NAU
NORTHERN
ARIZONA
UNIVERSITY

SAE Baja

2024-2025

Design Requirements Summary

Engineering Requirements

ER1 - Rear Ratio – 6.98:1
ER2 - Front Ratio – 3.62:1
ER3 - 4WD – Yes
ER4 - Moving powertrain parts must be guarded on all sides – Yes
ER5 - Gearbox vent system 100 mm away from exhaust – 100 mm
ER6 - 4WD driveshaft surrounded and separate from cockpit – Yes
ER7 - Minimum life cycle of gears – 10^9 cycles
ER8 - Torque output – 226 ft*lbs
ER9 - CV Length - <16 inches
ER10 - CV Angle – 40 degrees
ER11 - CV Joints – Yes
ER12 - Thickness of CV axle – 1.2 inches
ER13 - Weight – 75 grams
ER14 - Max diameter – 70mm
ER15 - Max Thickness – 40mm

Customer Requirements

CR1 - Efficiency
CR2 - Safety
CR3 - Durability
CR4 - Affordable
CR5 - Ease of Manufacturing
CR6 - Aesthetics
CR7 - Pass Techs
CR8 - Acceleration
CR9 – Lightweight

Ethan

Top Level Testing Summary

Experiment/Test	Relevant DRs	Testing Equipment Needed	Other Resources
EXP1 – Top Speed Test, Gear Efficiency Test	ER 1, 2, 4, 8 CR 1, 3, 7, 8, 9	Long Straightaway for reaching top speed	Performed at the Shop
EXP2 - Drive Car with 2WD	ER 1, 2, 4, 5, 8-15	Fuel Functioning Drivetrain Functioning Suspension Functioning 4WD system	Performed at the Shop
EXP3 – Terrain Test	ER 1, 2, 4, 5, 8-15	Rocky Terrain	Strenuous location to drive the car
EXP4 – Drive Car with 4WD	ER 1-6, 8-15	Fuel Fully Functioning Drivetrain Fully Functioning Suspension Fully Functioning 4WD system	Strenuous location to drive the car

Ethan

Detailed Testing Plans

EXP1- Top Speed Test, Gear Efficiency Test

Test/Experiment Summary: The vehicle's top speed and acceleration are key performance metrics. The acceleration event at competition evaluates how quickly the car can cover 100 to 150 feet from a standstill. Top speed influences performance in other dynamic events. Testing these parameters will help assess the sub team's success in designing a drivetrain that effectively transfers power from the engine to the wheels.

Procedure:

1. **Identify locations that have long, flat straightaways for reaching top speed**
2. **Measure 100 to 150 feet away from the start line**
3. **Time the vehicle to see how long it takes to cross the 100-to-150-foot threshold**
4. **Continue driving the vehicle until it stops accelerating and calculate the maximum speed of the vehicle**

Results: The data collected from this experiment will show the effectiveness of all drivetrain components based off the magnitude of the speed calculated.

Conclusion: Assessing the top speed of the car will demonstrate how the vehicle will perform in the acceleration event in the competition and will allow any modifications or adjustments to be made to further enhance the vehicle’s speed.

Rowan

Detailed Testing Plans

EXP2- Drive Car with 2WD

Test/Experiment Summary: The 2WD functionality test is an important experiment to conduct to ensure the vehicle operates correctly and appropriately in 2WD. The team will assess the vehicle as it makes laps near the machine shop to better understand the effectiveness of the drivetrain system.

Procedure:

1. **Start the vehicle**
2. **Slowly drive the vehicle around the machine shop**
3. **Assess the vehicle as it is in motion to determine if any adjustments need to be made**

Results: The results of this experiment will indicate if there are any major flaws or failures in the drivetrain system, which will help the team provide a functional vehicle for competition.

Conclusion: This test is an important first step in the testing of the Baja vehicle and will ensure the 2WD system is functioning correctly.

Rowan

Detailed Testing Plans

EXP3- Terrain Test

Test/Experiment Summary: The terrain test will include the vehicle traversing obstacles that may be found at the competition, such as large boulders, loose dirt/gravel, and other rocky terrain features. This test will help the team assess the vehicle's capabilities in rough terrain and will give a sense of how the vehicle will perform in the terrain at competition.

Procedure:

1. **Identify locations with rocky terrain that are easily accessible.**
2. **Drive the car over small obstacles to start off with and increase the size of the obstacle to test the vehicle's limits.**

Results: The results of this test will demonstrate how the vehicle traverses larger obstacles and will prepare the team for the obstacles seen in the competition.

Conclusion: This test will show the team how the vehicle functions over rough terrain, like terrain that will be seen at competition, to better understand the weaknesses and strengths of the vehicle.

Dylan

Detailed Testing Plans

EXP4- Drive Car with 4WD

Test/Experiment Summary: The 4WD functionality test will demonstrate the vehicles' ability to both shift into 4WD and shift backing in 2WD. The test will include a stationary test of the vehicle shifting into 4WD and a possible moving and shifting test, depending on the vehicle's capabilities at the time. This test will show the team if the 4WD system works efficiently and if there are any improvements or adjustments that need to be made to the vehicle.

Procedure:

1. **For the stationary test, the vehicle's rear will be jacked off the ground and held up by blocks to ensure the rear tires of off the ground**
2. **The vehicle will then be shifted into 4WD and will slowly accelerate to see if the 4WD system has actuated**
3. **The possible moving test will be done later in the testing phase**

Results: This test will show the team the functionality of the 4WD system in the vehicle and will highlighting any area of improvement, like adjusting the chain or tensioners to make the chain drive more efficient. These changes will help the team perform better in competition.

Conclusion: This test will be an important milestone in the testing of the Baja vehicle and will be a large indicator of whether or not the vehicle will perform well in the hill climb event in competition.

Seth

Specification Sheet

Customer Requirements	CR met? (Y/N)	Client Acceptable (Y/N)
CR1 - Efficiency	Y	Y
CR2 - Safety	Y	Y
CR3 - Durability	Y	Y
CR4 - Affordable	N	Y
CR5 - Ease of Manufacturing	Y	Y
CR6 - Aesthetics	Y	Y
CR7 - Pass Techs	Y	Y
CR8 - Acceleration	Y	Y
CR9 - Lightweight	N	Y

