

Design 2025

Friday, May 02, 2025 10:59 AM

Broad/ Introduction (5min)

- Hello my name is Carter Harrell, (introduce David and Micha). This year we had 3 main car goals for our IC car. First 10 overall placement. Second 440 lbs. Third 200 miles of test time. This year we had a horsepower goal of 60 peak wheel horsepower at 9000 rpm. We decided that the Yamamah r6 would be the best platform to achieve this goal on:

- Why 4 cylinder:

Pros:	Cons:
More stock HP	Heaver

Notes:

- Don't have an answer just move On or else they will burn you
- Talk about what you know
- Know where we are strong and where we arnt

- Why we chose the r6:

- Compared to the cbr found that there were minimal differences
- Familiar with the platform
- Spare parts availability
- Have made good power on the platform, with good reliability
- r6 has 123.5 hp vs 120 cbr600r

- Why run 93 octane

- Don't knock bc small pistons
-

- Stock vs Modified internals

Pros:	Cons:

- Forced induction vs n/a

-

- Where did you start you design:

- Started with the intake:

We have a water jet sheet metal intake design that is made in house. With a built in burst plate that prevents damage to the intake in the event of a backfire. We also have a bung for our maf sensor. We use a vertical design with one inlet, controlled by a throttle cable and butterfly. We use the stock Yamamah r6 injectors with port injection.

- Why aluminum?

Pros:	Cons:
Cheap	Bad flow
Easy to manufacture	
Light weight	

- How did we calc plenum volume?

-

- How did we calc runner length

-

Cooling Loop Thoughts

Sunday, May 18, 2025 8:22 PM

In this document are my thoughts for a slight change of some sub-system's of our car after seeing How the car was running during comp.-David.T

Context

Currently with our warm-up Procedure We turn the car on and let it get up to a temperature of 180. While the Engine is warming up to temperature We turn on and off the coolant/fan switch to let the water cycle through our system until it get to 180 degrees. My worry is not specifically With the warm up procedure itself but the fact that when the motor get to around 180 degrees farenheit eit the ecu turns on the water pump and radiator fan at the same time. Meaning that the only time that water is constantly flowing through the system is when it hits that temperature for that set amount of time. In some occasions we would have some issues with our engine getting very hot as-well. During Comp Me, James Maloney, and Brendan brought this issue up to a judge and this was some of the feedback. Another thing to note for our system aswell is that our fans and waterpump both turn on in sync.

After speaking with the judges and other teams that placed highly in design, we have discovered that the system we are currently running is problematic and could potentially be causing thermal fatigue and premature ware of the engine. Our method of monitoring engine temperatures consists of a coolant temperature probes in which the tip of the sensor is inserted into the coolant stream. As a result of this design, the sensor requires a constant flow of water. This ensures the engine is heating evenly and the sensor is accurately measuring temperatures.

Potential Solution

What the judge was saying was that the fact that we do this can potentially damage to our motor due to the fact that we do not have water continuously flowing through our motor. He was also saying that having a system like this could also lead to issues like premature blowby and wear on parts of the motor. A solution to this could be changing our current system to only have the fans turn on at 180 degrees. Now for the water pump we can use the information from what we did previously from radiator characterization (On the graph down below) and have our water pump run at different outputs based on our engine temperatures. For example during idle the water pump would run at 1 amps.(5-18-25).

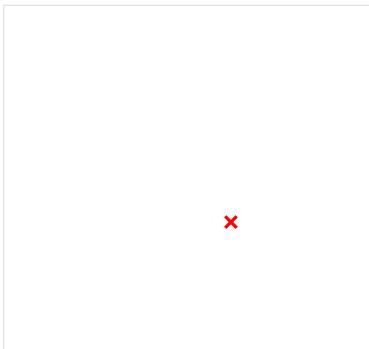
Further calculations should be run for "calibration" of this idle power. First measure the system head (in cad) and calculate the required pressure at the outlet of the pump to satisfy the system head. Measuring the pressure at the inlet and outlet of the pump would greatly improve the accuracy of this model and should be used to calculate pump efficiency.

