



Global MX-5 Cup ND.2 User Guide

Refer to the latest version of the Global MX-5 Technical Rules for up to date information regarding rules and regulations

Do Not Operate Vehicle until you've done the Following:

Read this entire document, all associated manufacturer instructions, and FIA Safety Regulations.

Fully installed a FIA seat, FIA safety belts and FIA Drivers Nets.

Connected the Fire Bottle Wiring in the Trunk and Activated the Fire System

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1.0 Starting the Car and Operation of Cooling Pumps

Check Oil and Coolant levels before starting the vehicle

The Switch panel on the dash has the following 4 Switches and 2 Buttons:

1. 3-Way Master:
 - a. Down "Off" = Power Off
 - b. Middle "ACC" = Accessory Power On
 - c. Up "IGN" = ACC + Ignition Power
2. Separate transmission & differential cooler pump and fan over ride switches:
 - a. Down = Power Off
 - b. Up = Power On
3. Fire Bottle Button: Press to Operate Fire Bottle
4. Fuel Reset: Press to Reset Fuel Counter to "0", Fuel Counter counts fuel used in liters when the engine is running.
5. 93 Oct / 100 Oct: Selector for Fuel Map Options. Make sure switch position matches the octane rating of the fuel you are running.



Figure 1: Switch Panel



Figure 2: Start Button

2.0 To Start the Engine:

- ❖ Move the 3-Way Master Switch up to the IGN position (figure 1). Depress Clutch Pedal (and brake as needed), Press and hold the Factory Start Stop Button. (figure 2)

3.0 To Turn the Engine Off:

- ❖ Move the 3-Way Master Switch to the OFF Position. Or, flip the external master kill switch on the cowl near the Windshield Wipers.

4.0 Fire System:

- ❖ Before vehicle use, the Fire Bottle Cable, see figure 3, must be reconnected to the bottle in the trunk. This line is disconnected during transport to eliminate any possibility of accidental discharge.



Figure 3. Fire Bottle Cable, Trunk.

- ❖ The control unit, see figure 4, on the center console has a switch that allows you to:
 - Test the battery
 - Test the system (when the system is in TEST, you can operate the trigger buttons without discharging the system to verify the wiring is working)
 - Engage or Arm the system.



Figure 4: Fire System Control Unit, Right Side of Center Console.

- ❖ Review the LifeLine instruction booklet included in the trunk kit, or online at <http://www.lifeline-fire.co.uk/>
- ❖ [Installation Guide](#)
- ❖ [System Care, Maintenance & Servicing](#)
- ❖ **!!! Always remember to TEST and ARM (or engage) the system prior to on track activity!!!**

5.0 Seat Installation:

- ❖ Before vehicle use, a FIA compliant Seat and seat mounting brackets must be installed meeting the requirements of FIA document, 2019 Appendix J – Article 253, Safety Equipment (Groups, N,A, R-GT), ART. 16, Seats, Anchorage Points and Supports. This document is available for download at <http://www.fia.com/Regulations>.
- ❖ An FIA compliant seat mounting baseplate, see figure 5, Mazda part # 0000-08-5111, is provided as a mounting surface.
 - Additional Plates may be welded to the provided seat mount plate to extend the mounting surface forward if necessary. Plates must be between 1/8" and 3/16" thick, must be attached by at least 2.75" of 1/8" weld, and may not be added for the purpose of ballast.



Figure 5: Seat Mount Base Plate

6.0 Seat Belt Installation:

- ❖ Before vehicle use, FIA compliant Safety Belts must be installed meeting the requirements given in FIA document, 2016 Appendix J – Article 253, Safety Equipment (Groups, N,A, R-GT), ART. 6, Safety Belts. This document is available for download at <http://www.fia.com/Regulations>. FIA compliant safety belts, eyebolts and backing plates are supplied with the vehicle.
- ❖ A bar for shoulder belt attachment, see figure 6, is provided in the rear of the car. Additional brackets may be welded to this bar, and this bar only, to achieve desired belt angle. All connection points must be designed to withstand 1,470 daN (3,405 lbs-force) per the FIA Safety Equipment Specification, 2016 Appendix J – Article 253, Safety Equipment (Groups, N,A, R-GT), ART. 6, Safety Belts.

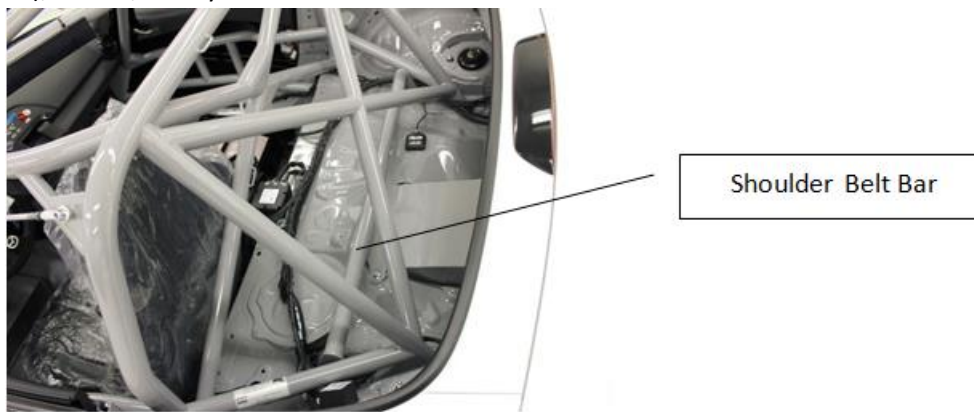


Figure 6: Shoulder Belt Bar

7.0 Battery Maintenance:

The Battery Tender BTL24A480CW Lithium Ion battery or the Odyssey Extreme PC1200 will be supplied with this vehicle. Both are very lightweight and efficient. Review Battery Tender's and Odyssey's user manuals to ensure the battery is properly maintained and remains in good working condition:

<http://products.batterytender.com/Batteries/Smart-Lithium-Battery.html>

<https://www.odyseymbattery.com/Support/Literature>

A few key points include:

- a) Fully charge new batteries before use.
- b) There is a new Battery Management System built into the batteries that will go into a protection mode to prevent over charging and over discharging. The reset harness must be installed on the battery to be able to reset the battery in the case that it ever goes into protection mode.
 - i. When the battery discharges below 11volts it will behave like it's completely dead until it is reset with the reset harness.

- ii. Note that your vehicle will not start if discharged much below 12.5 volts. c) Do not charge over 14.8 volts, and do not charge with more than 10 Amps.
- d) It is recommended to use a Lithium Ion trickle charger between uses to ensure the battery remains fully charged. <http://products.batterytender.com/Automotive/Battery-Tender-Junior-12V-0-75A.html>

8.0 Fluids:

Item	GMX5 Spec Fluid
Engine Oil	5w30 Flis Performance Oil
Rear Differential Oil	75W-90 Flis Performance Oil
Transmission Oil	75W-90 Flis Performance Oil
SADEV Transmission Oil	75W-90 Flis Performance Oil
Brake Fluid	DOT 4 OR HIGHGER
Fuel	91 – 101 Octane Series dependent
Coolant	Cool-aide or Mo Cool

- ❖ The vehicles are shipped with stock Engine Coolant to prevent freezing during shipment. A bottle of Maxima Cool- Aide is included in the Trunk Kit for use in competition which should only be mixed with distilled water.
- ❖ Fuel pump out: MUST HAVE MANNED FIRE EXTINGUISHER
 1. Make sure engine is not running and power is turned off. It is recommended to connect Battery Tender Lithium Ion Battery Charger to the Battery during pump out to ensure the battery is not over discharged.
 2. Connect pump out hose to dry break fuel line fitting, and place open end of hose into fuel storage container.



3. Remove Fuel Pump Relay from Fuse Box.



4. Replace Fuel Pump Relay with On/Off Relay Switch, make sure switch is in the off position.



5. Turn Vehicle Power On (up 1 click) to “ACC”. Going up to “IGN” will drain the battery unnecessarily.
6. Turn the On/Off Relay Switch to “On” and fuel should start pumping.
7. When fuel flow has slowed to a very slow trickle, pump out is complete. Turn the On/Off Relay Switch to “Off” and turn the vehicle’s power off as well.
8. While holding the Pump out Hose end in the Fuel Storage Container, Disconnect the dry break and lift up to drain remaining fuel left in the hose into the Fuel Storage Container.
9. Safely store fuel.
10. Replace On/Off Relay Switch with Blue OEM Fuel Pump Relay and replace fuse box cover.
 - a) If you start the car with the On/Off Relay Switch installed in the “Off” Position it may run for longer than you expect, but will eventually run out of fuel in the lines and behave like a car with no fuel.

9.0 Engine, Transmission and Differential Seals:

- ❖ The Engine, SADEV Transmission and Differential have been sealed with tamper proof/evident devices to prevent modification to these parts. Evidence of removal or tampering with these seals will be cause for disqualification and or fines in Global MX-5 Cup Competition.
- ❖ Open testing can be done with unsealed components, however for official Global MX-5 Cup Practice, Qualifying and Races, only sealed components may be used. Components that have become unsealed without the supervision of a Global MX-5 Cup Official, or Flis Performance cannot be recertified and resealed.

10.0 Auxiliary Power:

- ❖ The main power panel is mounted in the trunk of the car. There is a 6 way fuse block available for powering Accessories such as helmet blowers, cool suits, etc. The fuse block is rated at 30 amp for an individual connection, with a 65 amp max for all 6 branches combined. All connections made to this block will need to be insulated. See figure 7.



Figure 7: Power Distribution Panel (Trunk)

- ❖ There is also a standard 12volt Accessory Socket located under the dash just to the right of the center console that may be used. See figure 8.

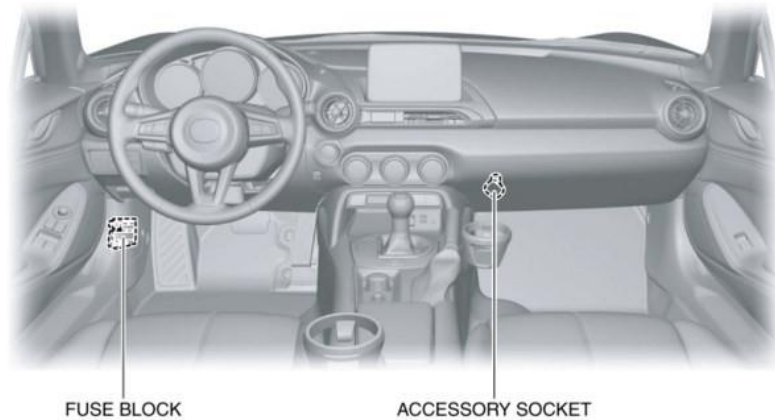


Figure 8: 12 volt Accessory Socket Location

11.0. AiM MXL2 Dash:

- ❖ The vehicle is equipped with an AiM MXL2 Dash. The MXL2 connects directly to the ECU Adaptor Harness through a 4 pin DTM06-4S Connector. Pin 1: CAN +, Pin 2: Ground, Pin 3: 12 volt, Pin 4: CAN - .
- ❖ Before your vehicle shipped, the MXL2 was updated with the latest firmware and a standard configuration template. The Standard Configuration can always be downloaded [here](#).
- ❖ Tracks can be uploaded to the MXL2 using AiM's RaceStudio 3 Software, having the track uploaded will ensure you are receiving lap time.
- ❖ The MXL2 instruction booklet is included in the trunk kit. User instructions and links for Downloads of the Race Studio 3 software can also be found here:
<https://www.aim-sportline.com/en/products/mxl2/index.htm>
- ❖ Always keep your RaceStudio 3 Software and the MXL2 firmware up to date.

