding such hazards is to keep aware of the vehicle's immediate surroundings and upcoming road conditions. However, at certain times there is little warning of such hazards, such as wildlife running out into your line of travel. When encountering road hazards, the defensive driving maneuvers may range in difficulty from maneuvering the tow vehicle and trailer to straddle a pothole, to changing lanes and / or speed in a short amount of time. Whatever the situation may be to avoid, the driver should keep these priorities in order when maneuvering to avoid a road hazard:

1. Safety of the driver and passengers, surrounding motorists and pedestrians
2. Personal property of the tow vehicle, trailer, surrounding vehicles, and other personal property
3. Wildlife
4. Personal property in the path of travel

8.13. Trailer Restrictions

Pay attention to road signs that warn against travel by vehicles towing trailers. For example, "Dead End" may mean great difficulty in turning around or backing out. Weight limits that are not applicable when driving a car may be exceeded with a truck and trailer. Know how tall the trailer is and pay attention to signs indicating height restrictions.

8.14. Freeway Driving

When towing a trailer, the vehicle will have slower acceleration when entering a freeway, so achieving highway speeds will take more distance. Freeway traffic has the right-of-way over incoming merging traffic, so you must look for gaps large enough to accommodate the vehicle/trailer combination. More space is also necessary when passing other vehicles, and judging just how much space is necessary takes practice. If there is not enough space and time to complete the pass, you may need to swerve quickly into another lane. This could result in a skid, over steering, trailer swaying, or a worst-case scenario of losing control and jack knifing.

Following distances must also be increased because the added weight of a trailer means it takes longer to slowdown and stop. When exiting a freeway, one should decelerate sooner than for a smaller vehicle. Be aware that many off ramps have reducing radius curves (the curve continually tightens), and that it will be necessary to stay to the outside of the curve so the rear wheels will not rub the curb or drop off the pavement.

In most states, vehicles towing trailers must stay in the right hand traffic lane or as close as possible to the right edge or curb. If you drive on a divided highway with four or more traffic lanes in the same direction or where a specific lane or lanes have not been designated, the preferred travel lane is the lane just to the left of the right hand traffic lane (this avoids traffic entering onto the highway). When overtaking or passing another vehicle going in the same direction, most states require the use of either: (1) the designated lane, (2) the lane just to the left of the right-hand lane, or (3) the right traffic lane when use of that lane is permitted.

8.15. Driver Fatigue

Towing a trailer over a long distance is not easy, especially under any adverse traffic or weather conditions. The constant attention that is necessary to safely transport a trailer often results into fatigue. Break up driving time by taking a 15- to 30-minute break every two to three hours. Get out of the vehicle and walk around, as this will help to loosen tired muscles and rest tired eyes. Use this time to inspect the vehicle, trailer and load. These breaks will also improve your alertness. Remember that night driving can be especially hazardous since the body naturally wants to sleep at night. Most drivers are less alert at night, especially after midnight. For a sleepy driver, the only sure answer to oncoming fatigue is to get off the road and sleep.

Plan trips with multiple drivers and switch drivers about every 2 hours to prevent driver fatigue.

8.16. Dealing with Road Rage

Recognize other drivers exhibiting signs of road rage and keep as distant from them as possible. Look for drivers who are excessively speeding, frequently changing lanes, driving too close behind other vehicles, or any other signs of aggressive behavior.

9. Handling Emergency Situations

All drivers are placed in emergency situations at some point in their driving careers, so they must be mentally prepared. If the driver can think about a certain emergency situation and decide how they would handle that emergency, they will be better prepared to react properly if it actually happens.

9.1. Fires

Most states require that commercial vehicles towing trailers carry at least one dry chemical or carbon dioxide (CO₂) type extinguisher with a rating of at least 4-B in

working condition. A fire extinguisher can keep a small, manageable fire from becoming a major, uncontrollable fire.

The best fire protection includes:

1. Proper maintenance and inspection of fuel systems and electrical equipment,
2. the use of a smoke detector, and
3. an LP gas detector.

The fire extinguisher should be suitable for the type of fire and large enough to put out the fire. For fuel or electrical fires, first try to disconnect the source of the electrical current or shut off the source of the fuel. If you are not sure, shut off everything. However, if it appears that fire may involve the fuel tank, evacuate the area immediately. The most common vehicle fire extinguisher is a 2 ½ lb ABC suitable for all types of fires, including fuel fires and electrical fires.

The following letter designates the type of fire suitability:

- A– Ordinary materials like wood and paper
- B– Petroleum products such as gasoline, propane kerosene
- C– Electrical

Always have a fire extinguisher recharged after it used, even if it is only partially empty. Conventional CO₂ extinguishers should be recharged periodically, even if they are not used. The dry powder used in CO₂ extinguishers tends to compact with road vibration. Before using it, rap the CO₂ extinguisher sharply on its side and bottom to shake the powder loose.