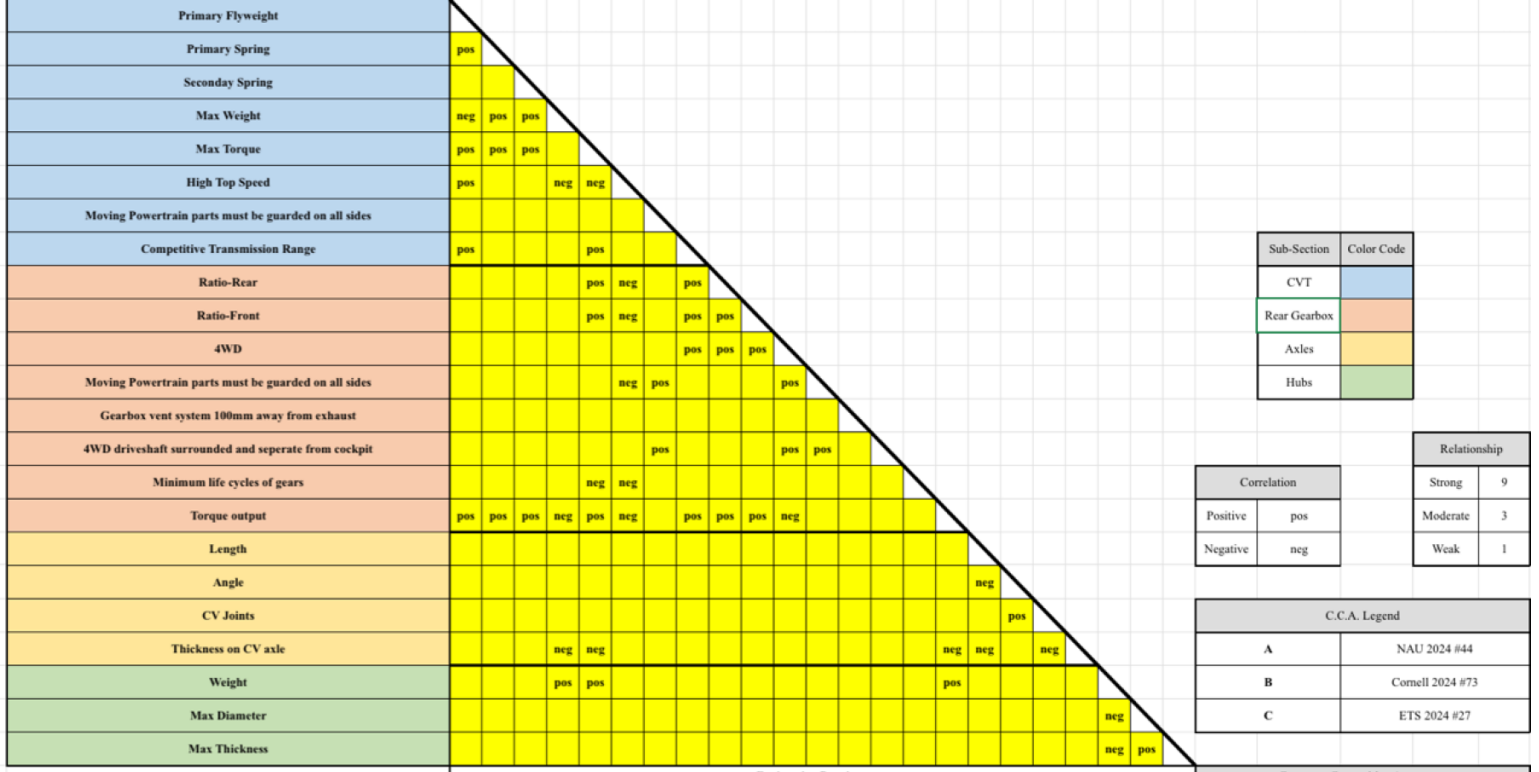
Matthew

Specification Sheet

Engineering Requirements	Target	Tolerance	Measured/Calculated Value	ER Met? (Y/N)	Client Acceptable (Y/N)
ER1 - Rear Ratio – 6.98:1	6.98:1	+/- 0.25	6.98	Y	Y
ER2 - Front Ratio – 2.95:1	3.62:1	+/- 0.25	2.95	Y	Y
ER3 - 4WD – Yes	Yes	N/A	N/A	Y	Y
ER4 - Moving powertrain parts must be guarded on all sides – Yes	Yes	N/A	N/A	N	N
ER5 - Gearbox vent system 100mm away from exhaust – 100mm	100mm	+/- 10mm	110mm	Y	Y
ER6 - 4WD driveshaft surrounded and separate from cockpit – Yes	Yes	N/A	N/A	N	N
ER7 - Minimum life cycle of gears – 10^9 cycles	10^9 cycles	+/- 10^8 cycles	200*10^3	Y	Y
ER8 - Torque output – 226 ft*lbs	226 ft*lbs	+/- 10 ft*lbs	226ft-lbs	Y	Y
ER9 – CV Length - <16 inches	16 in	+/- 2 in	8” Front, 16” Rear	Y	Y
ER10 – CV Angle – 40 degrees	40 degrees	+/- 5 degrees	40 degrees max	Y	Y
ER11 - CV Joints – Yes	Yes	N/A	Chosen	Y	Y
ER12 - Thickness of CV axle – 1.2 inches	1.2 in	+/- 0.25 in	1”	Y	Y
ER13 – Hub Weight – 75 grams	75 grams	+/- 25 grams	87.6 grams	Y	Y
ER14 – Hub Max diameter – 70mm	70 mm	+/- 10 mm	79.4 mm	Y	Y
ER15 – Hub Max Thickness – 40mm	40 mm	+/- 7.5 mm	44.4 mm	Y	Y

Nolan

QFD



Sub-Section	Color Code
CVT	
Rear Gearbox	
Axles	
Hubs	

Correlation	
Positive	pos
Negative	neg

Relationship	
Strong	9
Moderate	3
Weak	1

C.C.A. Legend	
A	NAU 2024 #44
B	Cornell 2024 #73
C	ETS 2024 #27

			Engineering Requirements																				Customer Competitive Assesment				
Relative Weight (%)	Customer Weights	Customer Requirments	Primary Flyweight	Primary Spring	Seconday Spring	Max Weight	Max Torque	High Top Speed	Moving Powertrain parts must be guarded on all sides	Competitive Transmission Range	Ratio-Rear	Ratio-Front	4WD	Moving Powertrain parts must be guarded on all sides	Gearbox vent system 100mm away from exhaust	4WD driveshaft surrounded and seperate from cockpit	Minimum life cycles of gears	Torque output	Length	Angle	CV Joints	Thickness on CV axle	Weight	Max Diameter	Max Thickness	1 Poor	2 Ok	3 Acceptable	4 Good	5 Excellent
11	4	Efficiency	9	9	9	9	9	1	1	9	9	9	9	1	1	1	9	9	9	9	9	3	9	3	3			A	B	C
22	5	Safety	1	1	1	1	1	3	9	1	1	1	1	9	3	9	1	1	3	3	3	9	1	3	3					ABC
10	3	Durability	3	3	3	3	1	3	1	3	1	1	1	1	1	1	9	3	9	9	9	9	1	9	9		A			BC
10	3	Affordable	9	1	1	9	1	1	1	3	1	1	1	1	1	1	1	1	3	1	3	9	1	3	3	BC			A	
5	2	Ease of Manufacturing	9	1	1	3	1	1	1	3	3	3	3	1	1	1	3	1	9	9	9	9	1	3	3		BC		A	
5	1	Aesthetics	1	1	1	3	1	1	1	1	1	1	3	3	3	1	1	1	1	1	3	3	3	3	3		A		B	C
22	5	Pass Techs	1	1	1	1	1	1	9	1	1	1	9	9	9	9	1	1	1	1	1	9	1	1	1					ABC
5	2	Acceleration	3	3	3	1	9	9	1	9	9	9	9	1	1	1	1	9	1	1	1	1	9	3	3			A	C	B
10	3	Lightweight	3	1	1	9	1	9	3	1	9	9	9	3	3	3	1	1	9	1	1	9	9	3	3			A		BC
		Technical Requirement Units	grams	grams	grams	lbs	lbf-ft	mph	N/A	N/A	N/A	N/A	Yes/No	N/A	mm	N/A	Cycles	ft*lbs	inches	degrees	N/A	inches	grams	mm	mm					
		Technical Requirement Targets	70	35	35	15	415	35	N/A	5	9.56:1	3.82:1	Yes	N/A	100	N/A	10^9	226	16	40	N/A	1.2	75	70	40					
		Relative Technical Importance	5	8	7	6	1	2	3	4	3	4	5	6	8	7	1	2	3	4	2	1	3	1	2					