Implement a method of controlling power supplied to the water pump which increases with engine temperatures. The water pump should be always on, and would ideally vary mass flow rate through the system based off engine temperatures. The same can be done for the fan mounted to the radiator, creating a dynamic system to help reduce stress on the LV system and ensure proper cooling of the engine.

Could use a PWM signal controller as suggested by Brenden
Or we could implement an additional control unit to CAN as suggested by Johnathan

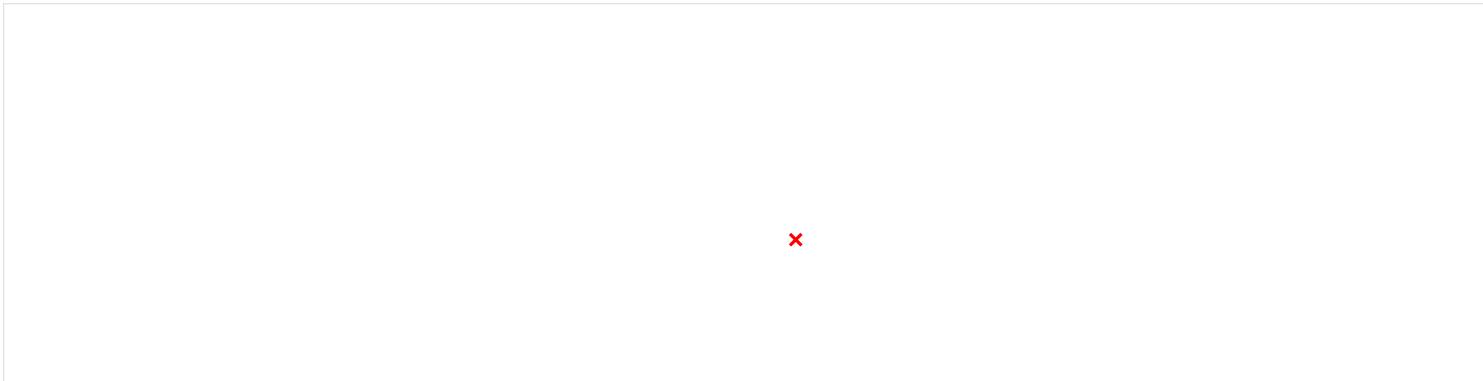
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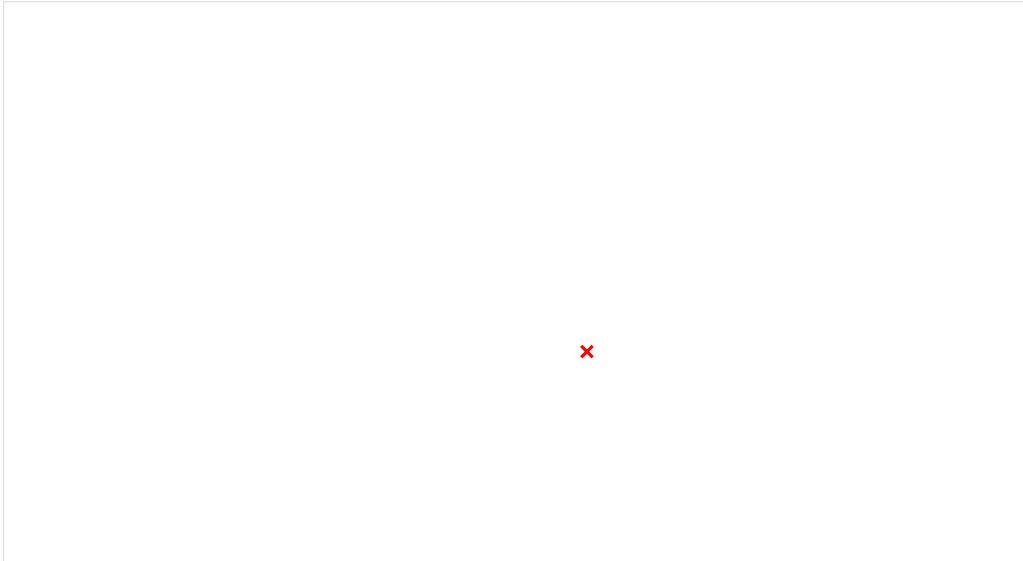
✗