12.0 ECU



The 2019 ND2 Global MX-5 Cup car is shipped with a Bosch MS6 Cup ECU. The ECU is encrypted specifically for the ND2.

Features:

- ❖ Fully encrypted to prevent tampering.
- ❖ Updatable by the end user only with officially released encrypted files produced by Flis Performance and Bosch Motorsports.
- ❖ Mounted inside the cockpit under the right side dash panel for protection from engine bay conditions.
- ❖ Two Fuel Maps selectable by switch on the Dash, one for 93 octane pump gas, and another for 100 octane race fuel.
- ❖ Built in Fuel Counter that counts fuel burned by the liter, can be displayed to the AiM Dash. Fuel Reset Button included on Dash Switch Panel.

13.0 Ballast Box:

A standard Ballast Box, Mazda part # 0000-08-5053 that mounts in place of the passenger seat is included. Ballast may be added to the vehicle using an empty Ballast Box with no lid, an empty Ballast Box with the lid, or a Ballast box with 5 and 10 pound plates as needed. Series rules and requirements may vary; Global MX-5 Cup Currently considers driver weight to be 220 lbs. So a driver weighing 200 lbs. would be required to add 10 lbs. of ballast to the ballast box, and a driver weighing 220 would add 0 lbs.

- ❖ Ballast Box, empty with the Lid and all fasteners, 27.5 lbs. / 12.5 kg
- ❖ The Ballast Box will hold up to an additional 130 lbs. / 59kg of ballast. Twelve 10 lbs. plates and two 5 lbs plates.
- ❖ 10 Pound / 4.53kg (Part Number 0000-08-5128-10) and 5 Pound / 2.27kg (Part Number 0000-08-5128-05) weights designed to fit in the box are available for purchase.
- ❖ Secure all ballast plates inside the box with two ½” nuts, and secure the lid with the four ½” bolts provided.
- ❖ Ballast may not be installed anywhere on the vehicle except inside the ballast box.
- ❖ The Ballast Box has tabs on each of the four sides to allow for items such as cool suit units to be strapped in place.
- ❖ A 75 pound lid is available for Race Series requiring additional ballast.

Global MX-5 Cup Ballast Chart			
Based on 220 lbs "driver weight"			
Driver Weight with Gear	Suggested # of 10-lb Ballast	Suggested # of 5-lb Ballast ²	Total Ballast Weight + Driver
140 lbs	8	1	225
145 lbs	7	2	225
150 lbs	7	1	225
155 lbs	6	2	225
160 lbs	6	1	225
165 lbs	5	2	225
170 lbs	5	1	225
175 lbs	4	2	225
180 lbs	4	1	225
185 lbs	3	2	225
190 lbs	3	1	225
195 lbs	2	2	225
200 lbs	2	1	225
205 lbs	1	2	225
210 lbs	1	1	225
215 lbs	0	2	225
220 lbs	0	1	225

Note: total weight goes to 225 lbs to allow for drivers to adjust in increments of 5 pounds and account for future weight adjustment.

14.0 Baseline Setup:

This vehicle has been shipped with a standard ride height and sway bar end link lengths that will need to be adjusted after your seat and ballast is installed. The minimum weights and ride heights given below are for reference only. Refer to series regulations for current weight and height requirements.

To set initial balance:

- ❖ Disconnect front and rear sway bars and place vehicle on scales with ballast and driver weight in place.
 - The minimum weight of the vehicle with no fuel and with driver is 2450 lbs. or 1095 kg. Use the ballast box and ballast plates described above to add ballast as needed to achieve the minimum weight with driver. The ballast box must remain in the car, extra weight(s) are optional. (Refer to Race Series Regulations for current Requirements)
- ❖ minimum ride height is 4" excluding the 2 plastic angles in front of the front tires, see figure 9, which attach to the front bumper cover and inner fender liners (see picture below). The recommended ride height would be 4-3/8" at the lowest part of the vehicle. (Refer to Race Series Regulations for current Requirements)



Plastic Angle Excluded from Ride Height Measurement

Figure 9: Plastic Angles Excluded from Ride Height Measurement

- 50.5 % Right Cross Percentage ((RF Weight + LR Weight) / Total Weight) is a recommended starting point, though this will vary by track and driver preference.
- ❖ Once desired ride height and cross weight % is achieved, set the sway bars to neutral by adjusting the end link lengths such that the sway bar can be reconnected without loading it.
- ❖ After the desired weight distribution is achieved, align your vehicle. Recommended Toe Settings are 1.5mm out on both front tires (3mm out total) and 1mm in on each rear tire (2mm in total). A very good starting point for camber is 2.8 degrees in the front and 3.0 degrees in the rear.

15.0 Dampers:

- ❖ The vehicle is equipped with 2-way adjustable Dynamic Suspension Spool Valve (DSSV) dampers by Multimatic.
 - Front Damper is Mazda Part Number 0000-04-5616
 - Rear Damper is Mazda Part Number 0000-04-5617
- ❖ The Dampers adjust 0 through 11 for Compression (Bump, Blue) and (Rebound, Red) using a square ended 4mm Allen key.
 - It is important that you do not use a ball end Allen key to make these adjustments, this could cause the Allen key receiver to strip out. A correct 4mm Allen key is provided in the Trunk kit.
 - An increase in the valve setting causes an increase in compression or an increase in rebound.
 - We recommend starting in the center, 5 Compression / 5 Rebound and adjusting from there as needed.
 - Note that there is a stop pin that prevents the valve from continuously rotating See figure 10.



Figure 10: Damper Valve with Seal. 5 Compression, 6 Rebound Shown

- ❖ The spring perches are manufactured with a 68mm hex design for adjustment and locking. A pair of 68mm Damper Perch Wrenches are needed to lock and unlock the perches to make ride height adjustments.
 - The 68mm Damper Perch Wrenches are available for purchase from Mazda Motorsports, Part # 0000-04-5620
- ❖ To service the Torrington bearing, the bottom clevis must be removed. A 36mm Damper Body wrench is needed to hold the clevis while loosening and tightening the nut.
 - The 36mm Damper Body Wrench is available for purchase from Mazda Motorsports, Part # 0000-04-5621
- ❖ The Damper valve block is sealed with a tamper proof label. Evidence of removal or tampering with these seals will be cause for disqualification and or fines in Global MX-5 Cup Competition. Service/Rebuild work may only be done through Carl Haas. Please see Flis Performance website for contact information.