Mobile laboratories typically contain numerous flammable/combustible solvents. Inventory all chemicals in the lab and ensure selection of proper type and size of a fire extinguisher.

9.2. Inclement Weather Conditions

When towing a trailer, one may experience a wide variety of inclement weather conditions such as: heavy rain, snow, ice, and fog. In these situations, it is imperative that the operator of the tow vehicle significantly increase the following distance between their vehicle and those in front of them, giving adequate time to assess situations and properly react while avoiding sudden turns or braking.

As mentioned in Section 8.8, the use of snow tires and/or snow chains is recommended when towing a vehicle in snowy or icy conditions. There may be state or local regulations regarding the use of snow tires and/or snow chains, so refer to these before using them.

In slippery conditions, drive slowly and take special precautions to avoid sudden starts, stops, or sharp turns. Activating the brakes while driving in slippery conditions may cause tire slippage and skidding.

9.3 Vehicle Skids

If the tow vehicle is in a skid, the driver should take the foot off the accelerator, steer gently into the skid, and apply the brakes. The braking technique will depend on the braking system of the tow vehicle; conventional or anti-lock. Before departing on a trip, the driver must determine which braking system the tow vehicle is equipped with.

Conventional brakes: The driver should pump the brake pedal rapidly, fully applying and releasing the pedal repeatedly.

Anti-lock brakes (ABS): The driver should firmly press down on the brake pedal, and keep it depressed. The ABS system will manage the braking from this point.

9.4. Vehicle Breakdown

If the tow vehicle breaks down, has a flat tire, or loses the primary connection to the trailer, it is imperative that the driver pull over to the shoulder of the road immediately and activate the hazard lights. If there is no shoulder, or if the shoulder seems unsafe, drive in the right lane at a slow speed with the hazard lights flashing, and stop only when the vehicle has reached a safe stopping place. In either case, the hazard lights should remain flashing. If available, use road flares and/or self-standing hazard placards to indicate the presence of the stopped vehicle on the side of the road. The importance of emergency signaling increases greatly if the tow vehicle and trailer cannot be maneuvered completely off the road, or if it is stopped at the top of a hill or around a curve in the road, where oncoming traffic cannot spot the stopped vehicle and trailer. In these cases, use every emergency signaling device possible to communicate the hazards well in advance of the parked tow vehicle and trailer.

If changing a flat tire, make sure the person changing the tire is not in the way of oncoming traffic. Any other personnel available should provide assistance while acting as a look-out and signal for oncoming traffic. Be sure the jack is adequate to lift the vehicle, the jack is in the proper position, and that at least one wheel is chocked (tire that is diagonally opposite from the flat tire). If a chock or block is not available, use a stone or any other object that is able to keep that wheel in position while jacking. If the vehicle moves while it is jacked up, the jack could slip out, leading to personal injury if additional property damage. For this reason, one should also make sure the jack is set on a flat hard surface.

If it is apparent that the vehicle is experiencing engine trouble, refer to the vehicle's manual for further action. It may be necessary to call for assistance in certain breakdowns. The importance of the vehicle manual and cellular phone are apparent when considering all the possible hazards associated with trailer towing.

10. Parking and Unhitching a Trailer

When the tow vehicle is stopped and ready to be placed in “Park”, perform the following:

1. Try to park on a level grade. Consider that what may seem level may still have a slight grade that need to be accounted for when unhitching a trailer.
2. If the tow vehicle has an automatic transmission, have someone chock the wheels of the trailer, then apply the parking brake. After this has been completed, the transmission can be shifted to “Park”, and the brake pedal can be released. Placing the tow vehicle in “Park” too soon may lock the transmission from the trailer shifting forward or back.
3. For manual transmissions, the parking brake must be applied, then the transmission must be placed into either first gear or reverse. Before unhitching the trailer, place jack stands at the rear of the trailer allowing enough room for the trailer to pivot when releasing the coupler from the ball hitch. The trailer jack can then be positioned to raise the coupler off the ball hitch. If there is any shifting of a load toward the rear, the jack stands will prevent the trailer from unexpectedly pivoting up when released. Always block the trailer wheels before unhitching.

11. Boat Launching and Recovery

One essential activity of the boater that distinguishes the experience boater from the novice is launching and recovery. The skill requires practice, and with practice comes proficiency and the development of a routine. Once a routine is established, maintenance problems are reduced to a minimum, safety concerns are minimal, and the researcher can concentrate on the tasks needed for the outing.

11.1. Pre-Launching Preparations

A list of common procedures and tips associated with pre-launch activities is provided below. These steps should be followed by all personnel, ranging from the novice to the most experienced boater.

1. Prepare your boat for launching away from the ramp as a courtesy to others and to prevent rushing during the launch.
2. Register your boat and pay for the launch at the self-service station.
3. Ensure that there has been no damage to the boat caused by the trip to the harbor.
4. Raise the lower unit or outboard so that it will not hit bottom during launching.
5. Remove trailer tie-downs and make sure that the winch is properly attached to the bow

eye and locked in position.