Mass Flow calculations from the bucket test



✗

Efficiency of water pump while varying current



✗

Increasing mass flow decreases pump efficiency measured in L/Wh

[Radiator Characterization Project Proposal](#)

Design Question Spitball

Friday, May 2, 2025 10:12 PM

System Architecture:

What was your power and torque goal for this year?

- Felt that would be best for engine
- Tradeoff between reliability and power
 - o How did you know how much power would become unreliable

Where did you start with your design?

- Started with exhaust design, recently tested and developed equal length headers
 - o Why did you start your design with the exhaust
 - Weak point from last year, did not flow well at all. Shown with dyno graph

How did you arrive at your engine block choice

- We figured that
- Didn't know

How did you pick your fuel

- Small pistons compared to normal engines and we don't knock even though timing is turned up
- Don't need higher octane fuel to combat knock
- Possible power gains?
 - o Don't think I would? E85 is less power dense would be more inefficient

How do you make the tradeoff between power and fuel efficiency

- In our tune we Need to look at

Do you run a stock R6?

- Looking at doing a 636 kit,
 - o Why do you think it is the best for our car
 - Don't know why, intake is limiting

X

Controls and Calibration

Talk me through your ECU selection

- Megasquirt V3, allows accel enrichment, allows tuning to be done with inhouse dyno
- We have a specific formula for how we do tuning
- Developing wheel speed sensors,
- Don't know why didn't consider other options

Do you have startup or cold weather tunes

- Accel enrichment for startup and flood clear

Analysis and Development

How does team make decision for which is limiting factor

- We found with our engine test stand that our headers give an increase of 10 horsepower
- Do you know how you would find that information
 - o Developing variable runner length and engine test stand, ran flow simulation, a one dimension engine simulation

What is your process for dyno testing

- Setting tune, establish tune
- Mainly looking for peak power, reliability testing on dyno
- Can't tune for torque currently, so tuned for peak power

Do you do any lot testing (different tunes for different drivers)

- Do a lot of skidpad testing and autocross testing
- Drexler tuning and preload and ramp
 - o Lied about this
- When doing skidpad testing , not sure what looking for

Systems

What is your intake configuration

- Aluminum sheet metal design, with single inlet, four runners

How did you decide, plenum volume and runner lengths

- Not sure

How did you decide your header configuration

- Ran matlab script that told us we needed 20 in for primary

How did you decide exhaust / header length

- Part of your script

What was your approach for muffler design

- Wanted two stage chamber to cancel out frequencies

Valvetrain changes?

- Could be something interesting to investigate in
 - o Don't see that as pressing issue, with cams you will have higher flow, restrictor, knows the theory for this question
 - o Talks a lot about restriction of intake

How do you make the tradeoff of investigating intake vs headers design

- Have seen improvement in headers, did increase in horsepower, and marginally better than the stock pipe that was designed in the last exhaust

How'd you design your cooling system

- Wanted cooling system that withstand 180degrees F, in Georgia,

How'd you start your drivetrain design

- Started at diff carriers, diff carriers failed last time
- Went back and redesigned the diff carriers, were heavier
- Goes through iterations when you don't need to

- "heres our FEA, here's our calcs"

Howd you select your final drive

- Don't know

Brenden Questions

Monday, May 12, 2025 3:07 PM

- Where did we draw the line between power and reliability?
 -
- Why the ms3?
 -
- What is the final drive and why?
 -