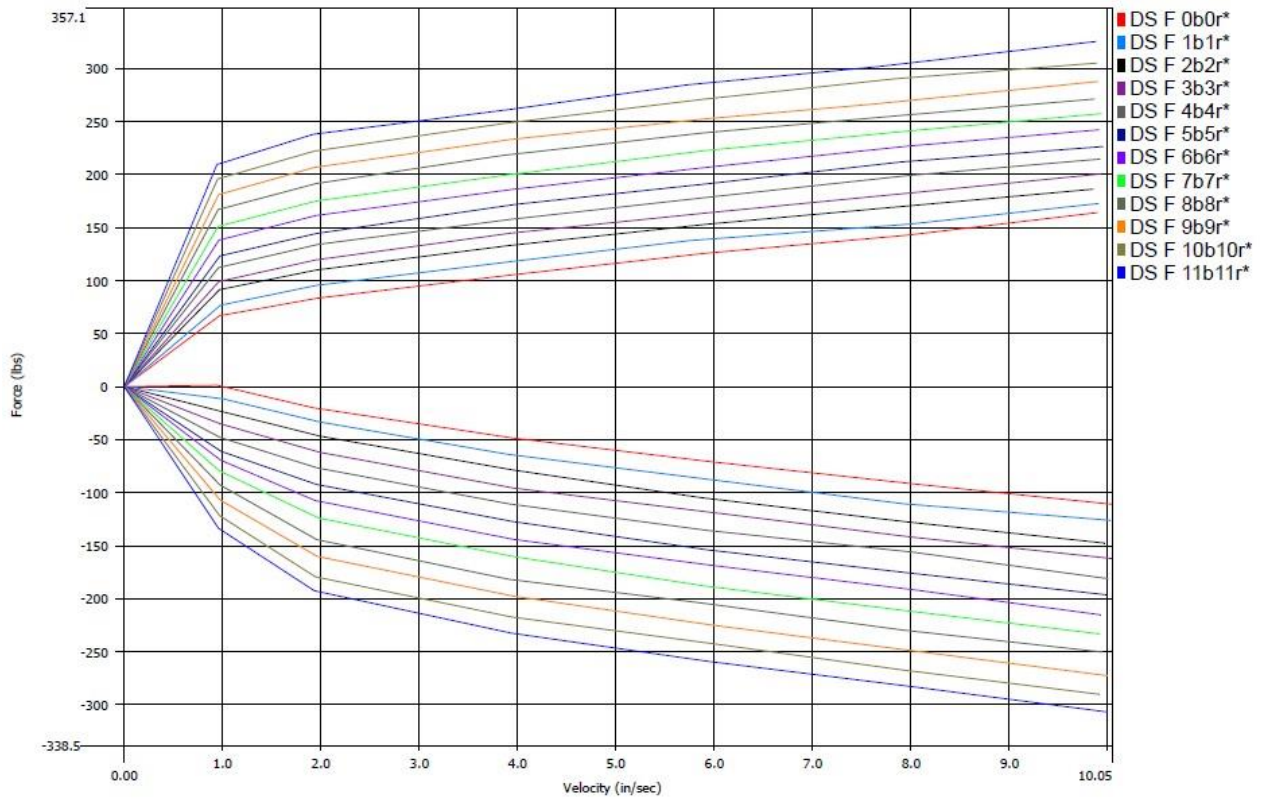


Figure 11: Typical Force Vs. Velocity Front Damper

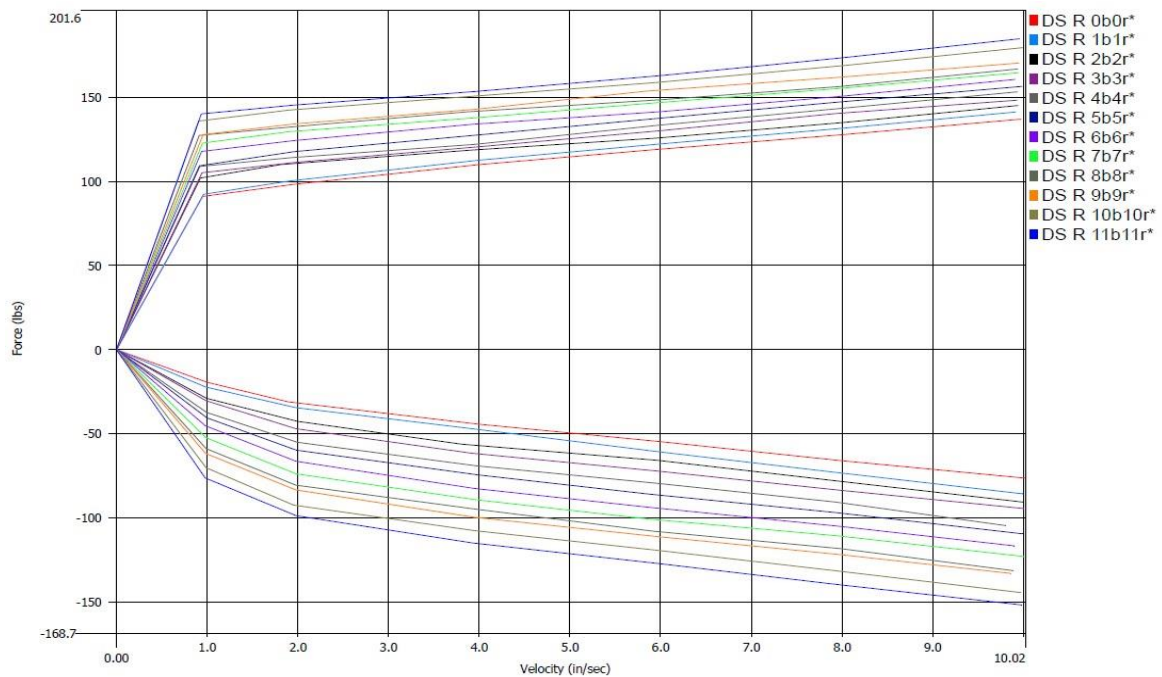


Figure 12: Typical Force Vs. Velocity Rear Damper

- ❖ The Front Sway Bar has three available stiffness settings: Stiff, Medium and Soft. The vehicle is delivered with the bar set at the recommended Medium setting.
- ❖ To soften the sway bar, disconnect the end links, adjust the lengths and spacer configurations as needed to reconnect the link to the outermost hole on the sway bar arm.
- ❖ To stiffen, disconnect the end links, adjust the length and spacer configuration as needed to reconnect the link to the inner-most hole on the sway bar arm.
- ❖ Changes must be made to both the left and right connections to achieve the stiffening or softening affect. See figure 13

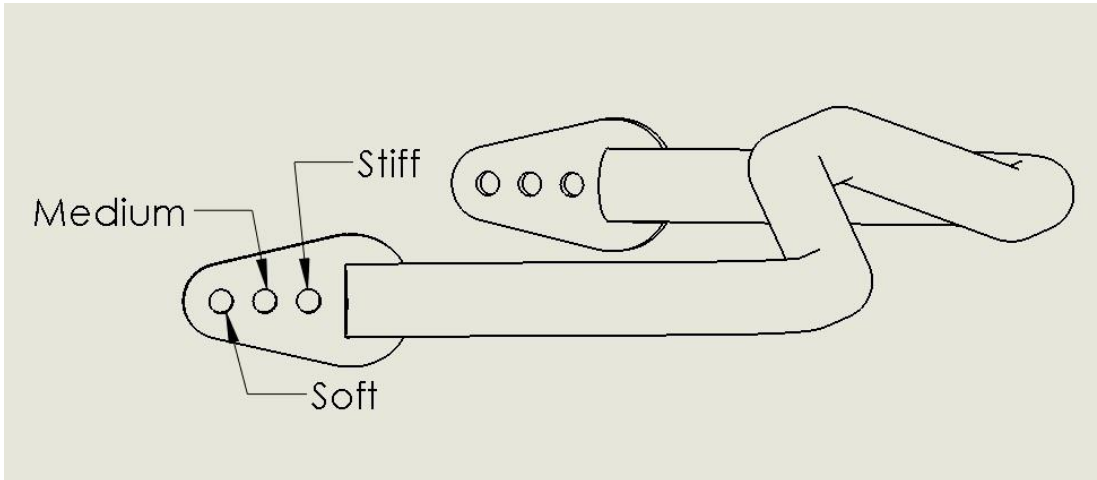


Figure 13: Sway Bar End Link Settings

17.0 Basic Handling Guide:

	Front		Rear	
	Comp / Bump	Rebound	Comp / Bump	Rebound
Straight line braking - front lockup	-			
Straight line braking - rear lockup	+			-
Trail braking - Slow turn-in response	+			+
Trail braking - Understeer	-			+
Trail braking - Oversteer	+			-
Turn in (no braking) - Understeer		-		+
Turn in (no braking) - Oversteer		+		-
Steady State Turning - Understeer*	-	-	+	+
Steady State Turning - Oversteer*	+	+	-	-
Corner exit - Understeer		-	+	
Corner exit - Oversteer		+	-	
Straight line accel - lack of traction		-	-	

* Steady state = no damper influence



18.0 Basic Service Intervals:

As with any standard service items, these intervals should be adjusted based on your level of use and special on-track conditions. The service intervals are based on 10-12 events per year, with a typical event weekend having approximately 3 hours of track time.

FLUIDS	SPEC FLUID	AFTER EACH EVENT	EVERY OTHER EVENT	ANNUALLY
Engine Oil	5w30 Flis Oil	Inspect and Replace		
Differential Oil	75w-90 Flis Oil	Inspect and Replace		
Transmission Oil	75w-90 Flis Oil	Inspect and Replace		
SADEV Transmission Oil	75w-90 Flis Oil	Inspect and Replace		
Brake Fluid	DOT 4 or Higher	Bleed		Full Flush
Engine Coolant	Maxima Kool Aid / Mo Kool W/Distilled Water			Full Flush

FILTER	MAZDA PART NUMBER	AFTER EACH EVENT	EVERY OTHER EVENT	ANNUALLY
Engine Oil Filter	PE01-14-320A	Replace		
Transmission Filter	000-08-5032		Service	Replace
Differential Filter	000-08-5032		Service	Replace
Intake Air Filter	PEES-13-3A0	Replace		

CHASSIS PARTS	AFTER EACH EVENT	REPLACE
Hub Bearing (front/rear)	Clean and Inspect	Annually
Wheel Studs	Clean and Inspect	Annually
Tie Rod End (left/right)	Clean and Inspect	As needed
Eccentric Bolts	Clean and Inspect	As needed
Rear Axles	Clean and Inspect	As needed
Engine Mounts	Clean and Inspect	As needed
Drive Shaft	Clean and Inspect	As needed
Rear Upright (left/right)	Clean and Inspect	As needed
Front Upright (left/right)	Clean and Inspect	As needed
Rear Suspension (left/right)	Clean and Inspect	As needed
Upper Control Arm (left/right)	Clean and Inspect	As needed
Lower Control Arm (left/right)	Clean and Inspect	As needed
Wheels	Clean and Inspect	As needed
Sway Bars (front/rear)	Grease Front Bushings	As needed
Drop Links Front (left/right)	Clean and Inspect	As needed
Drop Links Rear (left/right)	Clean and Inspect	As needed
Brake Duct (left/right)	Clean and Inspect	As needed
Torrington Bearings	Clean and Lube	As needed
Dampers	Clean and Inspect	As needed
Fire Bottle	Check Battery/Bottle Pressure	As needed
Safety Equipment	Clean and Inspect	See Service Date
Diff/Trans Cooler Pump Seals	Review Cooling Data	Rebuild Annually
Diff Bushings	Clean and Inspect	As needed
Front Brake Caliper Seals	Inspect	Annually
Front Brake Caliper Pad Pins	Inspect	Annually
Brake Line	Clean and Inspect	Annually
Power Plant Frame	Clean and Inspect	Annually

19.0 Transmission and Differential Filter Service:

The filter body is labeled “IN” and “OUT”, see figure 14, to indicate fluid flow direction through the filter. Note the direction of flow and ensure the filter is reinstalled in the correct orientation. The Transmission and Differential Pumps have an arrow showing the direction of fluid flow, see figure 15, these must agree with the flow direction of the filters. Fluid will not flow through the filter in the opposite direction and you will damage your transmission or differential.

To Service the Inline Filter:

- ❖ Remove filter body and disassemble as shown in figure 16.
- ❖ Clean out any debris and reassemble.
- ❖ Reinstall in correct orientation as described above.



Figure 14: Transmission and Differential Cooler Line Filter, Assembled



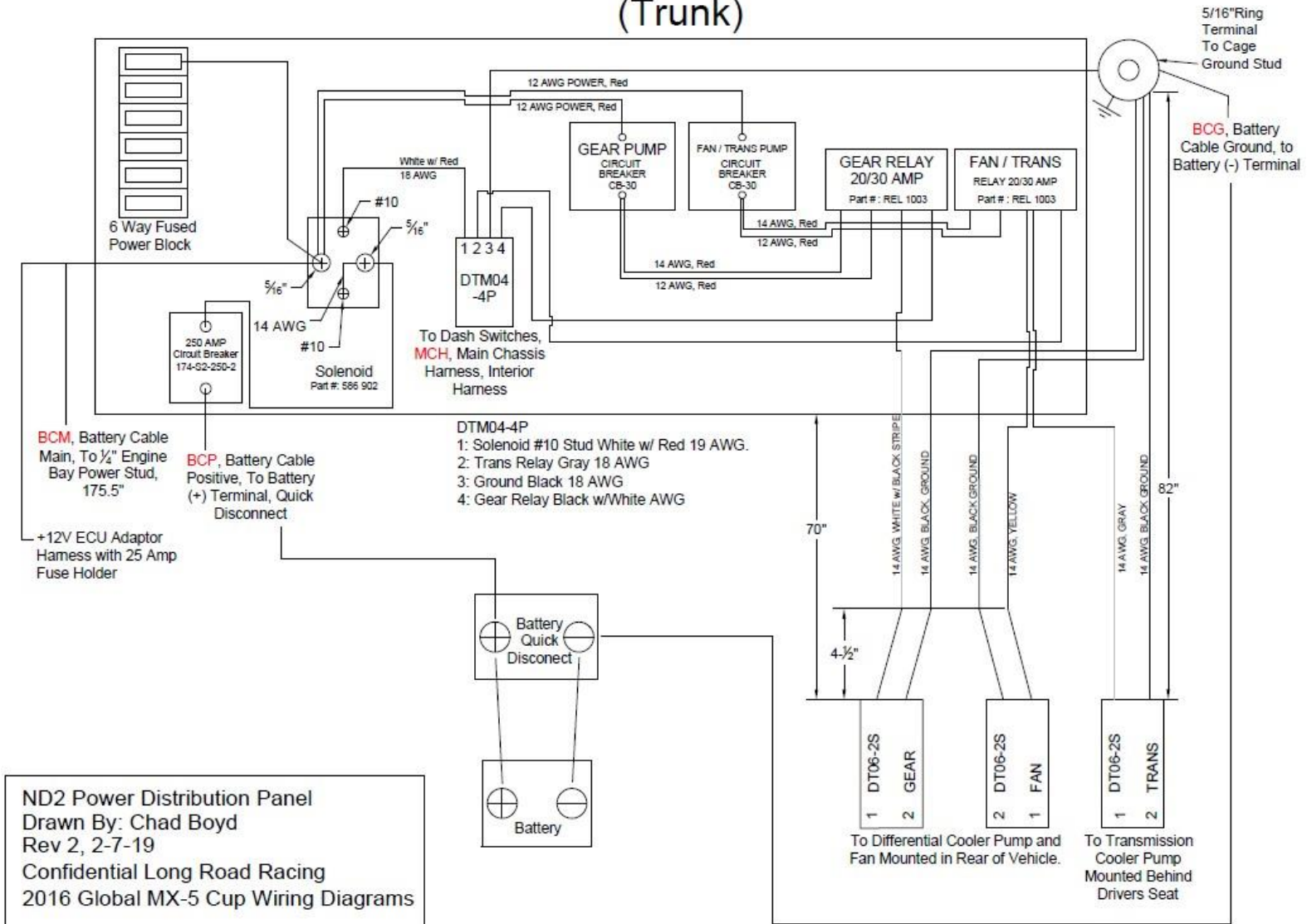
Figure 16: Transmission and Differential Cooler Line Filter, Disassembled