6. Put the drain plug in securely.
7. Connect the fuel tank, check fluid levels and safety equipment.
8. Disconnect the trailer light plug to prevent shorting of electrical system or burning out a bulb.
9. Attach a line to the bow and the stern of the boat so that the boat cannot drift away after launching and it can be easily maneuvered at the courtesy float.
10. Visually inspect the launch ramp for hazards such as a steep drop off, slippery areas and sharp objects.
11. When everything has been double checked, proceed slowly to the ramp remembering that your boat is just resting on the trailer and attached only at the bow.

Tip: The ideal situation is to have one person in the boat and one observer at the water's edge to help guide the driver of the tow vehicle.

11.2. Launching

A list of common procedures and tips associated with boat launching is provided below. As with the pre-launch preparations, all personnel should follow the general launching approach as outlined at this point.

1. Pull off to side in an area to prepare the boat for launch. Make sure vehicle and rig are not blocking the launch area or approaches.
2. Load personal gear into the boat. Put gear from the boat (canvas cover, straps, etc.) into the tow vehicle.
3. Turn the blower on to ventilate the bilge area. Open the engine compartment to help the process. Use your nose to smell for fumes; nothing works better than your sense of smell for detecting the odor of gasoline.
4. Put fenders out where appropriate to protect the boat when it is being launched. Prepare any lines that will help tie the boat off once it's in the water.
5. Check the lower unit to make sure the gear oil is topped off. If the oil is foamy, water is mixed with the oil. The oil needs to be replaced and gaskets replaced on both the fill and air vent holes. If the boat is an inboard outdrive and the lower unit is down, raise it before moving the trailer.
6. Put the drain plug in. If it is already in, check to make sure it is tightly in place.

7. Approach the ramp and back your trailer to the edge of the water. If you have two people, put one on board to help the driver judge when the trailer is in the right depth of water.

8. Unplug the lights.

9. Remove the straps that hold the boat on the trailer at the stern and/or amidships area of the boat if you have not done so already. Store in the boat for easy access when pulling the boat out. Do not remove the winch and safety chain hooks on the bow eye until the boat and trailer are in the water!

10. Back the trailer into the water. If there is someone on board, they can signal when to stop with the horn. A good rule of thumb is to back the trailer in until the trailer wheel hubs are just above the surface of the water. This might not work depending on the gradient of the ramp and how quickly it drops off. All ramps are different, so trial and error will play a big part in learning the ramps in your area. **Note:** Mechanics who work on trailer brakes recommend that trailer hubs never be submerged in salt water. If they are dunked, make sure they are rinsed off with fresh water at the end of the day and expect major brake work a minimum of every two years. Chock the wheels of the tow vehicle.

11. Lower the inboard/outdrive -- Check clearance for the lower unit to avoid damage. Start the boat and warm it up for two to five minutes. Remove the winch hook from the bow eye, release the lock or ratchet and remove the hooks. If the boat doesn't roll off the trailer, it will need to be put in forward gear to take tension off the cable. Put the throttle in forward gear when the engine is warmed up with just enough power to take tension off the cable. The partner can take the hook off and give the "O.K." hand signal to the operator. Communication between partners is essential to avoid injuries. Sometimes the weight of the boat is not enough to pull the cable out. Sometimes the gradient of the ramp is not steep enough for the boat to roll off. Put the boat in reverse, release the lock or ratchet, and back off two or three feet. Once the cable pays out, put the boat in neutral and remove the hook. It may help to throttle forward a short distance to slacken the cable.

12. Remove the hook and back the boat away from the ramp to a waiting area. Keep the boat clear of launch/retrieval area so other boaters can use the ramp.

11.3. Retrieval

The procedure for retrieving the boat is essentially the reverse of launching it. Key steps to take before getting on the road are:

1. Check to see that all straps and cables are tight.
2. Raise the lower unit.
3. Plug lights in and check to see that they are operational.

On a regular basis, nuts and bolts should be checked to make sure they are tight. Tires should be checked regularly and rotated. If your trailer is big, consider having it x-rayed once every 2-3 years for structural damage.

11.4. Environmental Considerations

11.4.1. Weather

You should never leave the dock without first checking the local weather forecast.

You can get weather information from TV, radio or from one of the weather channels on your VHF radio. At certain times of the year weather can change rapidly and you should continually keep a "**weather eye**" out, especially to the west, in order to foresee changes that might be impending.

There are indicators that you can look for that indicate an approaching weather change:

- Weather changes generally come from the west so scan the sky with your weather eye, especially to the west.
- A sudden drop in temperature and change in the wind often mean that a storm is near.
- If you have a barometer on your boat check it every two to three hours. A rapid drop in pressure means a storm is approaching.
- Watch for cloud build-up, especially rapid vertically rising clouds.