Nolan

Videos

Driving Test over curbs

~100 ft test drive

CV Axles plunge test

Dylan

4WD Functionality Test

4WD Functionality Test

Dylan

4WD Stool Test: Rear Tires Off the Ground to Show Front Drive Actuation

Dylan

Chain Drive Demonstration

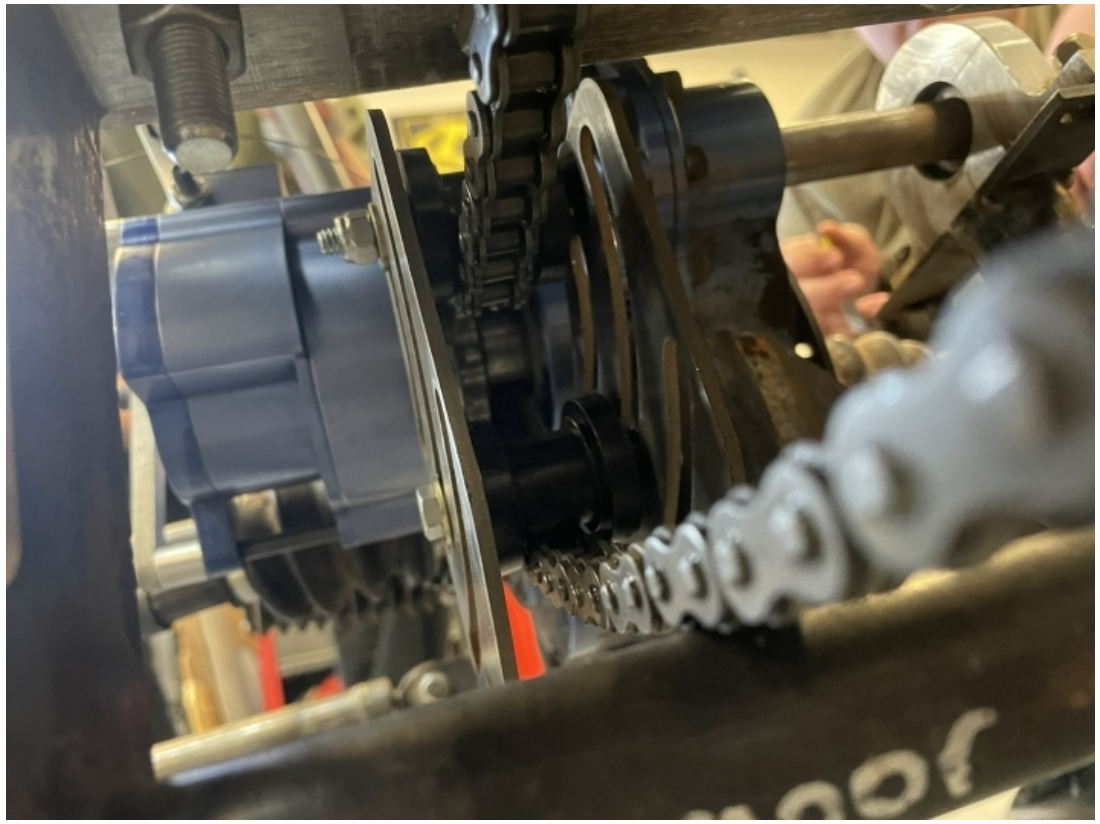


Image of Dog Box and Chain

Seth

Montage and Terrain Test

Rowan

Join NAU SAE Baja at:

MAJESTIC MARKETPLACE
FINE SPIRITS, CRAFT BEER & WINE

April 17, 2025: 3-8 PM

Located at:

601 Piccadilly Dr

Flagstaff, AZ 86001

In Aspen Place at the Sawmill

Come meet this year's competing team and see the car while enjoying some drinks and learning about what NAU SAE Baja is aiming to accomplish this year.

Would you like to support the Team?

All tax-deductible donations can be made through the QR code.

Please, when donating, write in the gift comments "Baja"

If you have any further questions, please reach out to drc385@nau.edu.

Thank You
Any Questions?

NAU NORTHERN ARIZONA UNIVERSITY

Final Testing Results

2024-2025 SAE Baja
Suspension, Steering and Brakes

Ryan Key
Ryan Latulippe
Oliver Husmann
Brennan Pongratz

Suspension

Taylor Hewitt
David Polkabla Jr.

Steering, Brakes

Customer Requirements (Suspension)

- Performance/Comfort
- Serviceability/Tunability
- Durability
- Affordable
- Ease of Fabrication
- Aesthetics
- Pass SAE Technical Inspection

Engineering Requirements (Suspension)

- Lightweight
- Suspension must pass tech
- Optimal ride height/ ground clearance
- Optimal Vehicle Width/Length
- Singular known replaceable failure point
- Efficiently designed knuckle
- Optimal camber/caster angles
- Optimize suspension travel

QFD (Suspension)

Suspension QFD													Baja 25' Suspension				
Team Members													Relationship		Date: 04/08/25		
Oliver Husmann													Strong	9	Legend		
Ryan Key													Moderate	3	A	2024 Cornell #73	
Ryan Latulippe													Weak	1	B	2024 SDSU #43	
Brennan Pongratz													N/A	0	C	2024 NAU #44	
		Technical Requirements											Customer Opinion Survey				
Customer Weights	Customer Requirments	Light weight	B.8.7 - all steering or suspension links exposed in the cockpit shall be shielded with a sturdy, robust, metal cover.	Optimal ride height/ground clearance	B.1.6 - Limitations - Vehicle width	Vehicle length/approach angle	Singular known replaceable failure point (bolt)	Efficiently designed knuckle	Optimal camber angles	Optimal caster angle	Optimize maximum suspension travel	1 Poor	2 OK	3 Acceptable	4 Good	5 Excellent
2	Performance/comfort	3	3	9	9	9	9	9	9	9	9		C			AB
3	Servicability/tunability	1	-1		3	9	9	9	3	3	9		C	B	A	
4	Durability	-3	3	3	3	9	9	9			3		C	B		A
6	Affordable	3	-1				3	9				C		B	A	
5	Ease of Fabrication	1	1				3	9	1	1	1		C	AB		
7	Aesthetics		3	9	9	3	1	9	3	3	9				BC	A
1	Pass Tech		9		9											ABC
Technical Requirement Units		lbs	mm	In.	In.	In.	Psi.	lbs, Psi, in., hrs.	Degrees	Degrees	In.					
Technical Requirement Targets		<50	<6.35	12-16	64	58-62			-2 - 2	12-18	12-16					

Top Level Testing Summary (Suspension)

Experiment/Test	Relevant DRs	Testing Equipment Needed	Other Resources
Exp1- Travel Test	CR1: Performance/comfort CR2: Serviceability/ tunability CR3: Durability ER7: Efficiently designed knuckle ER10: Optimize maximum suspension travel	Tape measure Large T-square Painters tape	Testing space Stack Objects
Exp2- Ride Height Test	CR1: Performance/comfort CR2: Serviceability/ tunability CR3: Durability CR6: Aesthetics ER3: Optimal ride height/ground clearance ER4: Optimal Vehicle width ER8: Optimal camber angles ER9: Optimal caster angles	Tape measure Large T-square Painters tape Angle gauge	Testing Space
Exp3- Body Roll Test	CR1: Performance/comfort CR2: Serviceability/ tunability ER8: Optimal camber angles ER9: Optimal caster angles	Cones Helmet Stopwatch Means to make a video	Driver Testing Track Fuel

Detailed Testing Plans Exp. 1 (Suspension)

- Experiment 1: Travel Test
  - Cycle to top of travel and measure
  - Cycle to bottom of travel and measure
  - Difference results in total wheel travel value
- Results
  - 10.5” Front
  - 13” Rear

Ryan K

Detailed Testing Plans Exp. 2 (Suspension)

- Experiment 2: Ride height test
  - Measure distance from ground to chassis for ride height and distance from outer edge of each tire for track width
- Results
  - 12in front and rear ride height
  - 62in front and 58in rear track width

Ryan L

Detailed Testing Plans Exp. 3 (Suspension)

- Experiment 3: Body Roll Test
  - Record vehicle take a turn with different shock pressures each run
  - Discuss with driver how handling feels
- Results
  - 12 psi main chamber, 25 psi “Evol” chamber, too soft
    - Ride height was too low
  - 25 psi main chamber, 50 psi “Evol” chamber, felt properly tuned according to driver

Specification Sheet (Suspension)

Customer Requirements	CR met? (✓ or X)	Client Acceptable (✓ or X)
CR1: Performance/comfort	✓	✓
CR2: Serviceability/tunability	✓	✓
CR3: Durability	✓	✓
CR4: Affordable	✓	✓
CR5: Ease of Fabrication	✓	✓
CR6: Aesthetics	✓	✓
CR7: Pass SAE Technical inspection		

Ryan K.

Specification Sheet (Suspension)

Engineering Requirement	Target	Tolerance	Measured/Calculated Value	ER met? (✓ or X)	Client Acceptable (✓ or X)
ER1: Light weight	700lbs	±50lbs	550lbs	✓	✓
ER2: Suspension must pass tech	N/A	N/A			
ER3: Optimal ride height/ground clearance	14in	±2in	12"	✓	✓
ER4: Optimal Vehicle width	64in	-4in	62F, 58R	✓	✓
ER5: Optimal Vehicle length	80in	±6in	81"	✓	✓
ER6: Singular known replaceable failure point	N/A	N/A	N/A	N/A	N/A
ER7: Efficiently designed knuckle	15hrs	±3hrs	17hrs	✓	✓
ER8: Optimal camber angles	0°	±2°	2.5°	X	X
ER9: Optimal caster angle	15°	±3°	+2°	✓	✓
ER10: Optimize maximum suspension travel	12in (F-R)	±2in	10"	✓	✓

Ryan L.