Figure 15: Transmission and Differential Cooling Pump

20.0 Wiring Diagrams:

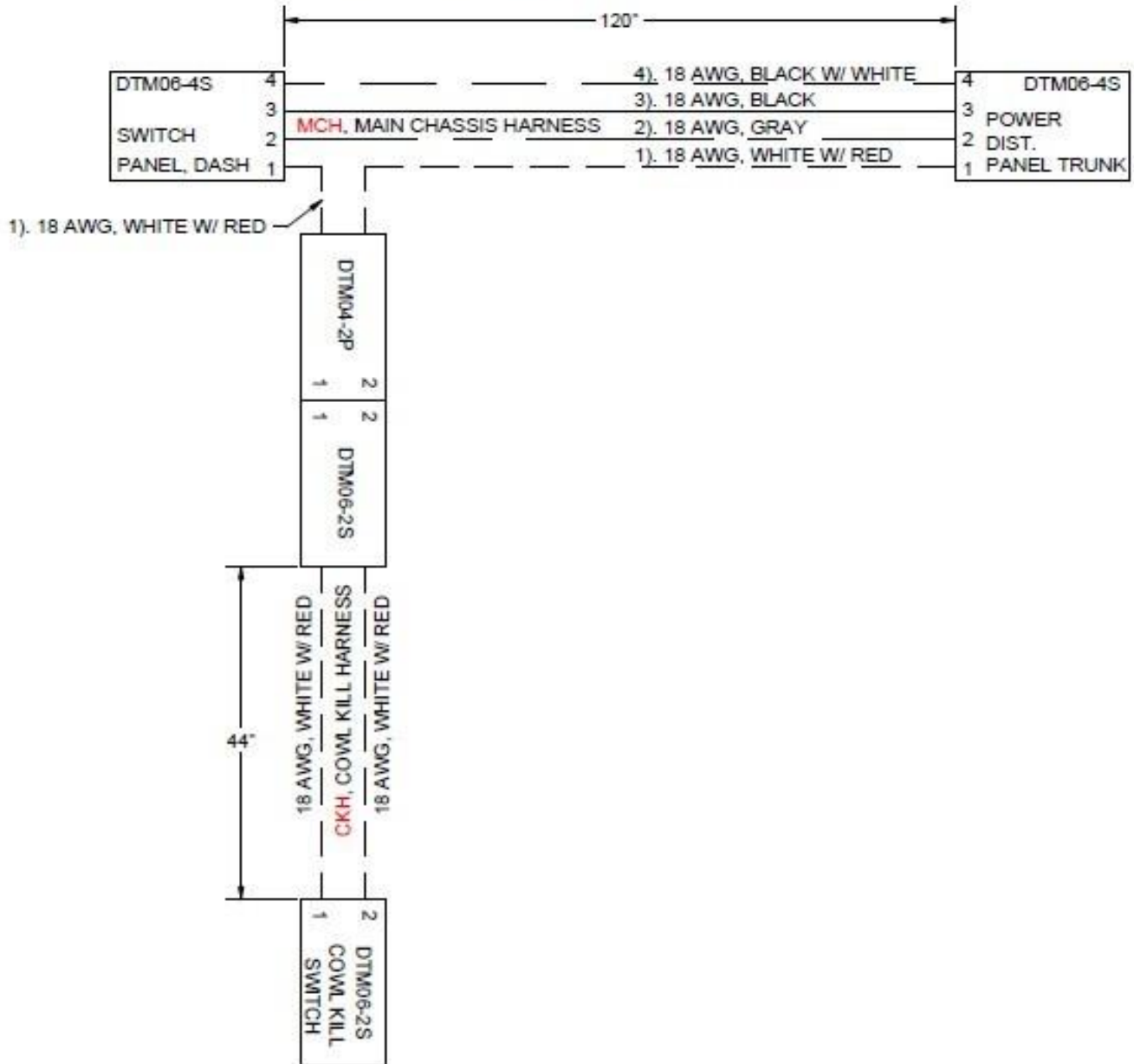
20.1 Power Distribution Panel (Trunk) ND2 Power Distribution Panel (Trunk)



20.2 Main Chassis Harness (Trunk to Dash)

Main Chassis Harness

Part # 0000-08-5050

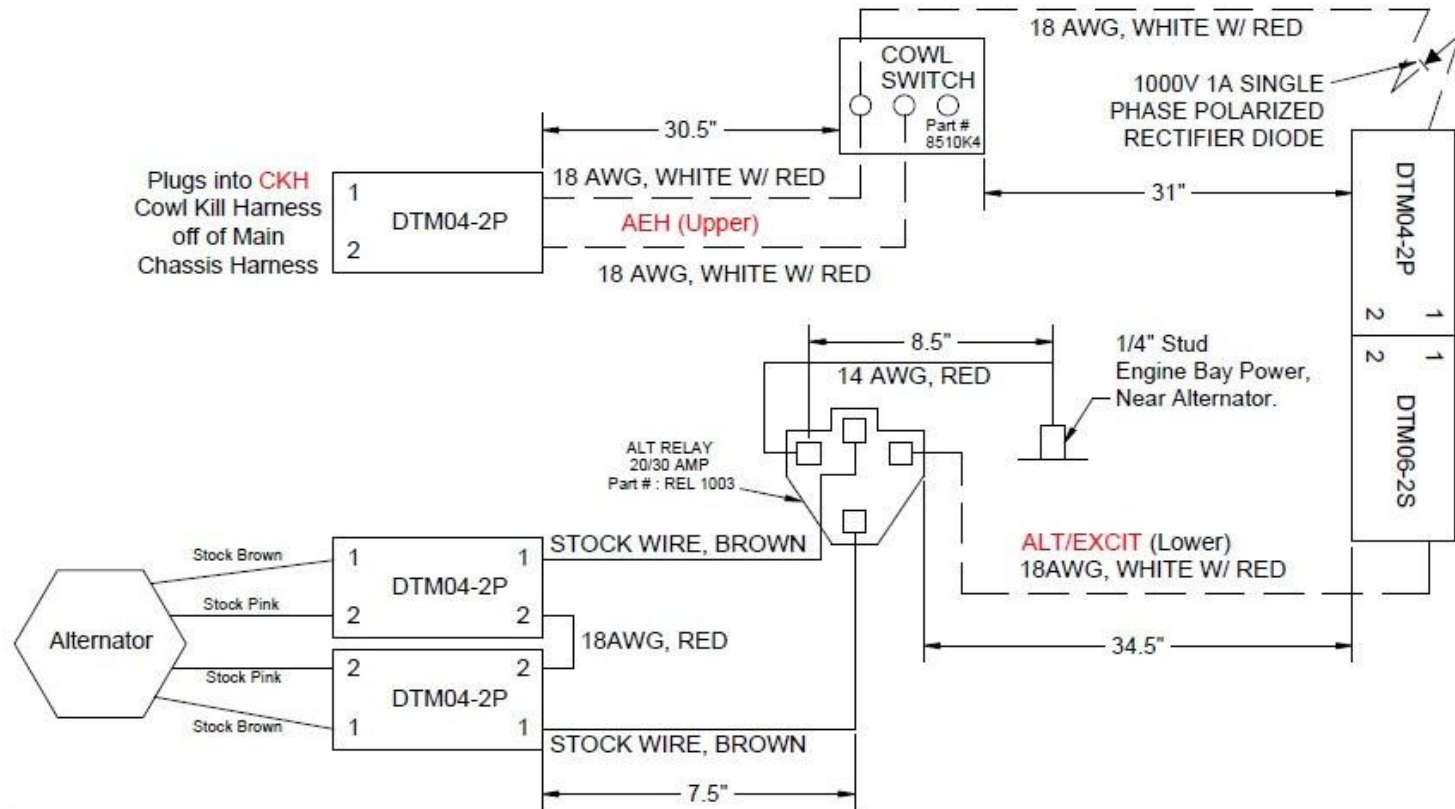


Main Chassis Harness
Drawn By: Chad Boyd
Rev: 3, 1-15-16
Confidential Long Road Racing
2016 Global MX-5 Cup Wiring Diagrams

20.4 Engine Bay (Cowl and Alternator Relay)

Engine Bay (Cowl Kill Switch and Alternator Relay)

Part # 0000-08-5051



Engine Bay (Cowl and Alt. Relay)
 Drawn By: Chad Boyd
 Rev: 4, 1-15-16
 Confidential Long Road Racing
 2016 Global MX-5 Cup Wiring Diagrams

- Despite the extensive Quality Processes in place during the manufacturing of your vehicle, it is highly recommended and general good practice with any race car, to do a full nut and bolt check on the car before first use, and in between on-track sessions.

22.0 Torque Specifications:

This list is not comprehensive. For items not listed consult the 2016 MX-5 Service Manual from Mazda.

1 Front Suspension # of Fasteners Torque Spec ft.-lbs.

	# of Fasteners	Torque Spec ft.-lbs.
Front Upper control Arm	2	40-47
Front Lower Damper Bolt	1	40-47
Front Upper Damper Nut	3	37-43
Front Hub	3	91-100

2 Front Brakes

Front ABS Sensor	1	71-88 in-lbs.
Front Caliper	2	59-74
Front Brake Line Banjo Bolt	1	110 in-lbs.
Front Brake Bleeders	4	107-141 in-lbs.

3 Rear Suspension

Rear hub	3	91-100
Rear Axle Nut	2	175-202
Rear Damper Top Mount Nut	2	34-40
Rear Damper Lower Bolt	1	49-59

4 Rear Brakes

Rear Brake Caliper Bracket	2	38-48
Rear Brake Caliper	2	15-18
Rear ABS Wheel Speed Sensor	1	71-88 in-lbs.
Front Brake Line Banjo Bolt	1	110 in-lbs.
Rear Brake Bleeders	2	54-70 in-lbs.