If a storm is near, you should:

- Reduce speed and proceed with caution
- Put on PFDs.
- Close all hatches and ports.
- Head for the nearest shore that is safe to approach and duck into the lee of land.
- Pump out bilges and keep dry.
- Change to a full fuel tank.
- Secure loose items that could be tossed about.
- Keep everyone low in the boat and near the centerline.

11.4.2. Tide and Current

Tide is the rise and fall of the water's surface. The tidal range is the amount of difference in low tide and high tide. Tidal range and its resulting effect on the depth of the water may be insignificant in some areas but in others you may have tides that rise and fall up to fifty feet. You should always be aware of the state of the tide especially when leaving and returning to shallow water.

Current is the flow of the water either from or to the sea as the tide rises and falls.

You should be aware of the effects of current on your boat. Current may flow as rapidly as five knots. If you lose an engine and are pushed along with current you could be swept out to sea or pushed aground.

11.4.3. Specific Local Hazards

You should be aware of, and plan for, any specific local hazards in the area in which you will be boating. You should have charts onboard for all areas you boat in. If you are boating in an area for the first time, seek assistance from other boaters or marinas with local knowledge who can inform you of additional safety precautions which must be considered.

You should be aware of any and all of the following:

- Hazardous Inlets
- Shoaling areas
- Whitewater areas
- Dams
- Locks
- Abnormal tides or currents

Make sure you check with state and/or local officials for requirements and specific conditions that may apply to a body of water on which you intend to boat. For example, some lakes prohibit any motorized vessels, while others might prohibit personal watercraft or have specific hours of operation.

11.5. Safety

Regardless of the type or size of the boat or watercraft that you may have, the use of common sense and the following boating and watercraft guidelines will promote an overall positive and safe boating experience. Each person on board of a watercraft is required to be equipped with a government approved life jacket or personal flotation device, of "PFD".

COMMON SENSE DO'S AND DONT'S:

DO slow down when passing a non-motorized craft such as a rowboat or a canoe.

DO always let someone responsible know when you are departing on any watercraft outing and when you plan to return.

DO always be alert for debris in the water.

DO make sure before you depart that your boat or watercraft is properly equipped, i.e., PFD's for each person in the boat, paddles, first aid kit, adequate amount of gas, etc.

DO always keep a flashlight and extra clothing in a water-resistant bag in case of emergency.

DON'T stand up while the boat or watercraft is in motion.

DON'T put too much weight in the back of your boat or watercraft.

DON'T throw garbage in the water.

DON'T mix alcohol and boating.

11.5.1. Boat Fuel Management

The golden rule to ensure proper ventilation of boats with built-in gasoline tanks is to run the "blower" for five minutes prior to starting the motor. Also, never refuel portable outboard motor tanks while they are still on-board the boat.

Gasoline tanks should be removed from the boat and placed on the dock or beside the boat. Once refilled, the tanks should then be wiped off to remove any spillage that may have occurred during filling. Smoking should never be permitted anywhere in the vicinity of the gasoline tanks or the refueling area.

11.5.2. Initial Safety Inspection (General Systems Compatibility done 1 week prior to project date)

Safety inspections of your boat and towing vehicle should cover the vessel from "end-to-end", meaning check all components and accessories. The following items should also be included on all watercraft:

Life Jacket

Fire Extinguisher

Flares

Paddles (2)

Life Saver/Seat Cushion/Throw Line

Anchor w/ rope

First Aid Kit, Flash Light, Air Horn, Cell Phone (1 / crew)

Tool Box (w/ sufficient repair equipment)

Waterproof storage bag or box

Bail out bucket or sump pump

Spare gas can

Incidentals (WD-40, Duct Tape, "LeatherMan" tool, etc)

12. Mobile Laboratories

12.1. Mobile Lab Safety

Safe work practice requires alertness and a knowledgeable awareness of potential hazards. Safety is the collective responsibility of everyone. It requires the full cooperation of all concerned. This means that each person must observe safety precautions and procedures and should:

- Follow all safety instructions carefully
- Become thoroughly acquainted with the location and use of safety facilities such as fire extinguishers, showers, exits, and eyewash fountains
- Become familiar with the hazards of the chemicals being used before the project is started
- Become familiar with the chemical operations and all hazards involved before the precautions on the labels and on the MSDS..

Many accidents have resulted from an indifference attitude, failure to use common sense, or failure to follow instructions. Be aware of what your fellow workers are doing because you can be a victim of their mistakes. Do not hesitate to point out to fellow workers that they are engaging in unsafe practices or operations. If necessary, report it to your supervisor.

Horseplay cannot be tolerated. Variations in procedures including changes in quantities or reagents may be dangerous. Never leave a reaction that is in progress.