Customer Requirements (Steering)

- Stay with the Budget
- Maximize Driver Comfort
- Simple to use
- Pass SAE Technical Inspection

Engineering Requirements (Steering)

- Maximize Steering Angles
- Minimize Steering Slop
- Maximize Stability
- 8ft Steering Radius

David

Top Level Testing Summary (Steering)

Experiment/Test	Relevant DRs	Testing Equipment Needed	Other Resources
Exp1-Slalom Course	ER1: Reduce Steering Radius ER2: Minimize Steering Slop CR2: Maximize Driver Comfort ER3: Maximize Stability CR3: Simple to use	Cones Helmet Stopwatch Means to make a video	Driver Testing Area Fuel
Exp2-Driving Course	ER1: Reduce Steering Radius ER2: Minimize Steering Slop CR2: Maximize Driver Comfort ER3: Maximize Stability CR3: Simple to use	Cones Helmet Stopwatch Means to make a video	Driver Testing Track Fuel
Exp3-Radius Test	ER1: Reduce Steering Radius CR2: Maximize Driver Comfort ER3: Maximize Stability ER4: 7ft Steering Radius	Cones Tape measure Helmet Means to make a video	Driver Testing Area Fuel

David

Detailed Testing Plans Exp. 1 (Steering)

- Experiment 1: Slalom Course
  - Driving the car around the parking lot while mimicking a slalom course
    - Tie rod weld broke during one of the slalom trials
  - Creating new tie rods made from steel with sizing changes to compensate.

David

Detailed Testing Plans Exp. 2 (Steering)

- Experiment 2: Driving Course
  - Driving the car around a predetermined course to test handling in an environment similar to the competition.
    - The car handled as expected with no issues with steering components.

David

Detailed Testing Plans Exp. 3 (Steering)

- Experiment 3: Radius Test
  - Driving the car in a circle and observing the turning radius
    - The measured turning radius was found to be 9 feet on pavement.

David

Specification Sheet (Steering)

Engineering Requirement	Target	Tolerance	Measured/ Calculated Value	ER met? (✓ or X)	Client Acceptable (✓ or X)
ER1: Reduce Steering Radius	8ft	±1ft	9ft	✓	✓
ER2: Minimize Steering Slop	0°	±5°	3°	✓	✓
ER3: Maximize Stability	N/A	N/A	N/A	✓	✓

Customer Requirements	CR met? (✓ or X)	Client Acceptable (✓ or X)
CR1: Maximize Steering Angles	✓	✓
CR2: Maximize Driver Comfort	✓	✓
CR3: Simple to use	✓	✓

David

QFD (Steering)

Customer Weights	Customer Requirments	Maximize Steering Angles	Reduce Steering Radius	Minimize Steering Slop	Maximize Stability							1 Poor	2 OK	3 Acceptable	4 Good	5 Excellent
	Stay within the Budget	0	0	0	0								C			AB
	Maximize Driver Comfort	1	1	9	9									C		AB
	Simple to Use	0	1	9	3										C	AB
	Pass Tech Inspection	0	0	0	0										C	AB
Technical Requirement Units		Deg	ft.	Deg	NA											
Technical Requirement Targets		45	8	0	NA											

David

Customer Requirements (Brakes)

- Safe to use
- Brakes are affordable
- Has no performance issues
- Easy to use
- Hydraulics within brake system function properly
- Brake rotors don't overheat when used excessively
- Brake pads work properly
- Brake system is easy to mount
- Brake system must pass tech inspection

Engineering Requirements (Brakes)

- Reduce braking distance
- Minimize pedal force
- Maximize safety
- Brakes must stop all four tires at once
- Maximize braking force
- Brake pedal made from aluminum or steel
- Vehicle must remain still while brakes are applied
- 2 independent reservoirs
- Maximize caliper clamping force

Top Level Testing Summary (Brakes)

Experiment/ Test	Relevant DRs	Testing Equipment Needed	Other Resources
Exp1 - Braking test	CR1: Safe to use CR3: No performance issues CR4: Easy to use CR5: Hydraulics function properly CR6: Brake rotors don't overheat CR7: Brake pads work properly ER1: Reduce braking distance ER2: Minimize pedal force ER3: Maximize safety ER4: Brakes stop all four tires at once ER5: Maximize Braking force ER10: Maximize clamping force	Cones, helmet, stopwatch, brake fluid, open reel tape measure, means to take a video	Testing area for driver, fuel
Exp2 – Brake Endurance test	CR1: Safe to use CR3: No performance issues CR4: Easy to use CR5: Hydraulics function properly CR6: Brake rotors don't overheat CR7: Brake pads work properly ER1: Reduce braking distance ER2: Minimize pedal force ER3: Maximize safety ER4: Brakes stop all four tires at once ER5: Maximize Braking force ER8: Brakes are designed for unobstructed travel ER10: Maximize clamping force	Cones, helmet, brake fluid, means to make a video	Testing area for driver, fuel

Top Level Testing Summary (Brakes)

Experiment/ Test	Relevant DRs	Testing Equipment Needed	Other Resources
Exp1 - Braking test	CR1: Safe to use CR3: No performance issues CR4: Easy to use CR5: Hydraulics function properly CR6: Brake rotors don't overheat CR7: Brake pads work properly ER1: Reduce braking distance ER2: Minimize pedal force ER3: Maximize safety ER4: Brakes stop all four tires at once ER5: Maximize Braking force ER10: Maximize clamping force	Cones, helmet, stopwatch, brake fluid, open reel tape measure, means to take a video	Testing area for driver, fuel
Exp2 – Brake Endurance test	CR1: Safe to use CR3: No performance issues CR4: Easy to use CR5: Hydraulics function properly CR6: Brake rotors don't overheat CR7: Brake pads work properly ER1: Reduce braking distance ER2: Minimize pedal force ER3: Maximize safety ER4: Brakes stop all four tires at once ER5: Maximize Braking force ER8: Brakes are designed for unobstructed travel ER10: Maximize clamping force	Cones, helmet, brake fluid, means to make a video	Testing area for driver, fuel
Exp3 – Brake pressure test	CR1: Safe to use CR3: No performance issues CR4: Easy to use CR5: Hydraulics function properly CR7: Brake pads work properly ER2: Minimize pedal force ER3: Maximize safety ER4: Brakes stop all four tires at once ER5: Maximize Braking force ER10: Maximize clamping force	Brake fluid, brake line pressure gauge	Testing area, safety glasses

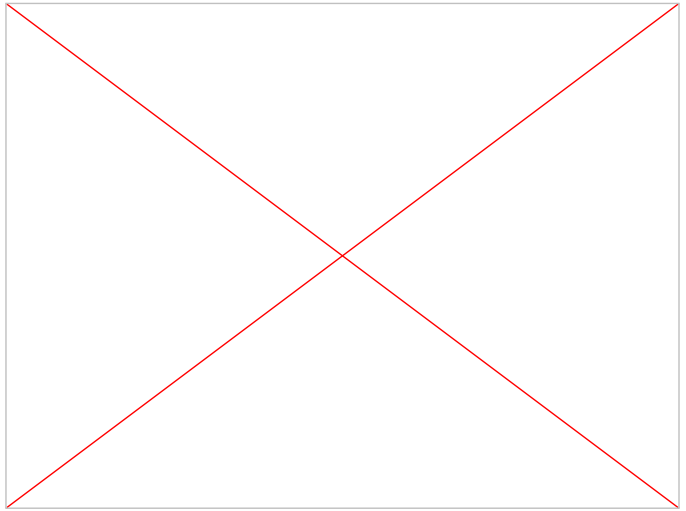
Detailed Testing Plans Exp. 1 (Brakes)

- Experiment 1: Braking test
  - Bring the car to about 10 mph, slam on the brakes at a specific spot, measure braking distance from that spot.
  - Car came to a stop quickly, will lock up brakes on dirt.