5 Engine Bay

Strut Tower Brace Center	2	12-19
Strut Tower Brace (Damper Nuts L& R)	6	37-43
Header Nuts	5	32-47
Motor Mount Lower	3	25-33
Motor Mount Upper	3	22-29
Motor Mount Upper Nut	1	24-30
Oil Filter Sandwich Plate Nut	1	35

6 Under Car

Tunnel Member "X" Brace	4	14-19
Member Bracket	4	14-19

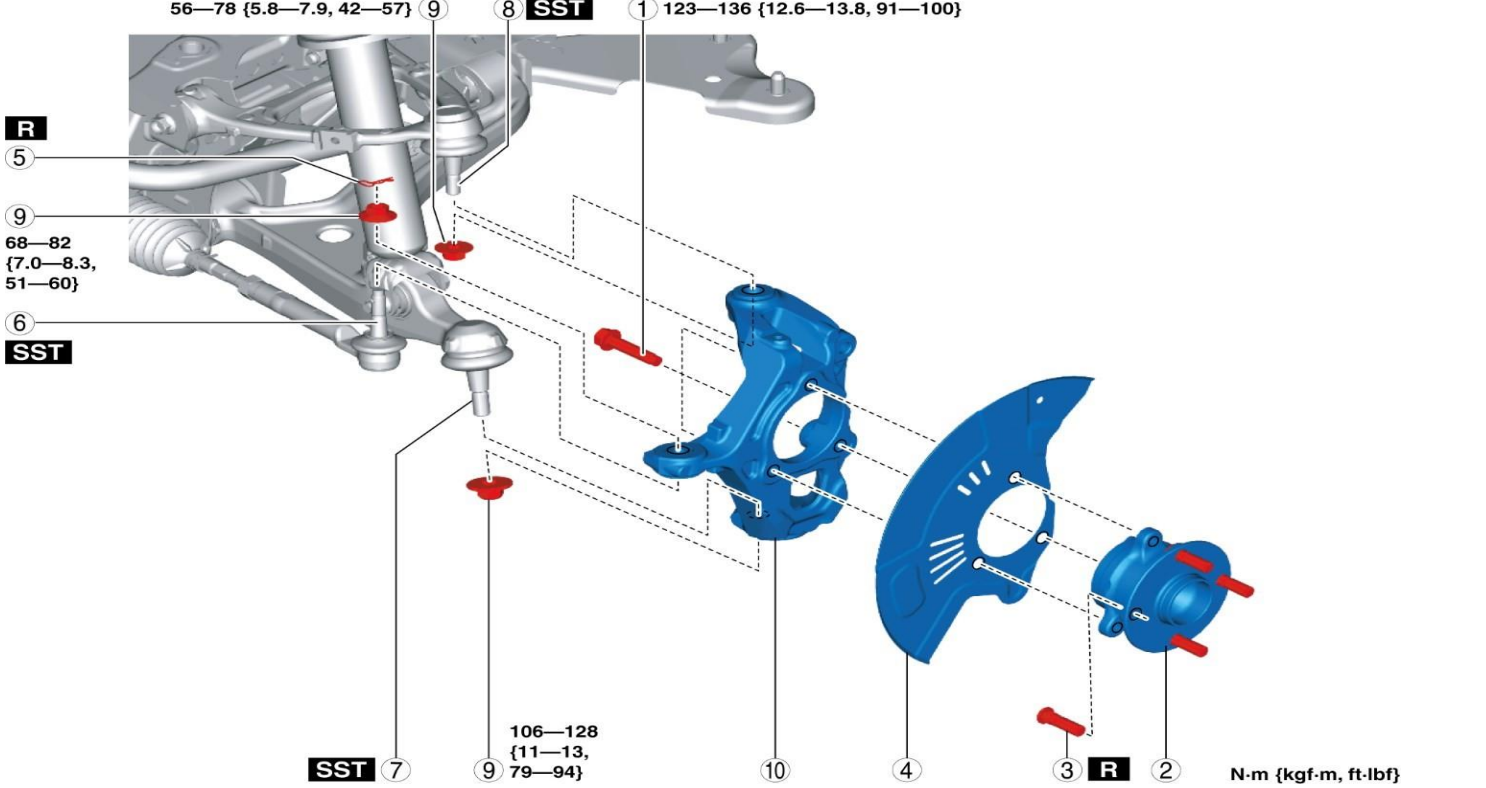
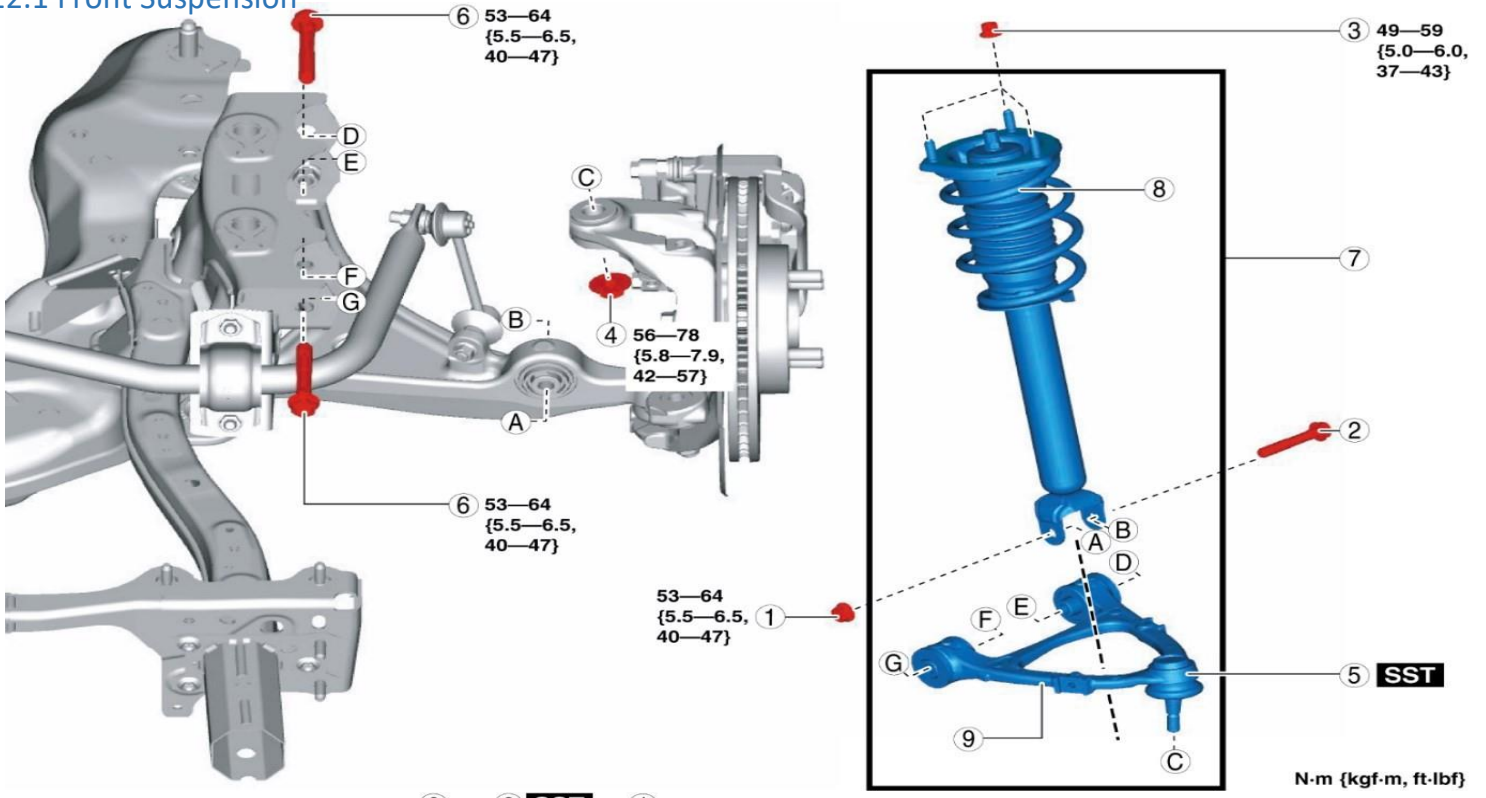
7 Differential and Transmission

Diff Bracket Top	4	40-51
Diff Bracket Sides (Mount Rubbers)	2	40-51
Rear Subframe Primary	6	78-92
Drive Shaft (Propeller Shaft)	4	37-43
Power Plant Framework Differential End	4	121-147