12.2. Personnel Protective Equipment (PPE)

12.2.1 Eye Protection

All persons in the sample prep areas, including visitors, must wear eye protection at all times, even when not performing a chemical operation. The use of contact lenses in the laboratory is acceptable, providing that other eye protection is used (i.e. goggles, glasses, or face shields).

12.2.2. Clothing

Laboratory work in general should be done with the protection of a laboratory coat. Lab coats with long sleeves or other protective clothing must be worn at all times when handling potential skin irritating substances.

Lab aprons must be worn when handling extremely caustic or toxic material. When washing glassware, a neoprene apron should be worn.

Do not wear high-heeled shoes, open-toed shoes, sandals, and shoes made of woven material. Shorts and cutoffs are also inappropriate.

12.2.3. Gloves

Hands and arm protection must be considered whenever there is a health danger associated with skin contact. The proper type of glove must be used whenever work involves a chemical of this kind. Several types of gloves are used for protection from chemicals. These are as follows:

- Acids – Neoprene Rubber Gloves
- Solvents (gases/chlorinates) - Nitrile
- Soils – Latex

12.3. Food and Beverages

Following these basic work practices is essential:

- Before leaving any chemical work area, wash your hands and arms thoroughly even if gloves had been worn.
- Do not apply cosmetics in a chemical work area.
- Use only the respirator equipment that has been personally assigned to you. If you need a respirator, a fit test will be performed and a respirator will be issued.

12.4. Housekeeping

Safety starts with housekeeping. A clean, neat and orderly work area is an important reflection of safe work habits and attitudes.

Good housekeeping means cleanliness and order and is a day-to-day job. It is each employee's responsibility to keep his working area neat and orderly at all times.

- Dirty dishes/glassware should be cleaned as quickly as possible. Space in a mobile lab is already limited so clean and replace all materials used as soon as possible. Broken glassware and empty bottles and containers must be disposed of immediately. Empty solvent bottles should be rinsed and defaced before disposal.
- Chemicals and solvents should never be left out overnight, but should be stored away in their proper places.
- Every effort should be made to keep floors and other working areas free of debris and spilled material. Chemicals spilled on the floor or counter top must be cleaned up immediately.
- Fume hoods should not be cluttered or used for storage.
- Aisles, doorways, and emergency equipment must not be blocked at any time. Portable equipment or material should not be placed closer than one foot to the

edge of a doorway.

- Electrical cords must never be stretched across an aisle. This creates a slip/trip hazard.
- Avoid behavior that might confuse, startle, or distract another worker. Avoid running in the lab.
- Lab coats should not be left lying around in the lab or break/lunch area.
- Desks, tables, workbenches should be cleared and clean at the end of the workday.

13. Glossary of Terms

Attitude - the height of the tow vehicle with respect to the trailer. For towing, the tow vehicle and trailer elevations should match for a level connection.

Axle - the supporting shaft upon which a trailer and tow vehicle's wheels revolve.

Brake lights - lights mounted to the rear of the tow vehicle and trailer to signal other drivers that the towing vehicle has activated its braking system

Breakaway switch - a device that deploys a trailer's emergency brakes once the trailer becomes separated from the tow vehicle.

Crosswinds - winds that blow perpendicular to the direction of the vehicle's travel.

Coupler - the part of the trailer hitch that physically connects to the hitch ball.

Draw bar (ball mount) - the device that slips into the hitch receiver so that the hitch ball can be mounted.

Emergency brakes - emergency braking system for trailers that is activated upon an unexpected release of the trailer from the tow vehicle.

Escape ramp - a long bed of loose soft material to slow a runaway vehicle, sometimes used in combination with an incline. Escape ramps are often used on steep mountain grades.

Fifth wheel handle - the device used to release or lock the plate jaws.

Fifth wheel hitch plate - the device that allows the trailer to rotate.

Fifth wheel pin box - structure attached to the bottom front section of the trailer frame (the pin is attached to the bottom).

Fifth wheel plate jaws - the device that holds the pin in the fifth wheel trailer hitch apparatus.

Fifth wheel side rails - support rails that are bolted to the tow truck bed to support the fifth wheel hitch.

Gear - a specific drive setting in either a manual transmission (gears 1-5, reverse) or automatic transmission (park, drive, reverse, neutral).

Gross Axle Weight Rating (GAWR) - the maximum total weight that a specific axle (front/rear) is capable of supporting.

Gross Trailer Weight (GTW) - the weight of the trailer, trailer load (boat, ATV, mobile

laboratory) and normal cargo load, sitting detached from the tow vehicle.

Gross Vehicle Weight Rating (GVWR) - the maximum allowable weight of the fully loaded vehicle.

Hitch - Weight Carrying - hitch designed to carry all of the trailer tongue weight on the tow vehicle's rear axle. This is the simplest hitch configuration, but is limited by its stability while towing.