EnD Design Debrief

Thursday, May 15, 2025 10:01 AM

Design Debrief

- Did not care about 4 vs 1 cylinder selection
- Did not care about the goals or points distribution
 - o "okay lets move on"
- Talked about hubs
 - o Talked about the change, didn't ask questions
 - Did not focus that much on the actual driveline
 - o Did go through the explanation of how we got axle lengths and tri pod setup
 - o He liked the final drive information
 - Wanted a more diverse and why do we use a final driver for a specific event
 - Forgot to add the traction bar in final drive analysis
 - o Went into the 420 vs 520 chain
 - Did not care about it because it wasn't on the car or for future testing
 - o Overall did not care that much about the testing of the car
 - o Spend majority of time on the intake
 - Answered all the questions
 - Wanted to get the correlation of the MFR of our CFD and real life on the dyno
 - Can actually do that
 - Did not care about the intake shape or geometry
 - Was okay with the construction, noticed the burst plate
 - o Choke flow
 - Talked about restrictor and choke flow
 - He knew the optimal choke flow off the top of his head
 - o Throttle body sizing
 - Wanted to know why we reached choke flow sooner than the theoretical
 - o Optimal throttle body size and why not have a smaller one compared to the bigger one
 - o Asked if the plenum was design for throttle response, was in presentation
 - o Was satisfied with the information on the runners
 - o Did not care about the intake testing, probably just ran out of time
- Asked questions:
 - o Talked about muffler
 - Did not care that much, just wanted to see if we passed sound
 - o How we tuned the drexler
 - Cheesed him, setup min and max turns, driver feedback
 - o Asked a little about tune per event
- Overall:
 - o Mixed opinions, will get better results this year
 - Based off the content and answered a lot of the questions better
 - o Had 5W-40, wanted to know why we ran that oil, what is the number stand for, what is the peak operating temperature

Meetings

Tuesday, June 18, 2024 12:01 AM

2-26-25 Meeting and engine notes

Wednesday, February 26, 2025 7:04 PM

Engine plan:

-Backstory/update

The motor was finished last night but has some issues some have been resolved and others have not:

Issue 1-No compression on any cylinder

- This issue was resolved
- The solution was that the timing chain had jumped a tooth this in turn kept the valves open longer and we had compression leaking out of the valves.

Issue 2-No compression on cylinder 3

- Is not resolved currently
- Have a few theories about how to resolve this issue.
- Had compression on all the rest of the cylinders.

Cylinder 1-150

Cylinder 2-100

Cylinder 3-0

Cylinder 4-90

- There are a few things that can cause low compression on one cylinder like this. Last time it was a head gasket. However I am fairly confident in the headgasket because it is brand new. Also it is one of the inboard cylinders so doubt it would be that.
- My theory is the valves, and I have a few reasons for this
 - Reason number 1: We are building zero compression. If we had failing rings or something like that then we would build at least something.
 - Reason 2: I visually inspected the valves and could see a large amount of carbon and oil deposits on the valves. I also noticed that it looked like they were not sealing all the way. This seems like it is the most likely issue and will be starting with this issue first.

Solutions:

- I am going to try and fix the valves with the heads on. I think I can get some acetone on the valves and hope it will break down that carbon. However, if that does not work then the head and all the timing will have to come off so we can properly remove and clean each valve.
- We have titanium valves meaning we can't lap them. The reason is that the valves are coated to add a harder coating since Ti is brittle. Meaning if you lap the valves you remove the coating. Also when you lap the valves you have to reshim them because it's an overhead cam and uses buckets and shims. So we would most likely be just replacing the valves in cylinder 3 with spares we have.