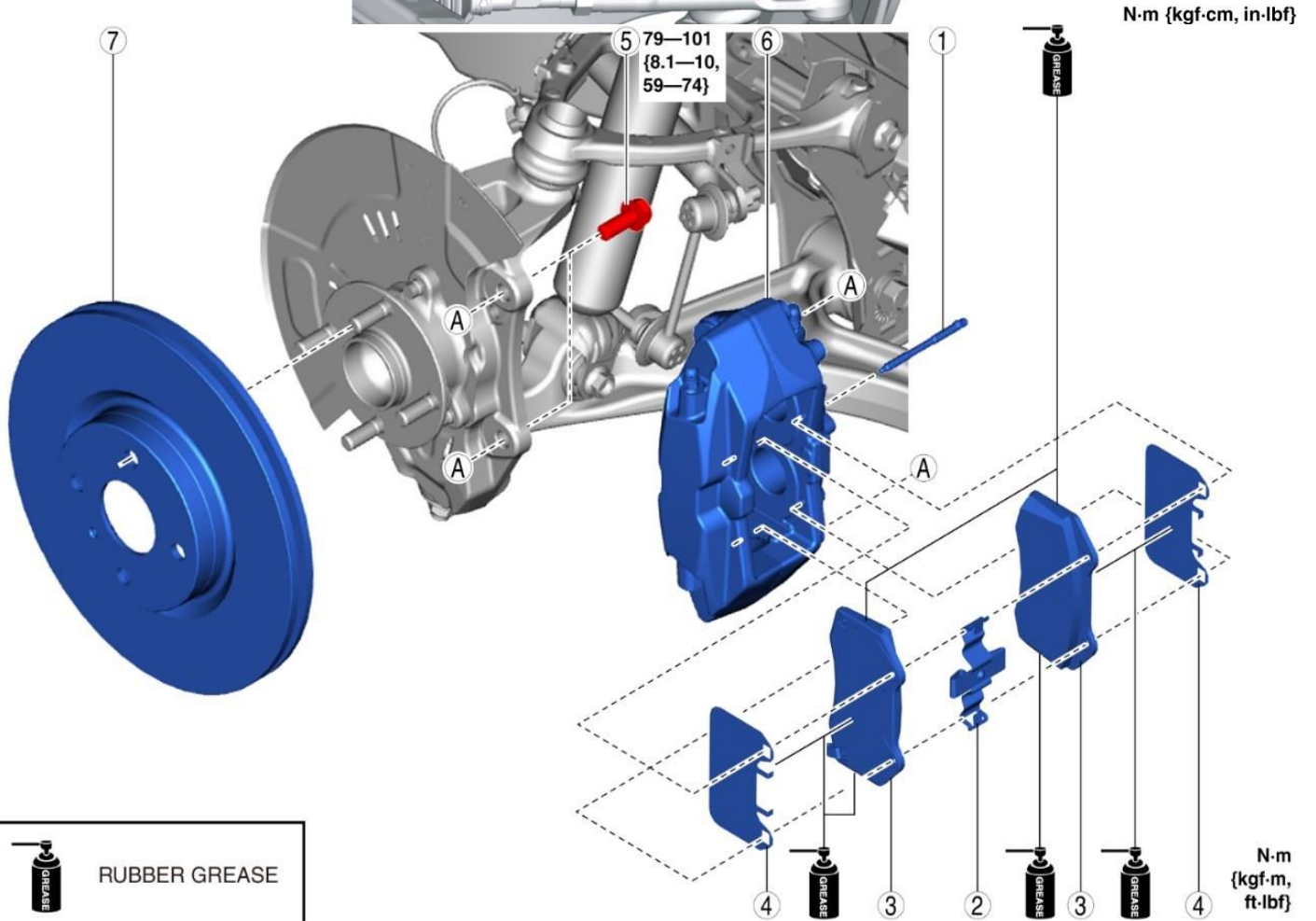
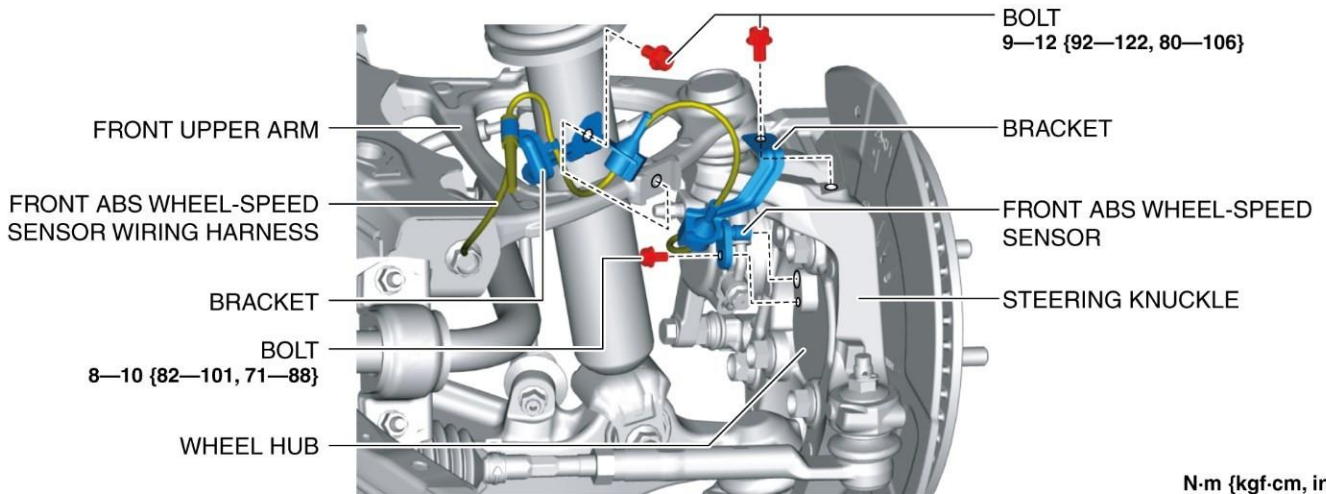
Power Plant Framework Transmission End	4	100-120
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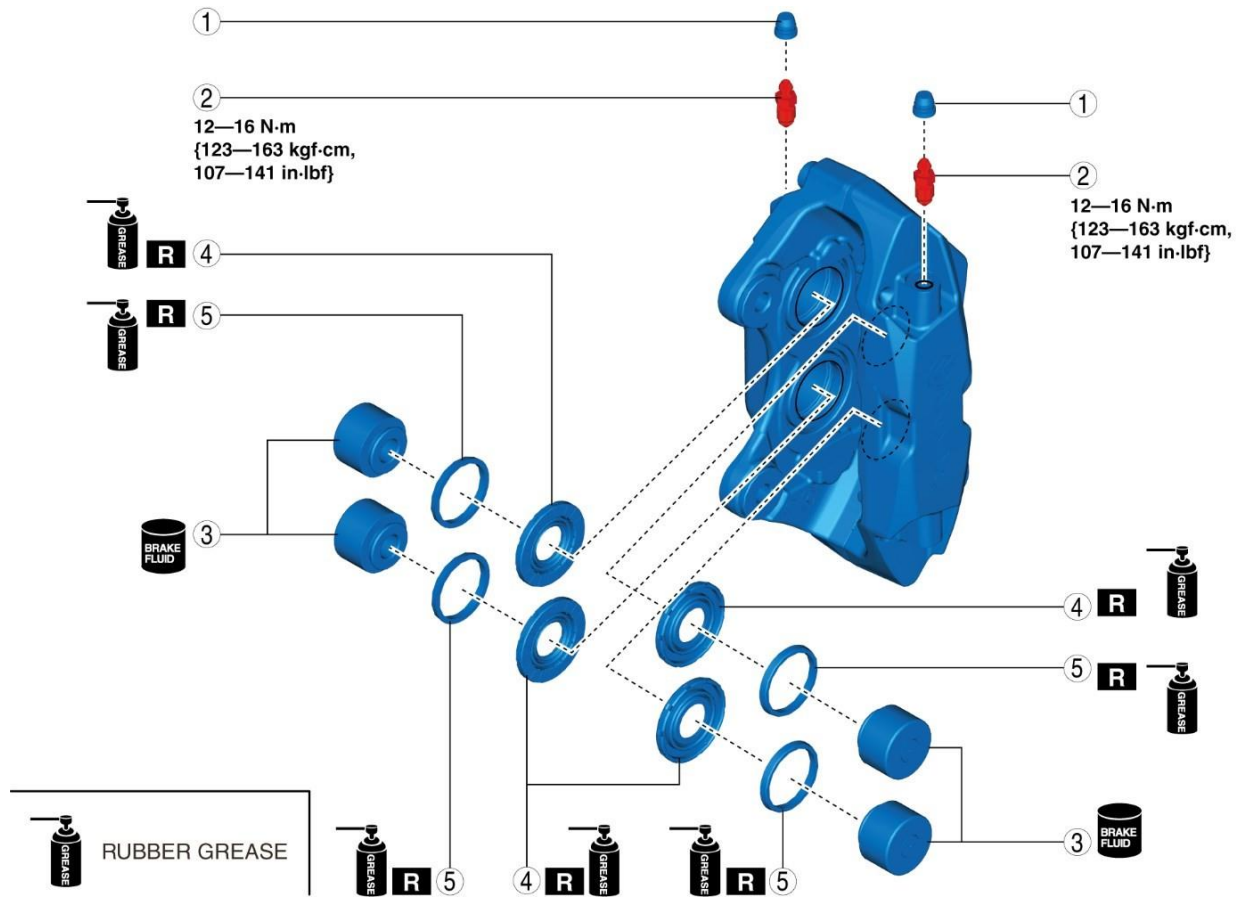
8 Wheels	16	80
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22.1 Front Suspension