Hitch - Weight (Load) Distributing - hitch designed to distribute the tongue weight to all axles of the tow vehicle, which helps stabilize the trailer and prevent swaying while towing. This type of hitch is often used for heavier loads since the tongue weight is distributed between all axles of the tow vehicle.

Hitch - Fifth Wheel Trailer - trailer hitch used for heavier trailers or loads that cannot be handled by a conventional hitch. The fifth wheel hitch occupies the center of a truck bed, with the hitch pin located just in front of the center line of the tow vehicle's rear axle.

Hitch ball - the part of the hitch that physically connects the trailer to the tow vehicle by receiving the coupler from the trailer tongue.

Hitch pin - tool that locks the draw bar (ball mount) into the hitch receiver.

Hitch receiver - the part of the hitch fitted to the tow vehicle. The design of the receiver determines if it is a weight-carrying or weight-distribution hitch.

Hitch weight - see Trailer Tongue Weight (TTW)

Jack knife - an accident where a vehicle pulling a trailer goes into a skid, the trailer swings out, and the vehicle folds back to meet it. Jack knifing often occurs on slippery roads when a driver takes a curve too fast or has to make a sudden stop.

Lug nuts - the nuts that bolt the wheel to the hub assembly.

Payload - the total weight of passengers and cargo inside of a vehicle.

Reducing radius curve - exit ramps where the road curve continually tightens.

Running lights - lights mounted on the side of the tow vehicle and trailer to indicate their presence, used predominantly at night and times of inclement weather or other vision-reducing conditions.

Safety chains - metal chains that provide an additional connection between the tow vehicle and trailer. These chains cross under the trailer tongue in an "X" pattern to form a saddle that prevents the tongue from dropping to the road in the event of a hitch disconnection.

Spring bars - used with weight distribution hitches to distribute the tongue weight among all axles of the tow vehicle.

Surge brakes - an independent trailer braking system that is activated by a master cylinder located at the junction of the hitch and trailer tongue. An independent hydraulic system is used for braking power.

Sway control device - an optional connection between the draw bar and the trailer tongue designed to lessen the pivoting motion between the tow vehicle and trailer.

Tail lights - lights mounted on the rear of the tow vehicle and trailer to indicate their presence, used predominantly at night and times of inclement weather or other vision-reducing conditions.

Tire - wheel covering, usually made of rubber and reinforced with cords of nylon, fiberglass, or other material, and filled with compressed air.

Tire pressure - an indicator of tire inflation, usually measured in units of pounds per square inch (psi). In order to get an accurate tire pressure reading, the measurement should be done when the tire is cold.

Tongue - the front of the trailer that physically attaches to the tow vehicle.

Trailer frame - the frame of the trailer.

Trailer jack post (landing gear) - this equipment serves as a landing gear that is lowered before the trailer is detached from the tow vehicle in order to provide a support for the front of the trailer so that it can remain level after detachment from the tow vehicle.

Trailer Tongue Weight (TTW) - the weight obtained from by detaching the fully loaded trailer from the tow vehicle and placing only the trailer jack post on the scale.

Transmission - a system of gears and associated parts that transmits power from the engine to the drive axles. The transmission for tow vehicles can be manual (stick shift/clutch) or automatic.

Turn signals - lights mounted on all sides of the tow vehicle and on the rear of the trailer to indicate the tow vehicle / trailer turns and lane changes.

Wheel base - the distance from the front to the rear axles in a tow vehicle or trailer.

Wheel chains - special chains designed to be placed over vehicle tires for traction in extreme weather conditions (snow, ice, etc.).

Wheel chock - a block or wedge placed under the wheel to prevent it from moving.

Wheel rim - the portion of the wheel that attaches to the wheel axle and holds the tire in place.

Appendix A – Trailer Towing Pre-Trip Safety Inspection Checklist

Trailer Towing Pre-Trip Safety Inspection Checklist – Page 1

Date:

Reviewer:

Review the following checklist and indicate whether each item is satisfactory (SAT.), unsatisfactory (UNSAT.) while including applicable notes. All unsatisfactory issues must be properly addressed before the trailer can be towed.	SAT.	UNSAT.	NOTES LEGEND
I. Tow Vehicle			
1. The tow vehicle has enough power to safely tow the trailer load.			
2. The tow vehicle has received regular preventative maintenance work.			
3. The tow vehicle has adequate fuel, battery power, oil, and engine coolant.			
4. The tow vehicle tires are properly inflated and balanced, and do not show excessive wear or damage.			
5. The wheel fasteners (lug nuts) are present, tight, and free of rust.			
6. Wheel rims are free from damage.			
7. Tow vehicle is level when attached to the loaded trailer.			
8. All lights (dash lights, headlights, tail lights, clearance lights, brake lights, directional signals, hazard lights, high beams, reflectors) are in proper working order.			
9. All brakes are in proper working order.			
10. Side view mirrors provide an unobstructed rear view on both sides of the vehicle.			
II. Hitching Apparatus			
1. The receiver is properly mounted to the tow vehicle.			
2. The receiver, draw bar, hitch ball, coupler, sway control device, spring bars, safety chains, and power connection wiring are all functional and compatible with the tow vehicle and trailer.			
3. The power and brake control connections between the trailer and tow vehicle are compatible, provide enough slack for turning and are in good working order.			
4. The landing gear (trailer jack) is functional.			
5. The hitch ball and coupler are the same size. When attached, the ball is firmly seated in the coupler, and the latching mechanism is locked.			