Taylor

Detailed Testing Plans Exp. 2 (Brakes)

- Experiment 2: Endurance test
  - Drive the car around for several hours and inspect brakes for any signs of wear or deformation
  - The brakes were used frequently throughout testing and have no issues with overheating



Detailed Testing Plans Exp. 3 (Brakes)

- Experiment 3: Brake Pressure Test: Use a brake pressure transducer to determine the maximum pressure going through the brake lines to ensure that we use the correct pressure sensor for the brake light.
  - **IN PROGRESS**

Taylor

Specification Sheet (Brakes)

Customer Requirements	CR met? (✓ or X)	Client Acceptable (✓ or X)
CR1: Safe to use	✓	✓
CR2: Brakes are affordable	✓	✓
CR3: Has no performance issues	✓	✓
CR4: Easy to use	✓	✓
CR5: Hydraulics within brake system function properly	✓	✓
CR6: Brake rotors don't overheat when used excessively	✓	✓
CR7: Brake pads work properly	✓	✓
CR8: Brake system is easy to mount	✓	✓
CR9: Brake system must pass tech inspection		

Specification Sheet (Brakes)

Engineering Requirement	Target	Tolerance	Measured/Calculated Value	ER met? (✓ or X)	Client Acceptable (✓ or X)
ER 1: Reduce braking distance	60 ft	N/A	46 ft	✓	✓
ER 2: Minimize pedal force		±		✓	✓
ER 3: Maximize Safety	N/A	N/A	N/A	✓	✓
ER 4: Brakes must stop all four tires at once	N/A	N/A	N/A	✓	✓
ER 5: Maximize braking force	500 lbs	± 25 lbs	482 lbs	✓	✓
ER 6: Components for brake pedal must be made of aluminum or steel	N/A	N/A	Aluminum	✓	✓
ER 7: Brake system must have sufficient force to hold vehicle while engine is running	7700 ft-lbf/s	± 35 ft-lbf/s	N/A	✓	✓
ER 8: Brakes shall be designed for unobstructed travel	N/A	N/A	N/A	✓	✓
ER9: Brake system must have 2 independent hydraulic reservoirs	N/A	N/A	N/A	✓	✓
ER 10: Maximize clamping force of brake calipers	90 psi	± 2 psi			

QFD (Brakes)

Correlation	
Positive	+
Negative	-
N/A	

Reduce Braking Distance											
Minimize Pedal Force											
Maximize Safety	+										
Maximize Safety	+	+									
Must Stop All Four Tires At Once		-	+	+							
Maximize Braking Force	+	+	+	+							
Pedal Components must be made from aluminum or steel	+	+	+	+	+						
Brake System must have sufficient force to hold vehicle while engine is running	-	-	+	+	+	+	+				
Brake Pedal Shall Be Designed for Unobstructed Travel	+	+	+	-	+	+	-	+			
Brake Systems Must Have Two Independent Hydraulic Resevoirs	+	+	+	-	+	+	+	+			
Maximize Clamping Force			+	-	+	+			+	+	
					Technical Requirements						

Customer Weights	Customer Requirements	Reduce Braking Distance	Minimize Pedal Force	Maximize Safety	Easily Serviceable	Must Stop All Four Tires At Once	Maximize Braking Force	Pedal Components must be made from aluminum or steel	Brake System must have sufficient force to hold vehicle while engine is runnii	Brake Pedal Shall Be Designed for Unobstructed Travel	Brake Systems Must Have Two Independent Hydraulic Resevoirs	Maximize Clamping Force
9	Safety	9	9	9	3	9	9	3	9	9	9	9
3	Affordable	-1	-1	-1	1	-3	3	9	-3	-3		3
2	Performance	1	3	3	1	3	3	1	3	9	1	9
7	Easy Operation	9	3	9		1	3		9	9	3	9
4	Hydraulic	1	9	3			1	-1	3	1	9	9
3	No Overheating	9	-1	9	-1	3	9		3		1	
8	Long Pad Life	9	3	9	-1	3	3		9	3	3	1
3	Easy to Mount	-3		3	3		2		1		3	1
2	Pass Inspection	-3	3	9	3	9	9	9	9	9	9	9
Technical Requirement Units		ft	lbf	N/A	N/A	N/A	psi	lbf	ft-lbf/s	N/A	N/A	psi
Technical Requirement Targets		60	55.8				500	450	7700			90

Relationship		Baja 2025 Brakes	
		Date: 9/12/2024	
Strong	9	Legend	
Moderate	3	A	NAU 2024 #44
Weak	1	B	Cal Poly 2024 #36
N/A		C	Cornell Univ. #73

Customer Opinion Survey				
1 Poor	2 OK	3 Acceptable	4 Good	5 Excellent
			A	BC
				ABC
			A	BC
			AB	C
			AB	C
			A	BC
			ABC	
				ABC
				ABC

Thank You

NAU NORTHERN ARIZONA UNIVERSITY

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UNIVERSITY

SAE Baja

Chassis Team
2024-2025

Engineering Requirements

Requirement	Description
ER1	Increase Strength
ER2	Light Weight
ER3	Low Cost
ER4	Driver Egress
ER5	B.3.2.17 Roll Cage Spec sheet filled out
ER6	B.3.2.16 Primary members steel OD, ID requirements
ER7	B.3.2.16 Alternate Material requirements
ER8	B.3.2.3 Secondary members OD, ID requirements
ER9	B.3.2.15 Welding samples requirements
ER10	B.3.2.1 Straight (40in) and bent members (33in unsupported, <30deg length
ER11	B.3.2.5 Lateral cross member and CLC <=8in requirements
ER12	B.3.2.6 RRH Continuous vertical members & +/- 20 degree verticality
ER13	B.3.2.7 LDB max 5in from top & bottom of roll cage
ER14	B.3.2.12 FBM max 45 deg. from vertical, FBMup & FBMlow joints
ER15	B.3.2.9 LFS must extend from RRH to past driver's heels
ER16	B.3.2.12.1 Gussets required if RHO and FBMup are not continuous
ER17	B.4.2.4.3 Safety harness tubes are in RRH plane from one side to the other
ER18	B.3.2.13.2 Rear bracing structural triangle connecting

	points A & B (within 2in)
ER19	B.3.2.8 RHO & RRH dimension and placement guidlines
ER20	B.3.2.10 SIMs run 8in-14in above lowest point of the seat
ER21	B.3.2.11 UST connect to LFS members securely below the seat
ER22	B.3.3.1 Roll cage clearance for the largest driver (6in helmet) (3in torso & limbs)
ER23	B.4.2 Min. 5 point harness with 3in webbing with single metal buckle
ER24	B.4.2.4.2 Shoulder webbing laterally placed 6in-9in
ER25	B.12.2 Lap and anti-sub mounting tabs (double shear) >=0.09in thick & >=1.3125in of weld length
ER26	B.4.5 Must have a conventional seat (65-90deg back angle) with back & bottom plane
ER27	B.4.5.3.2 Seat has 4 mounting points on the bottom and 2 on the back plane
ER28	B.12.2 Seat tabs >=0.125in thick, fastener of 0.25in dia. spacers <=0.5in thick
ER29	B.4.2.6.2 Anti-Sub belt angle 0-20deg aft of the chest line
ER30	B.4.2.4.1 Mount shoulder belts at or below driver's shoulders =<4in
ER31	B.10.3.3.1 Cockpit kill switch is within easy reach of a restrained driver

Charles

Customer Requirement

CR1	**Performance**
CR2	**Safety**
CR3	**Durability**
CR4	**Affordable**
CR5	**Comfort**
CR6	**Ease of Fabrication**
CR7	**Aesthetics**
CR8	**Pass Techs**
CR9	**Balanced Weight**

Ryan

Top Level Testing Summary

Test	Relevant DRs	Testing Equipment	Other Resources
Exp 1 - Drive the Car	CR1,2,3,5,9 ER1 - ER3	Fuel Fully Functioning Drivetrain Fully Function Suspension	Location to drive the Car.
Exp 2 - Driver Egress	ER4	The Car Stopwatch	Driver or Someone that is the Same Size
Exp 3 - Mock Tech Inspection	ER5 - ER31	Tech Sheet from SAE Tape Measures Angle Gauges Different Sized Rods	2025 SAE Baja Rulebook Someone to Proctor Mock Tech Inspection