Notes:

- Engine is about out
- Exhaust is done
- Really really hoping to have the engine building compression in
-

2-12-25

Wednesday, February 12, 2025 7:48 PM

Wheels spinning on jacks:

- Diff carrier???? Apparently something was off with the bottom shim???
- Lore?? Bray fixing
- 30tho off the diff carrier
- causing misalignment of diff carrier
-

- Need to fit up chain
- If you ever cut a new chain cut it without any shims in. You want the shortest chain possible

- Would like to have the wheels spinning by the end of the week so we can do testing this weekend
- Want to start getting stuff together to be manufactured while the car is apart.

1st -Muffler

2nd -Fuel tank (James will be getting dxf's together)

3rd -Motor rebuilt (drop in after powder coat)

4th -Intake (with new venturi)

Other Tasks:

- Need pie cuts done for muffler (Ben doing this)
- Gonna be hard without horizontal bandsaw lot of grinding
- Might want to try the one in O building
- Have to get my design slides done ahhhhhhhhhhh
- Come to GTMS dyno this Saturday @10

[In-Order from Top to Bottom]

If there is a hold up on one thing move to the Next objective until u cant do no more

First start IC:

- Engine runs for least a min
 - Engine in
 - Fuel tank installed
 - Fuel Rail installed
 - Safety wire bolts
 - Fuel lines Install
 - New fitting ariving to shop Monday
 - Radiator insatalled
 - Water pump installed
 - Water lines

- Headrest installed
- Intake installed
 - Safety wires Bolts
- Heatshield installed
- Maser switch installed
- Dash tabs connected to V area
 - Install Starter and Estop
 - Need to buy a M6 Nut for starter wire
- PDU welded
 - Install PDU and Starter solenoid
- Wiring harness connected
 - Front
 - Rear (engine harness)

- Move under own power Driveline
- Rear wheels turn on jack stands
 - Throttle cable installed
 - Clutch cable installed
 - Pneumatics installed
 - Bottle
 - Solenoids
 - Control board
 - Diff carriers (Left side) machined
 - Old Axis installed
 - Front sprocket installed
 - Rear sprocket installed
 - Chain installed
 - Chain guard installed
 - Clutch Handle Installed

2-5-2025

Wednesday, February 05, 2025 7:36 PM

First start:

- Throttle cable
- Wiring
- Test for fuel leaks
- Chance needs welder of lv tabs:
 - Dash
 - PDU
 - Ground

Driveline tasks:

- Cooling loop
- Driveline installed
- Front Sprocket
- Rear Sprocket
- Chain
- Chain Guard
- Axles and tripods
- Clutch handle
- Find tabs
- Cable attached
- Muffler
- Find mounting tabs
- Heat shield
- Safety Wire Fuel rail
- Safety wire intake
- Safety Wire Tension caps
- Find Shifting plate
- Shifting board
-

Manufacturing list: (after powder coat)

- Diff carrier
- Gas tank (second highest priority behind diff carrier)
- Intake with new venturi
-

Car Goals:

Overall:

- Top 10 Overall
- Build 2 cars
- Cost and biz finalists
- 100 points in design
- 200 miles of testing

IC:

- Build quickly and devolve through testing
- Optimize car performance through testing
- Weight: 430 lbs.

EV:

- Implementation of new pouch architecture
- Weight: 440 lbs.

3-29-25 Yamaha R6 Dissassembly

Saturday, March 29, 2025 1:35 AM

Today we got a 2015 Yamaha R6 motor And we are dissasembling it to get the Motor for IC.

The Reason for using this different Generation bike is because it uses the same motor as the 2008 Version.