Trailer Towing Pre-Trip Safety Inspection Checklist – Page 2

Date:

Reviewer:

Review the following checklist and indicate whether each item is satisfactory (SAT.), unsatisfactory (UNSAT.) while including applicable notes. All unsatisfactory issues must be properly addressed before the trailer can be towed.	SAT.	UNSAT.	NOTES LEGEND
II. Hitching Apparatus (continued)			
6. The safety chains are securely attached to both the tow vehicle and trailer, crossing under the trailer tongue in an "X" pattern.			
7. The safety chains connect the trailer and tow vehicle, while providing enough slack for turning.			
8. The eyelets holding the safety chains all have their open-ended hooks facing the outside of the hitch connection.			
9. If using a fifth-wheel trailer hitch, the following equipment is in good working order: fifth-wheel plate, plate jaw and handle, hitch plate, pin and pin box, and side rails.			
III. Trailer			
1. The trailer frame is free of cracks, fractures, bends and other signs of weakness.			
2. All lights (tail lights, clearance lights, brake lights, directional signals, hazard lights, reflectors) are in proper working order.			
3. The trailer tires are properly inflated and balanced, and do not show excessive wear or damage.			
4. The trailer wheel fasteners (lug nuts) are present, tight, and free of rust.			
5. Trailer wheel rims are free from damage.			
6. Loaded trailer is level when attached to the tow vehicle.			
7. Running boards (if present) are in good condition.			
8. Winch (if present) is in working order.			

Trailer Towing Pre-Trip Safety Inspection Checklist – Page 3

Date:

Reviewer:

IV. Load Distribution			
1.	The trailer load has a center of gravity that is as low as possible, and there is no risk of loose items falling off the trailer.		
2.	Taken separately, the towing vehicle and trailer have even weight distributions (front to rear, left to right). This has been verified by visual inspection and/or scale measurements.		
3.	The trailer weight and its distribution are compatible with the tow vehicle and hitching system, as verified by conducting a Vehicle-Trailer Compatibility Checklist as included in the Trailer Towing Safety Manual (Appendix B)		

Inspection Notes /Issues Found / Remedial Action Taken:[illegible]

Appendix B - Trailer-Truck-Hitch Compatibility Analysis

Trailer – Truck – Hitch Weight and Rating Survey and Compatibility Analysis

Date: _____

Reviewer: _____

Tow Vehicle: _____

Trailer Load: _____

The following analysis should be conducted by an EPA staff member who has taken the Trailer Towing Safety Course. These worksheets provide a guide to ensuring that the weight distribution of the trailer is compatible with the tow vehicle and hitching system.

In Table B-1, the reviewer determines the 16 individual values as outlined. From this, an analysis of weight distribution and tow vehicle / trailer load compatibility can be conducted in Table B-2. If any of the checklist questions in Table B-2 are answered as “NO”, efforts must be made to redistribute the load or find other equipment capable of handling the loads necessary for the specific trip. If any weight redistributions are done to address a specific issue, the entire analysis will have to be repeated to ensure that none of the redistributions affected other potential compatibility checklist items.

These forms should be completed, and the inspector shall be able to answer all the checklist questions in Table B-2 with a “YES”. This form should be attached to the pre-inspection trailer checklist, and a copy of both forms should be sent to the safety manager. Note: No trip involving the towing of a trailer can take place before both this compatibility analysis and the pre-trip inspection checklist have been satisfactorily completed.