Detail Testing Plan

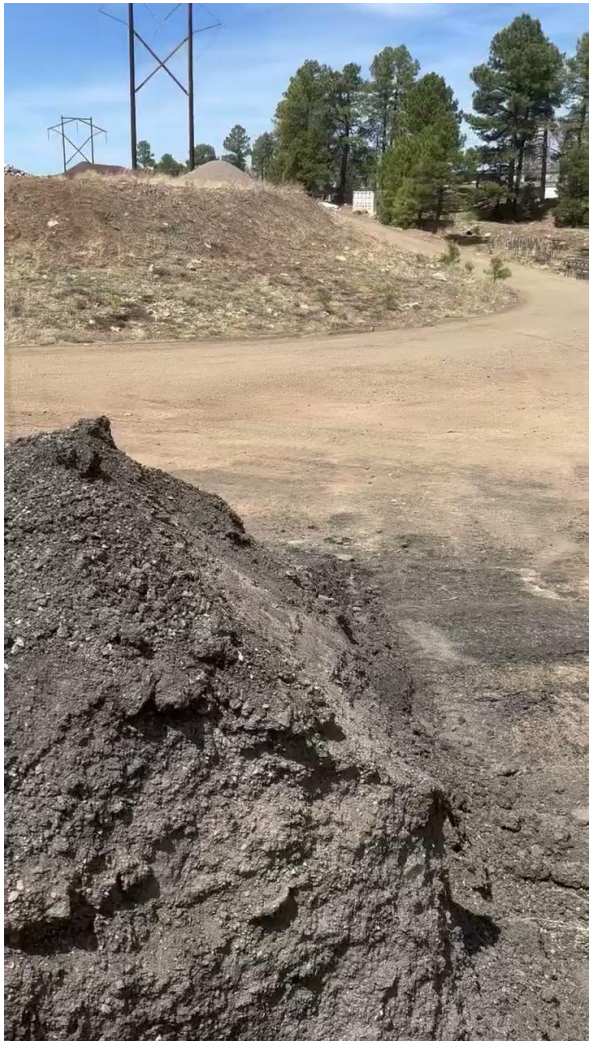
Experiment 1: Driving the Car

- Questions:
  - Gauging overall performance
  - Visually monitoring vibrations
  - Feedback on driver position
  - Visually inspect frame for deflections or interference

Charles

Experiment 1

- Findings:
  - Fuel needs to be pointing straight downwards
  - False Floor in front is 100% needed for comfort.
  - Steering and pedal placements are good. Seat placement is not a big deal.



Ryan

Results

Wyatt

Detail Testing Plan

Experiment 2: Driver Egress

- Questions:
  - Can the passenger exit the car in 5 seconds
- Procedure:
  - Have the drivers of the car present
  - Buckle the driver into the frame with the seat and wheel
  - Time the driver exiting the car

Charles

Experiment 2 Results

Both were able to get out of the vehicle both directions in under 5 seconds

Ryan

Detail Testing Plan

Experiment 3: Mock Tech Inspection

- Questions:
  - Will the chassis pass technical inspection
- Procedure:
  - Print out a tech inspection sheet to run through
  - Present unbiased opinion
  - Address any potential issues

Wyatt

Experiment 3: Results

- The Subteam has ran through the Tech Inspection on their own.
- This experiment will be as finalized as possible on 4/18/2025 with the help of Dr Willy.

Charles

Pass

Not Passed

Tech inspection sheet

B.3.2.17	Newly completed roll cage specification sheet must be present and filled out.	○		FR
B.3.7.1	Calculations, purchase invoices, and material certifications of the materials used in the roll cage and bracing shall be required at technical inspection. Must be within 5 years of Jan 1 of the competition year.	○		FR
B.3.2.16	Primary roll cage members must be constructed of steel tubing with a minimum carbon content of 0.18%., OD of 25 mm (1.0 in), wall thickness of 3.0 mm (0.120 in).	○		FR
B.3.2.16	Roll cage documentaiton package was accepted online. If status is not accepted, documentation package must be verified on site.	○		FR
B.3.2.3	Secondary members may be circular or rectangular in shape and have a minimum OD (or width) of 25.4mm (1.0 in) and a minimum wall thickness of 0.89mm (0.035 in).	○		FR
B.3.2.16	Check thickness of Primary and Secondary Roll Cage Materials in a minimum of two places each. (1.57 mm (0.062 in) and 0.89 mm (0.035 in) minimum)	○		FR
B.3.2.15	One destructive testing (sample #1) and one destructive inspection (sample #2) weld sample for each process performed by each roll cage welder is required at technical inspection. Weld samples shall be permanently marked with welder name, welder school, and weld date. A completely separated destructive test speciment (sample 1) will not be accepted.	○		FR
B.3.2.15	Weld samples are constructed of the same Primary Material and with the same process(es) as the inspected vehicle.	○		FR
B.3.2.15	Weld samples exhibit superior weld strength with respect to the base material.	○		FR
B.3.2.15	Weld samples exhibit sufficient and substantially uniform weld penetration.	○		FR
B.3.2.1	Straight members may not extend longer than 1016 mm (40 in.) between Named Points and bent roll cage members may not be longer than 838 mm (33 in) unsupported. Bent members shall not contain an individual bend greater than 30 deg. or comply with B.3.2.4	○		FR
B.3.2.5	Front two points (C) shall be joined by a lateral cross member (CLC); Located on the top plane of the roll cage. Lateral cross members not less than 8 in. long.	○		FR
B.3.2.6	RRH must have continuous vertical members and driver seat cannot protrude aft of the RRH plane.	○		FR
B.3.2.6	Rear Roll Hoop (RRH) must be substantially vertical (+/- 20° from vertical).	○		FR
B.3.2.7	LDB max 127 mm (5 in) from top and 127 mm (5 in) from bottom of roll cage. Min angle of RRH and LDB ≥ 20°. A single, straight LDB exempt from length requirement.	○		FR
B.3.2.12	Front Bracing (FBM) max 45 deg. between vertical and FBMUP w/o Front FAB. No angle requirement if front braced.	○		FR
B.3.2.12	FBM_{UP} joins points C to D. FBM_{LOW} joins points D to F.	○		FR
B.3.2.9	LFS members must extend from RRH to points forward of driver's heels which are connected by the FLC (and ELC for nose cars).	○		FR

B.3.2.12.1	If the RHO and FBM_{UP} are not made of a continuous tube, a gusset is required at point C.	○		FR
B.4.2.4.3	Tubes anchoring safety harness shoulder straps shall be mounted to the primary welded structure of the vehicle and within the plane of the RRH. Shoulder belt harness tube must extend from one side of the RRH to the other.			FR
B.3.2	Roll cage members and tubes shall be joined by welding the entire circumference and shall not exhibit any injurious defects such as cracking, burn-through, cold lapping, or insufficient penetration.	○		FR
B.3.6	Members which are drilled through both walls for the purpose of mounting fasteners or routing accessories shall be reinforced with a weld-in sleeve no larger than 50% of the member diameter.	○		FR
B.3.2.13	Projected to side view, roll hoop bracing triangulation angles must be at least 20°.			FR
B.3.2.13.1	If front roll hoop bracing is used, it must connect FBMUP, LFS, and SIM <5 in from Point C. Point P must be vertically supported to Point Q. Points P and Q only exist with a complete front FAB system.	○		FR
B.3.2.13.2	If rear bracing is used, there must be a structural triangle connecting point B (within 2 in) to either point A or S (within 2 in). The aft vertex of the structural triangle must also be connected to whichever point A or S (within 2 in) is not part of the structural triangle (this member is exempt from the maximum 30° bend rule). The aft vertices must be joined the lateral cross member RLC. Members connecting to A must have a 45 degree angle with ALC.	○		FR
B.3.2.8	RHO must be >1041 mm (41 in) above driver seat; LC at point C must be >305 mm (12 in) forward of seat back; and RRH must be >737 mm (29 in) wide at 686 mm (27 in) above seat. All dimensions are with respect to the template in B.3.2.8	○		FR
B.3.2.10	The side impact members shall run between 203 mm (8 in) and 356 mm (14 in) above the lowest point of the seat in contact with the driver.	○		FR
B.3.2.11	The UST shall connect the LFS members and pass below the seat.	○		FR
B.3.2.14	All butt joints are reinforced with an internal sleeve and exhibit at least 102 mm (4 in) linear distance of weld bead.	○		FR
B.3.5	Bolted roll cage meets specifications.	○		FR
B.3.3.1	The roll cage is large enough for the largest driver. The driver's helmet will be at least 152 mm (6 in) away from a straight-edge applied to any two places outside of the structure.	○		FR
B.3.3.1	The driver's torso, knees, shoulders, elbows, hands, and arms must have 76 mm (3 in) of clearance to the outside structure of the cockpit, less the roll cage padding.	○		FR
B.3.2.10	The structure provides 25 mm (1.0 in) of clearance between a straight edge applied to any two points on the roll cage and any part of the driver's foot while actuating all pedals through the full range of motion.	○		FR
B.3.1	The roll cage **protects** the driver as intended. No tubes showing any cracks or deformation. Final judgment will rest with National Technical Inspectors.	○		FR