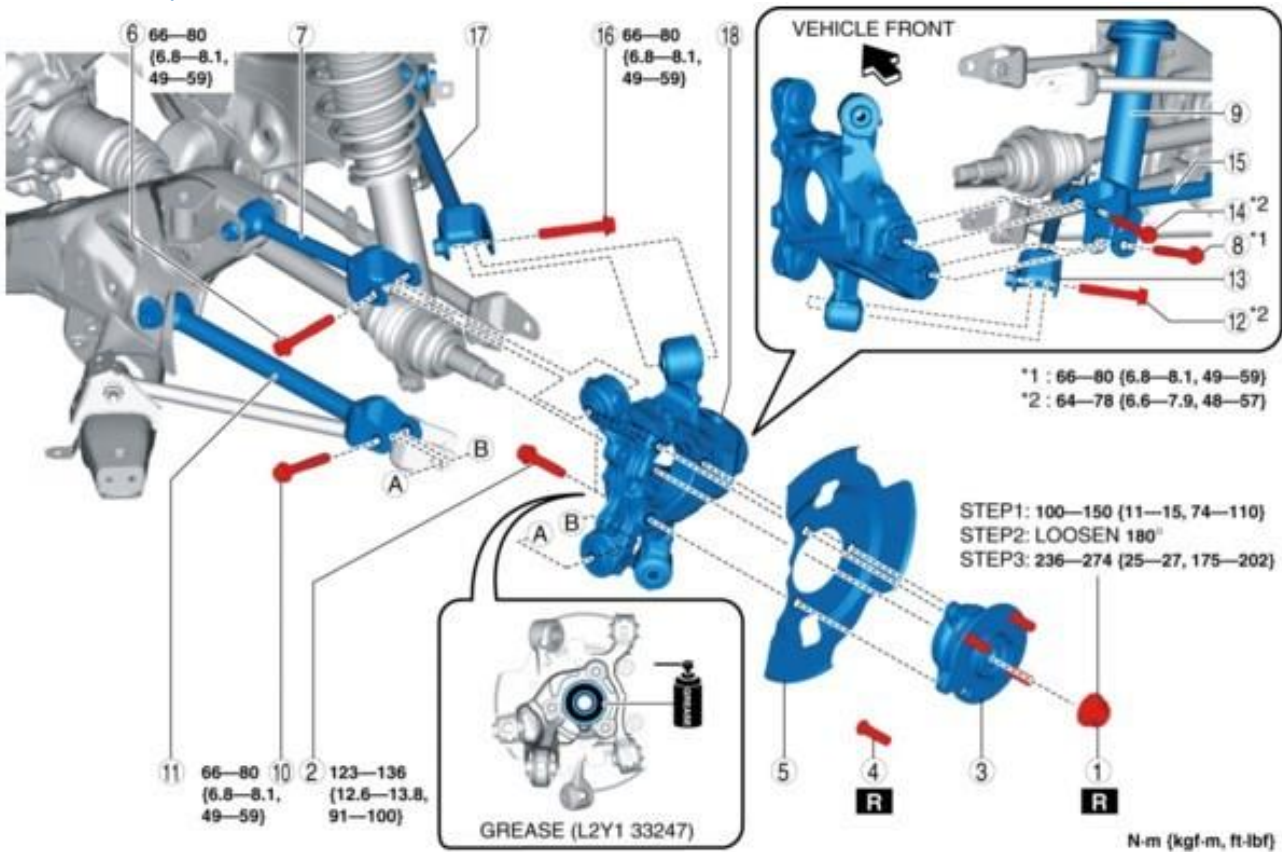


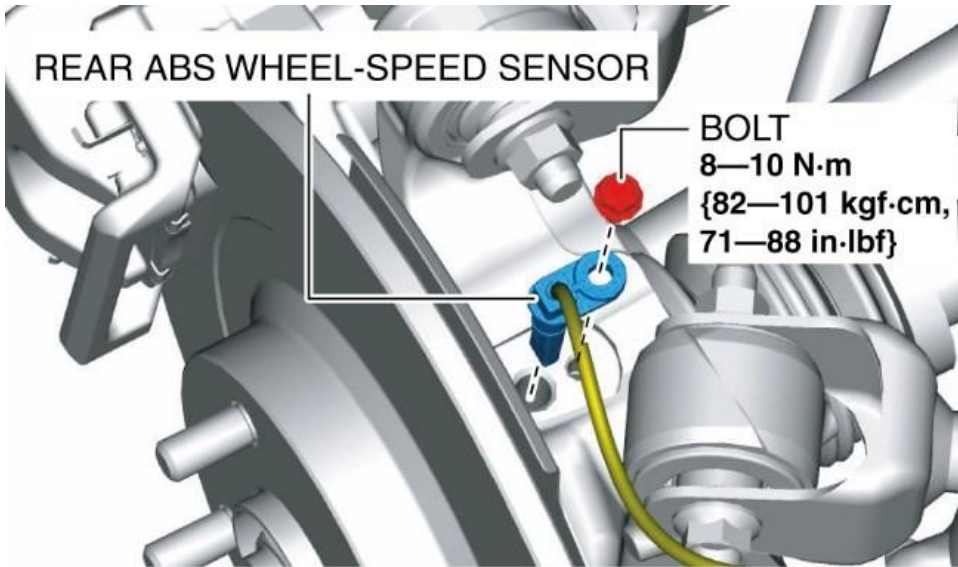
22.2 Front Brakes





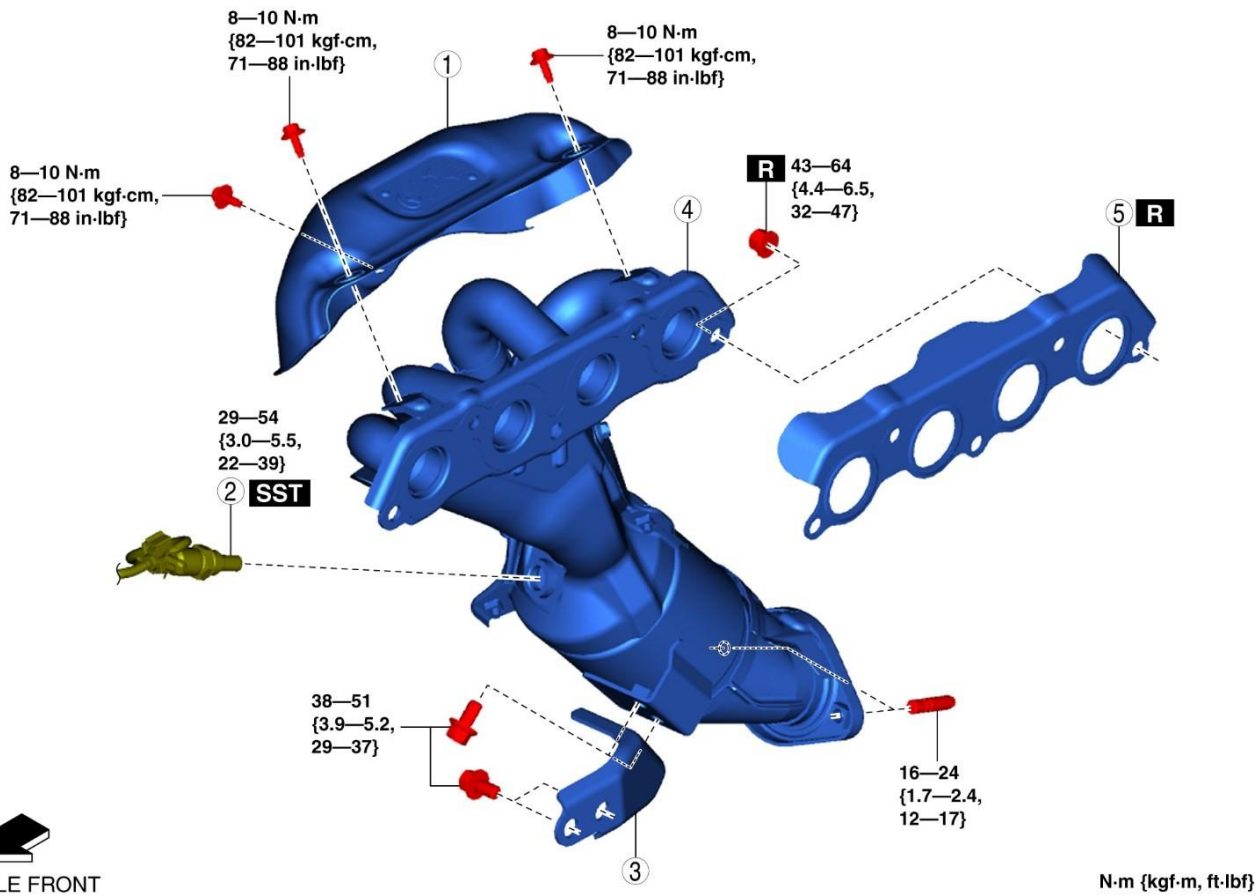
19.3 Rear Suspension



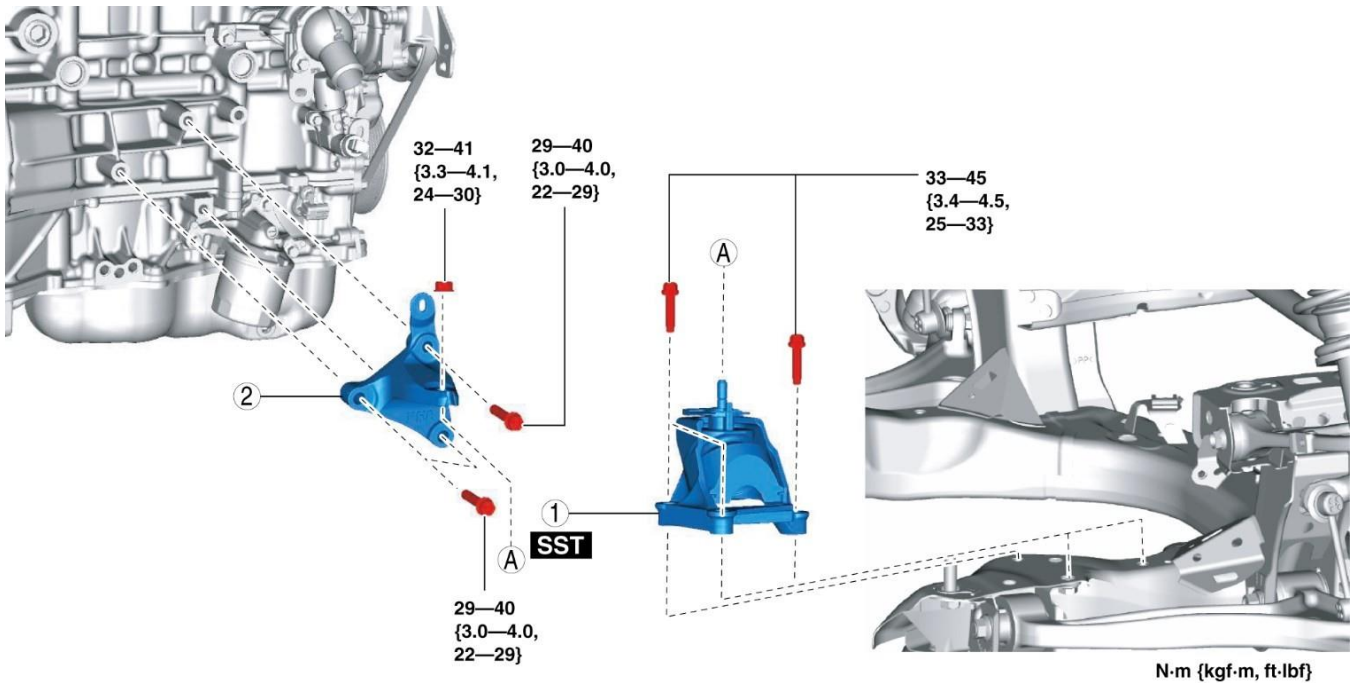


22.5 Engine Bay



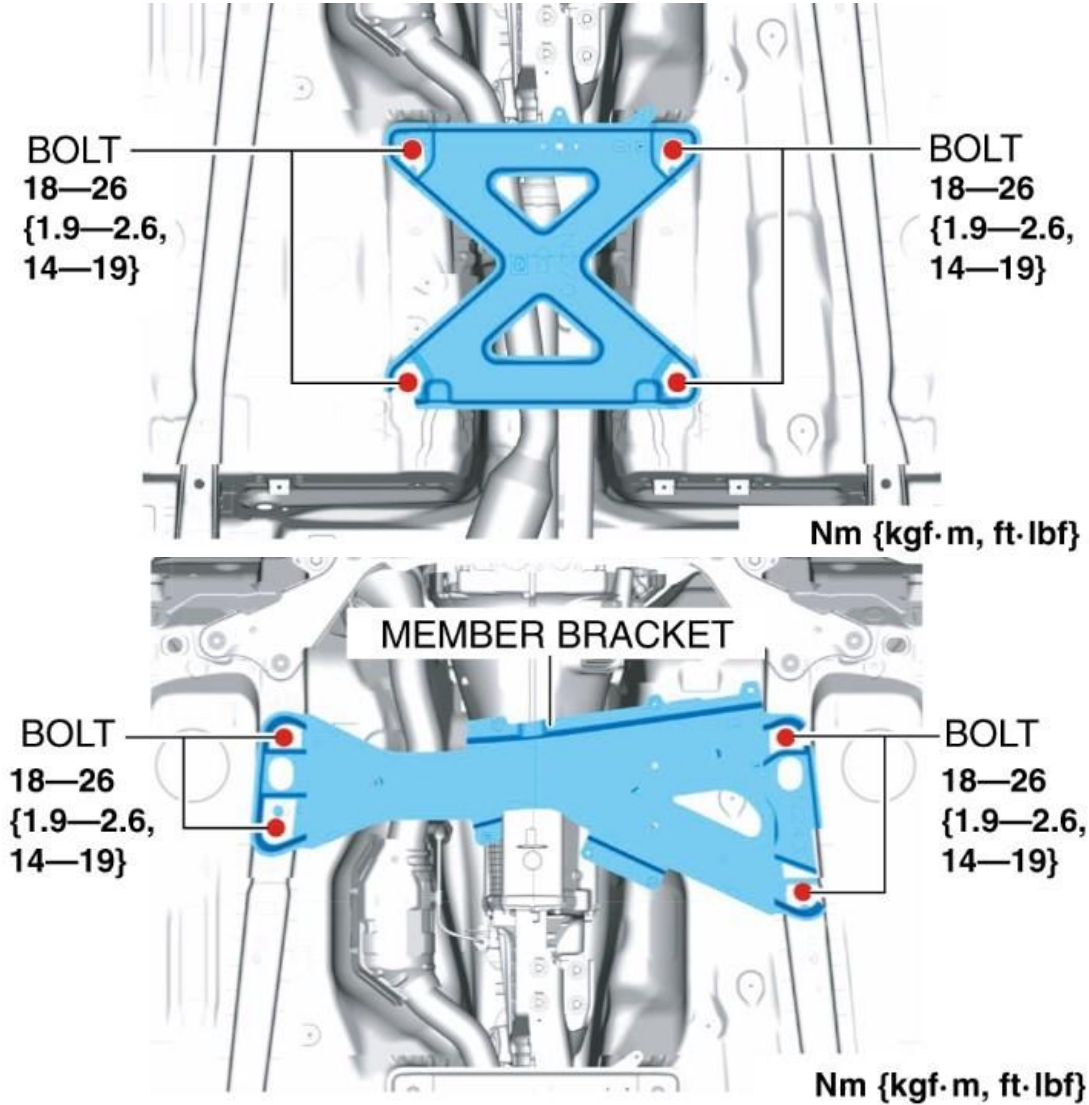


Note: Stock Exhaust Header shown. Torque specification for Motorsports Header are the same.