Table B-1. - Trailer-Truck-Hitch Weights and Ratings

Line Item	Trailer / Vehicle Component Weight/Rating	Description	Weight/Rating
Trailer Weights			
1.	Gross Trailer Weight (GTW)	Scale Reading from the trailer and all trailer contents (i.e. boat, lab, ATV, equipment) sitting detached from the vehicle.	
2.	Trailer Tongue Weight (TTW)	Also known as Hitch Weight, this value is obtained by detaching the trailer at full load, placing only the landing gear (trailer jack) on the scale. The trailer should be at the height that it will be towed at, since the attitude affects the scale reading	
Tow Vehicle Weights			
3.	Base Curb Weight (BCW)	This is the weight of the tow vehicle (fuel included) with no passengers or equipment. This value can usually be obtained from the vehicle owner's manual.	
4.	Gross Vehicle Weight (GVW)	The BCW, plus the weight of all passengers and equipment. This value can be obtained by placing the entire tow vehicle on the scale (trailer detached) with all passengers and equipment inside the vehicle.	
5.	Gross Combination Weight (GCW)	This is the combined weight of the towing vehicle, trailer, trailer load, passengers and associated equipment. This value can be obtained by positioning all of the wheels of both the loaded tow vehicle and loaded trailer on the scale, or taking the sum of GTW and GVW.	
6.	Gross Axle Weight - Front (GAW-Front)	This is the total weight placed on the tow vehicle's front axle while the trailer is attached. This value can be obtained by placing only the front wheels of the tow vehicle (trailer attached) on the scale.	
7.	Gross Axle Weight - Rear (GAW - Rear)	This is the total weight placed on the tow vehicle's rear axle while the trailer is attached. This value can be obtained by placing only the rear wheels of the tow vehicle (trailer attached) on the scale.	

Line Item	Trailer / Vehicle Component Weight/Rating	Description	Weight/Rating
Tow Vehicle Weight Limits			
8.	Gross Vehicle Weight Rating (GVWR)	This is the maximum permissible weight of the vehicle while fully loaded. This limit can usually be obtained from the vehicle's owner manual, or inside the driver's side door.	
9.	Gross Combination Weight Rating (GCWR)	This is the maximum permissible weight of the towing vehicle, trailer, trailer load, passengers, and associated equipment. This limit is provided in the vehicle manual, or can be provided by the manufacturer.	
10.	Gross Axle Weight Rating - Front (GAWR - Front)	This is the total weight that the tow vehicle's front axle is capable of carrying. This limit can usually be obtained from the vehicle's owner manual, or inside the driver's side door.	
11.	Gross Axle Weight Rating - Rear (GAWR - Rear)	This is the total weight that the tow vehicle's rear axle is capable of carrying. This limit can usually be obtained from the vehicle's owner manual, or inside the driver's side door.	
12.	Maximum Trailer Towing Rating (MTTR)	This is the maximum load that the vehicle is capable of towing. This limit can usually be obtained from the vehicle's owner manual, or inside the driver's door.	
Hitch Weight Limits			
13.	Hitch Capacity (HC)	This is the maximum load that the hitch can safely tow. This limit is often given right on the hitch frame.	
14.	Tow Ball Rating (TBR)	This is the maximum load that the tow ball can safely support. This limit is often stamped directly onto the tow ball itself.	
15.	Tongue Weight Rating (TWR)	This is the maximum tongue weight that the hitch system can safely carry. This limit is often given right on the hitch frame.	
16.	Draw Bar Tongue Rating (DBTR)	This is the maximum tongue weight that the draw bar can safely support. This limit is often given right on the draw bar itself.	

Table B-2. Trailer-Truck Hitch Compatibility Checklist

Question / Check of Conformance	YES	NO	If no, this issue should be addressed before trip departure. Possible solutions include:
Gross Trailer Weight Checks			
Is Line Item 1 (GTW) less than Line Item 12 (MTTR)?			(1) Select another tow vehicle with a higher MTTR. (2) Reduce the GTW.
Is Line Item 1 (GTW) less than Line Item 13 (HC)?			(1) Select another hitch with a greater HC. (2) Reduce the GTW.
Is Line Item 1 (GTW) less than Line Item 14 (TBR)?			(1) Select another hitch system or tow ball with a greater TBR. (2) Reduce the GTW.
Trailer Tongue Weight Checks			
Is Line Item 2 (TTW) 10-15% of Line Item 1 (GTW)?			(1) Verify that the trailer is properly loaded. (2) Select another trailer appropriate for carrying the desired load.
Is Line Item 2 (TTW) less than Line Item 15 (TWR)			(1) Decrease the TTW (keeping within 10-15% of GTW). (2) Select another hitch system with a higher TWR.
Is Line Item 2 (TTW) less than Line Item 16 (DBTR)?			(1) Decrease the TTW (keeping within 10-15% of GTW). (2) Select another draw bar and/or hitch system capable of handling the load
Tow Vehicle and Trailer Weight and Distribution Checks			
Is Line Item 4 (GVW) less than Line Item 8 (GVWR)?			(1) Decrease the GVW. (2) Select another vehicle with a greater GVWR.
Is Line Item 5 (GCW) less than Line Item 9 (GCWR)?			(1) Decrease the GCW (GVW plus GTW) (2) Select another vehicle with a greater GCWR.
Is Line Item 6 (GAW-Front) less than Line Item 10 (GAWR-Front)?			(1) The distribution of the tow vehicle load needs to be adjusted.
Is Line Item 7 (GAW-Rear) less than Line Item 11 (GAWR-Rear)?			(1) Decrease the TTW (keeping within 10-15% of GTW). (2) The distribution of the trailer load needs to be adjusted.

END OF COMPATIBILITY ANALYSIS