Ryan

Pass

Not Passed

Tech inspection sheet

B.4.4	SFI 45.2 rated head restraint must be mechanically fastened (No Velcro or adhesive) to the vehicle. Head restraints may also be mechanically fastened or integral to the driver's seat.	○		1
B.4.2	Minimum 5-point harness with 3-inch webbing and a single metal-to-metal quick release lever buckle. No cam lock systems.	●		1
B.4.2.1	All driver restraint systems must meet either SFI Specification 16.5/16.1, or FIA specification 8853/98. Not older than 3 years as of Jan 1st of competition year. New style tags only.	●		1
B.4.2.4.2	The shoulder webbing shall be laterally spaced between a minimum of 152 mm (6.0 in.) and 229 mm (9.0 in.) center to center and be directly routed towards the driver's shoulders.			1
B.4.2.4.6	Restraint webbing may pass through the firewall as long as the firewall construction is extended to protect the harness webbing.	○		2
B.4.2.4.3	Shoulder belts shall be looped around a straight frame tube meeting secondary member requirements and have provisions to limit lateral webbing movement.	●		2
B.4.2.4.3	The shoulder harness must be securely mounted to the primary welded structure of the vehicle and within the plane of the RRH. Check for proper adjuster routing.	●		2
B.12.2	Lap and anti-sub belt mounting tabs shall be no less than 0.090 in. thick, have at least 1.3125 (1-5/16") in of weld length per tab, have no holes other than those required for bolts, and not display significant deformation when pulled on. Fastener and tab hole diameters must be the same.	●		2
B.4.2.5.2	Lap belt tabs must be in double shear, free to pivot and align with the direction of the load. Tabs must be welded to the primary structure. Webbing may not be routed against the seat as to impede the function of the restraint system.	●		2
B.4.2.6	Anti-submarine belts may be bolted by tabs, wrapped around a tube, or wrapped around a bolt in double shear. Webbing redirections over 30° are unacceptable. Webbing must not significantly twist between mounting point and latches.	●		2
B.12 **B.4.2.5.2** **B.4.2.6.3**	All fasteners in the **driver's harness** system shall meet requirements of B.12. Lap belt and/or anti-submarine belt bolts must be at least 12 mm or 7/16 in.	●		2
B.4.5	Vehicle must have a conventional seat with the driver's back angle between 90 and 65 degrees from horizontal. Suspension seats are prohibited.	●		2
B.4.5.3.2	The seat has a distinct back plane (not the firewall), with at least two mounting points no closer than 6 inches apart, at or near the RRH to tubes meeting at least secondary frame member requirements.	●		2
B.4.5.3.2	The seat has a distinct bottom plane (not the skid plate), with at least four mounting points no closer than 6 inches to tubes meeting at least secondary frame member requirements.	●		2
B.4.5.3.3	Unmodified FIA or SFI rated seats are permitted if factory mounting procedures are followed.	●		2
B.4.5.3.3	Any tubes mounting the seat shall be terminated at both ends	●		2
B.12.2	All tabs used to mount seats shall be at least 0.125 in thick accomodating a fastener of 0.25 in. diameter. Seat tab dimensions shall meet requirements of B12.2. Spacers shall not be greater than 0.5 in thick. Radially drilled tubes must be sleeved.	●		2
B.4.2.6.2	Driver anti-submarine belt angle is between 0 and 20 degrees aft of the chest line.	○		2
B.4.2.4.5	Belts shall be adjustable for different drivers. Minimum excess webbing is 4 inches.	●		2

B.4.5	Seat works in concert with the safety harness to secure driver.	●		2
B.8.3	This firewall must be metal, and at least 0.508 mm (0.020 in) thick. Large cutouts, including those for CVT and engine air intakes are explicitly prohibited. Drivetrain clearances are permitted per B.9.1 and have no gaps larger than 6.35mm (0.25in)	●		1
B.8.7	Open universal joints in steering system near drivers feet shall be covered to prevent entanglement. Steering linkages shall be properly shielded and covered with a sturdy, full-width cover.	○		1
B.8.6	Skid plate material must be metal, fiberglass, plastic, or similar material. Skid plates shall extend the length of the cockpit and prevent debris and foreign object intrusion into the cockpit.	●		1
B.8.8	Fire extinguisher mounted on the right side, easily accessible, with the top below the driver's eye, and the top half above the SIM. Mounting bolts must meet B12 and match hole geometry. The pull knob shall be free and clear of any access obstructions. ***Radial clearance to the pull knob shall be 2.5 in.***	●		1
B.12.2	The fire extinguisher may be mounted with traditional 0.125 in thick tabs per B.12.2, or by fuel tank style tabs per B.6.5.1.	●		1
B.8.8.4	Mount must resist shaking loose, but the extinguisher must be easily removable.	●		1
B.8.8	Two extinguishers with a Minimum UL rating of 5 B C; must be equipped with a **manufacturer installed dial gauge**; gauge must be **readable and properly charged**. Must have OEM pin retainer. No zip ties or tape.	●		1
B.8.8.3	Fire extinguisher mount is the approved Drake or DV8 quick-release mount. No other mounts are acceptable.	●		1
B.8.8.1	All extinguishers must be labeled with school name and car number.	○		1
B.7.2	Only foot operated, cable throttle controls are allowed. Wide open throttle stop is required (at the pedal).	●		1
B.7.2	Throttle cable cannot be bare from the forward mounting point to the firewall.	●		1
B.8.3	The firewall shall separate the cockpit and engine area, covering the entire plane of the RRH. Pass throughs for 4WD equipment are permitted if sealed.	●		1
B.8.5	Body panels must cover the area between LFS member and SIM. The material must be plastic, fiberglass, metal or similar material. No gaps can exist that are larger than 6.35 mm (0.25 in). Must use quick-disconnect methods.	○		1
B.10.4.1	BSAE approved, unmodified brake lights shall be mounted minimum 1000 mm (39.4 in) from ground, and clearly visible in daylight when illuminated. Light shall be completely extinguished when brakes are not actuated.	●		1
B.10.4.1	Brake and reverse lights must be entirely visble when viewed at a 45 degree angle from center. The total viewing angle shall be no less than 90 deg.	●		1
B.10.4.1	Each independent brake circuit must be equipped with a hydraulic pressure switch. Actuation of any one circuit or combination of any circuits shall turn the brake light on.	○		1
B.10.4.2	Cars with reverse must have reverse light (SAE "R") of LED design and alarm mounted at min 700 mm (27.6 in) from the ground and aft of the RRH/firewall.	●		1
B.10.3.2	Vehicle must have two kill switches of type: Ski-Doo 01-171, 27-0154, 27-0152, or Polaris 4015321 and must only be used for engine kill switch functions and shall not de-energize the brake light.	●		1
B.10.3.3	One switch must be located on the driver's right side of the vehicle, aft of the RRH, on a ***panel perpendicular (+/- 15°) to the firewall***, no more than 178 mm (7 in) from the top of the roll cage. Threaded kill switch fasteners shall meet rule B.12.	○		1