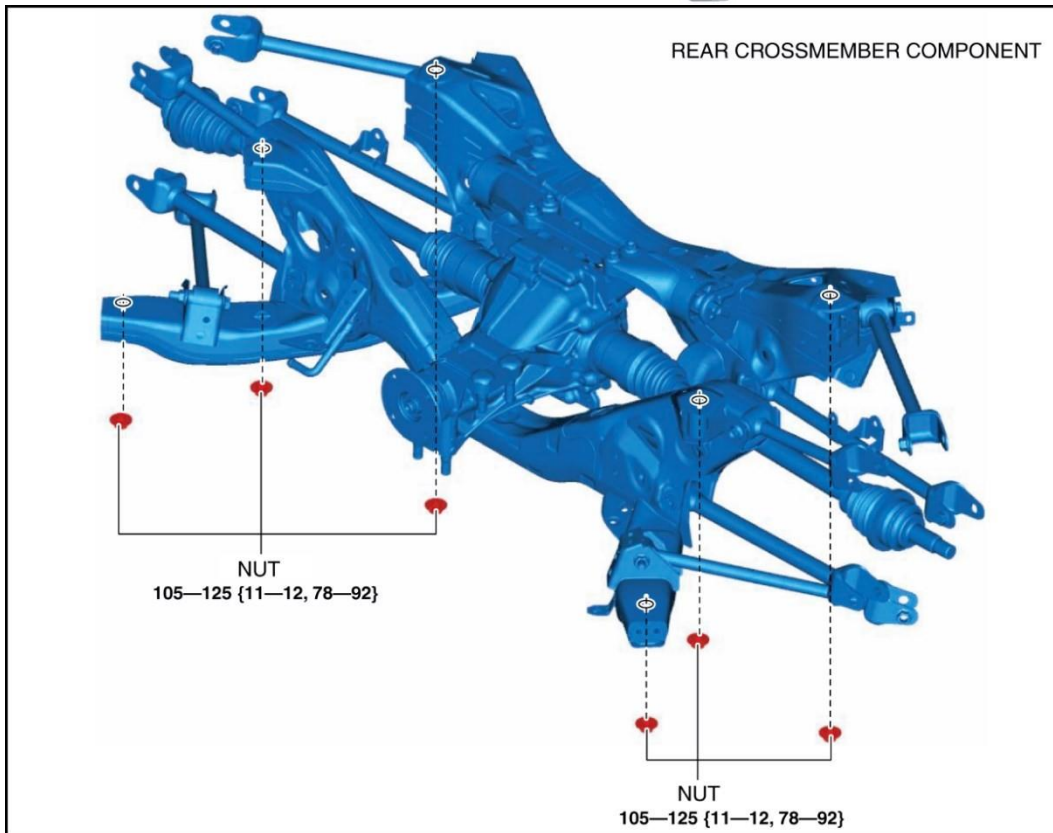
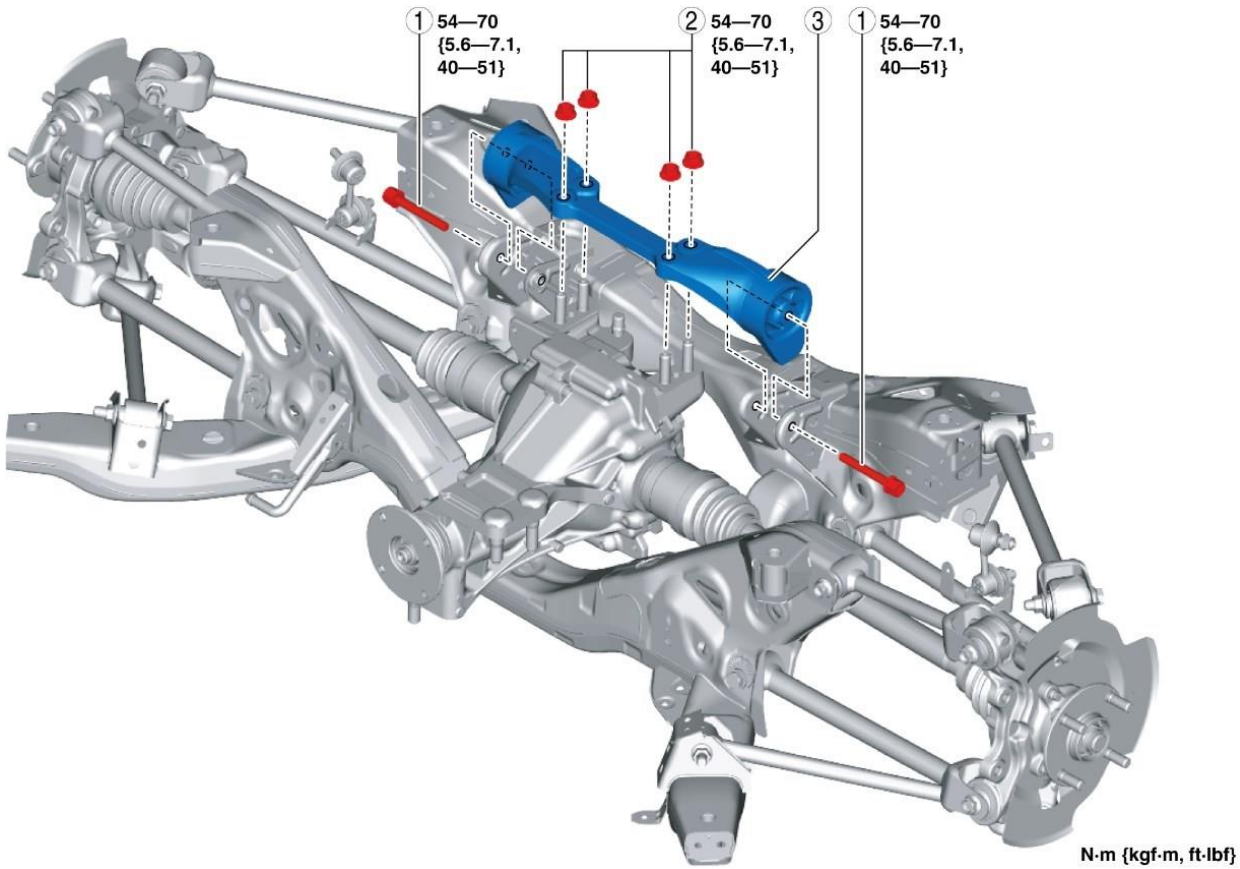


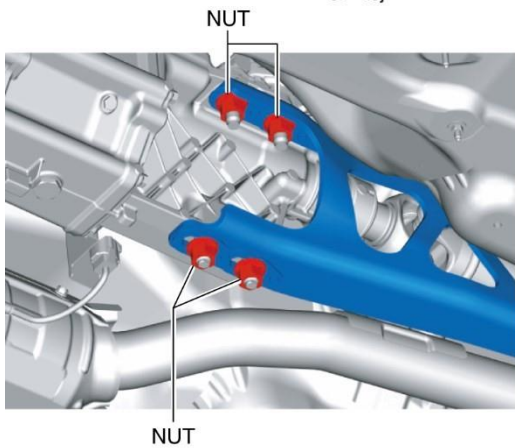
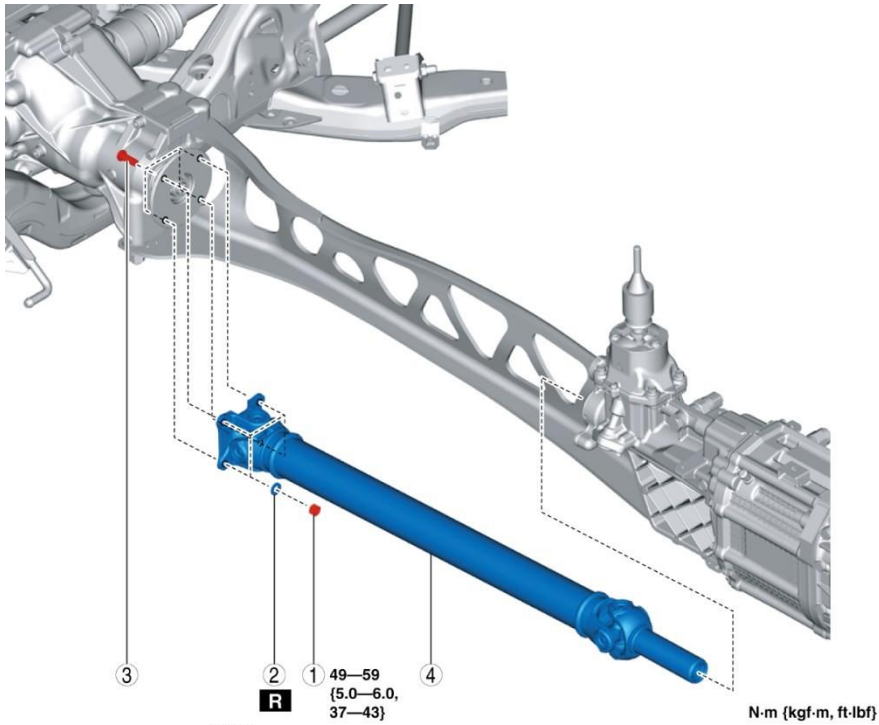
Note: Engine Mount Reinforcement Brackets are included and are installed with the Stock Bolts.

22.6 Under Car

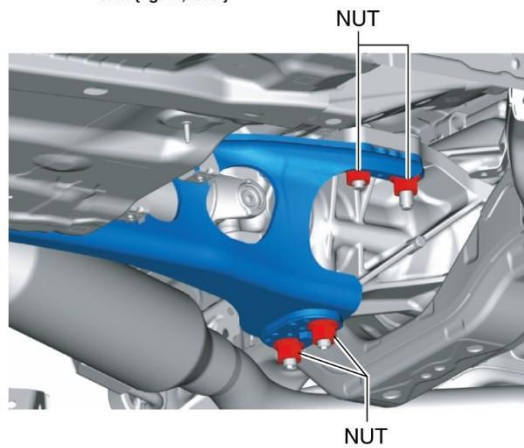


22.7 Differential and Transmission



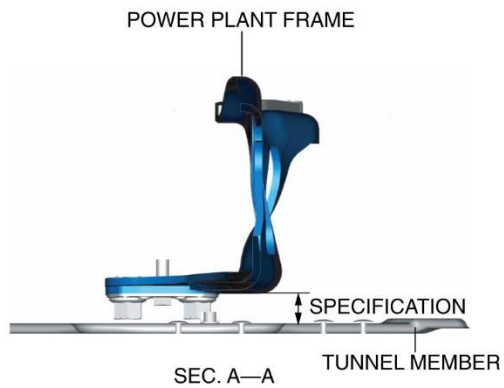
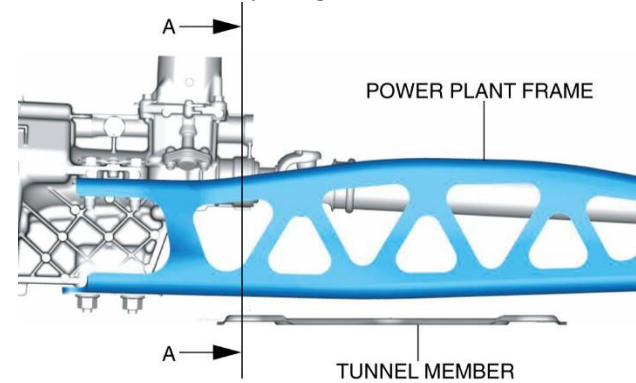


Tightening torque
135—164 N·m {14—16 kgf·m, 100—120 ft·lbf}



Tightening torque
164—200 N·m {17—20 kgf·m, 121—147 ft·lbf}

Power Plant Frame Spacing:



Specification

- Between bottom surface of power plant frame and top surface of tunnel member: 22.4—28.4 mm {0.89—1.11 in}