Wyatt

Pass

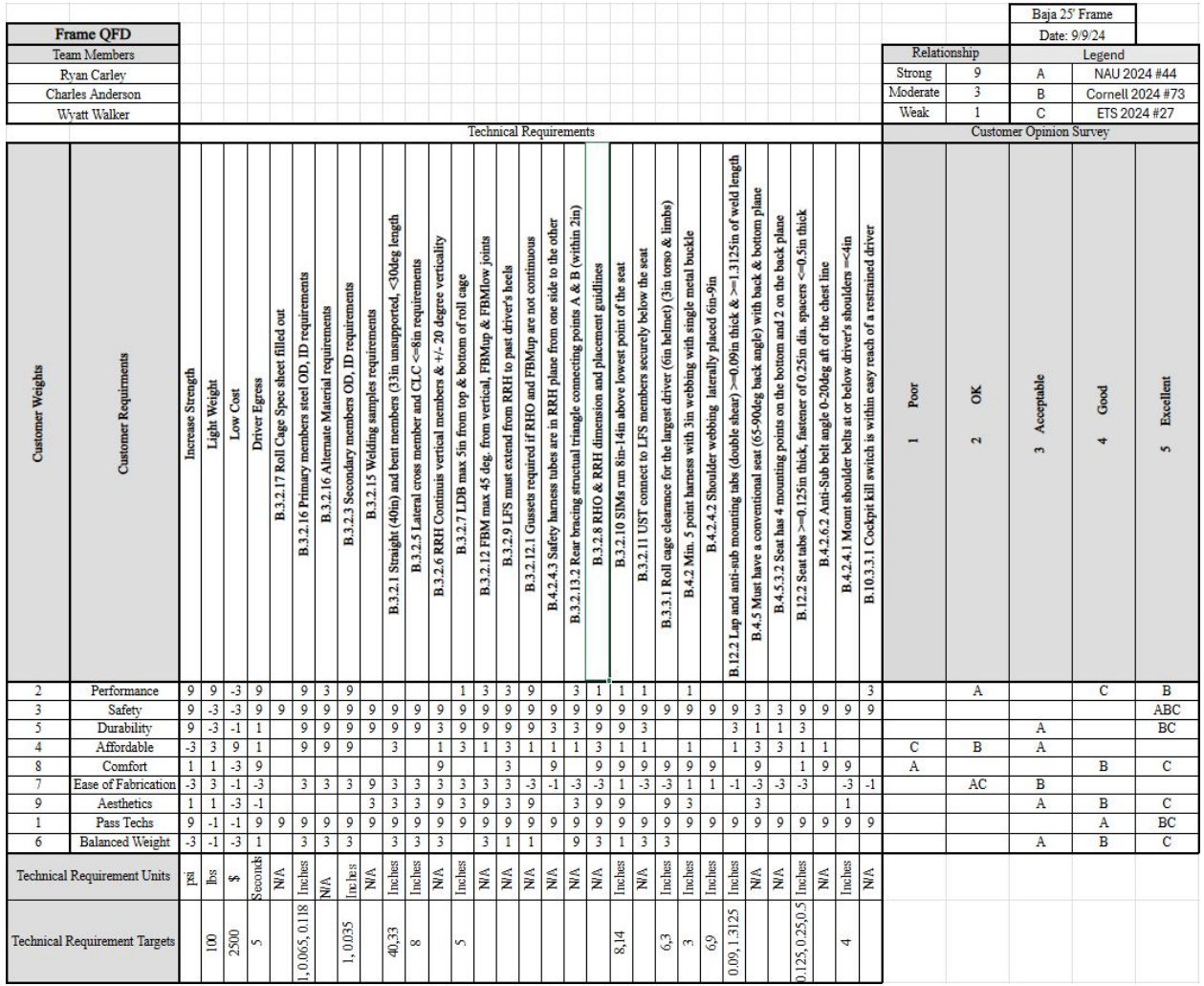
Not Passed

Tech inspection sheet

B.10.3.3	The second kill switch must be located on the driver's left side, along the SIM, and be easily actuated by the driver. No other push button switches are permitted on the left SIM. Any type of guard/cover to prevent accidental contact is explicitly prohibited.			1
B.10.2	Kill switch wiring must be sealed, protected or securely attached to the frame to prevent the wires from being entangled with the driver or obstacles.			1
B.10.4.1	Reverse and brake lights shall remain effective at all times. No cut-out or disabling switches are permitted for any braking or reverse system.			1
B.10.1	Max system voltage 60 VDC or 50 VAC RMS. All circuits shall have appropriate means of circuit protection.			1
B.10.1.1.3	Min battery voltage for safety appliances is 11 VDC (nominal).			1
B.10.1.1 B.10.1.1.5	The batteries must be effectively sealed and secured and not leak in the event of a roll over. Terminals shall be insulated. Check battery chemistry.			1
B.11.2	Front hitch is tubular, Max OD 1.25 in, Min OD 1.00 in. Vertical location between LFS and SIM. Must be able to pass hitch inspection gauge.			1
B.11.3	Rear hitch may be fixed or swivel style, 0.125 to 0.375 in thick, Hole diameter is 1.0 in to 1.25 in. 1.0 in max edge distance. Fixed style attachment width is 3.0 in minimum. Swivel hitches require a graded fastener and tabs 0.125 in thick with a total attachment weld length of at least 3.0 inches.			1

Charles

QFD



Frame QFD	
Team Members	
Ryan Carley	
Charles Anderson	
Wyatt Walker	

Baja 25' Frame
Date: 9/9/24

Relationship		Legend	
Strong	9	A	NAU 2024 #44
Moderate	3	B	Cornell 2024 #73
Weak	1	C	ETS 2024 #27

		Technical Requirements																													Customer Opinion Survey				
Customer Weights	Customer Requirments	Increase Strength	Light Weight	Low Cost	Driver Egress	B.3.2.17 Roll Cage Spec sheet filled out	B.3.2.16 Primary members steel OD, ID requirements	B.3.2.16 Alternate Material requirements	B.3.2.3 Secondary members OD, ID requirements	B.3.2.15 Welding samples requirements	B.3.2.1 Straight (40in) and bent members (33in unsupported, <30deg length	B.3.2.5 Lateral cross member and CLC <=8in requirements	B.3.2.6 RRH Continuis vertical members & +/- 20 degree verticality	B.3.2.7 LDB max 5in from top & bottom of roll cage	B.3.2.12 FBM max 45 deg. from vertical, FBMup & FBMlow joints	B.3.2.9 LFS must extend from RRH to past driver's heels	B.3.2.12.1 Gussets required if RHO and FBMup are not continuous	B.4.2.4.3 Safety harness tubes are in RRH plane from one side to the other	B.3.2.13.2 Rear bracing structual triangle connecting points A & B (within 2in)	B.3.2.8 RHO & RRH dimension and placement guidlines	B.3.2.10 SIMs run 8in-14in above lowest point of the seat	B.3.2.11 UST connect to LFS members securely below the seat	B.3.3.1 Roll cage clearance for the largest driver (6in helmet) (3in torso & limbs)	B.4.2 Min. 5 point harness with 3in webbing with single metal buckle	B.4.2.4.2 Shoulder webbing laterally placed 6in-9in	B.12.2 Lap and anti-sub mounting tabs (double shear) >=0.09in thick & >=1.3125in of weld length	B.4.5 Must have a conventional seat (65-90deg back angle) with back & bottom plane	B.4.5.3.2 Seat has 4 mounting points on the bottom and 2 on the back plane	B.12.2 Seat tabs >=0.125in thick, fastener of 0.25in dia. spacers <=0.5in thick	B.4.2.6.2 Anti-Sub belt angle 0-20deg aft of the chest line	B.4.2.4.1 Mount shoulder belts at or below driver's shoulders <=4in	B.10.3.3.1 Cockpit kill switch is within easy reach of a restrained driver	1 Poor	2 OK	3 Acceptable	4 Good	5 Excellent
2	Performance	9	9	-3	9		9	3	9					1	3	3	9		3	1	1	1		1							3		A		C	B
3	Safety	9	-3	-3	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	3	3	9	9	9	9				ABC
5	Durability	9	-3	-1	1		9	9	9	9	9	9	3	9	9	9	9	3	3	9	9	3				3	1	1	3					A		BC
4	Affordable	-3	3	9	1		9	9	9		3		1	3	1	3	1	1	1	3	1	1		1		1	3	3	1	1			C	B	A		
8	Comfort	1	1	-3	9								9			3		9		9	9	9	9	9	9				1	9	9		A			B	C
7	Ease of Fabrication	-3	3	-1	-3		3	3	3	9	3	3	3	3	3	3	-3	-1	-3	-3	1	1	-1	-3	-3	1	-3	-3		-3	-1			AC	B		
9	Aesthetics	1	1	-3	-1					3	3	3	9	3	9	3	9			3	9	9			9	3					1				A	B	C
1	Pass Techs	9	-1	-1	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9				A	BC
6	Balanced Weight	-3	-1	-3	1		3	3	3		3	3	3		3	1	1		9	3	1	3	3											A	B	C
Technical Requirement Units		psi	lbs	$	Seconds	N/A	Inches	N/A	Inches	N/A	Inches	Inches	N/A	Inches	N/A	Inches	N/A	N/A	N/A	N/A	Inches	N/A	Inches	Inches	Inches	Inches	N/A	N/A	N/A	Inches	N/A					
Technical Requirement Targets			100	2500	5		1, 0.065, 0.118		1, 0.035		40, 33	8		5							8, 14		6, 3	3	6, 9	0.09, 1.3125			0.125, 0.25, 0.5		4					

Ryan

Thank You

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If you have any further questions, please reach out to drc385@nau.edu.