After Doing Disassembly of other components **This is Results of the Compression Test**

Cylinder 1 150 PSI

Cylinder 2 155

Cylinder 3 150

Cylinder 4 150

11-14-24

Thursday, November 14, 2024 8:23 PM

Michelin Shootout:

- Tech car
- Pack trailer
- Shakedown car

10/31/24

Thursday, October 31, 2024 8:24 PM

Headerbungs
asda

Intake ram pipe
dffjgfhji

1-29-2025

Wednesday, January 29, 2025 8:12 PM

To do:

- Look for filler neck for rad
- Need to remanufacture diff carrier
- Look into bracing for diff
- Need to fix axles
- PDU box in
- Fuel rail
- Fuel lines
- Dash after y is installed
- Intake after headrest
- Need to make 4:1 sprockets 420
- Need to make current set for back up
- Need to find front sprocket stock
- Find rear sprocket stock
- Find steel for front sprocket

Plans:

- Work on new motor until after powered coat

Things needed for rolling car:

- Put ev's suspension on ic rear might be good
- Take ic old suspension off
- Put in old ic axels for getting it going
- Weld floorplan on (2 more)
- Find lc seatbelt tabs
- Intake after headrest
- Bray showing how to do pedal box tn
- Seatbelt tabs
- Breaklines
- Steering can actually go in once y is welded in

Orders:

- Co2 regulator
- Diff seals
- Diff bearings
- Ev axles
- 420 chain
- 520 chain
- Master links for both
- Dt nuts and bolts for rear sprocket
- Reimbursement James for injector kit

1/16/25 Meeting Notes

Thursday, January 16, 2025 7:30 PM

Car Goals:

Overall:

- Top 10 Overall
- Build 2 cars
- Cost and biz finalists
- 100 points in design
- 200 miles of testing

IC:

- Build quickly and devolve through testing
- Optimize car performance through testing
- Weight: 430 lbs.

EV:

- Implementation of new pouch architecture
- Weight: 440 lbs.

Orders:

- Head gasket
- Need to cut the 4:1 sprockets
- Start looking at how much the big bore engine will actually cost (outsourcing the machining)
- Look at dxf for gas tank
- Order seals for drexler
- Crush washers for exhaust
- Axels??? From last year
- Diff carrier flex???
- IA Plate???
- Brake pads???
- Need to see what stock we have for sprocket and fuel tank

Stuff that needs to be done:

- Fire wall tabs
- Front motor mounts (figure out sol)
- Finish welding up headers
- Body tabs
- IC rad tabs (bolt to rad to mock up)
- 3d print dash jigs for both
- Full box for IC dash (may just knock these out myself)
- **GET TOOLS IN HOMES TO MAKE EHS HAPPY**
- Find engine parts in dyno
- Get bottom end rebuild
- Motor mounts
- Engine in
- Driveline and scatter shield
- Front and rear susp
- Dash tabs and estops
- Water pump
- Rebuild Injectors
- Gas tank (need to talk to Marco about making a new one)
- **STEARING RACK TABS**
- Battery box (after heat shield and gas tank)
- Ecu tabs
- Clutch handle
- Muffler tabs
- CO2 bottle tabs
- Breaks
- Firewall tabs
- 2x catch cans
- Floor pan tabs
- Side panel tabs
- Swiss cheese tabs
- IA plate and bonding
- Head rest
- Master switch
- GRND tabs
- Pedal box rails
- Break light
- Seat belt tabs

1/22/2025

Wednesday, January 22, 2025 7:31 PM

Car Goals:

Overall:

- Top 10 Overall
- Build 2 cars
- Cost and biz finalists
- 100 points in design
- 200 miles of testing

IC:

- Build quickly and devolve through testing
- Optimize car performance through testing
- Weight: 430 lbs.

EV:

- Implementation of new pouch architecture
- Weight: 440 lbs.

Stuff that needs to be done:

- Fuel tank jiggling is next
- Need to get with Marco on if we making new tank
- Need to get new diff carrier ($\frac{1}{2}$)
- Going to get Yamah part numbers tonight would like ppl to come with me to dyno
- Might be working of engine this weekend
- GTMS dyno pt.2 on Saturday pop out need people
- GTMS might park their car overnight in dyno on Friday
- Need to get dyno computer working
- Need to look at rear bearing^{1``}

Side notes:

- Don't destroy parts that come off the car I am not naming any names, but I have heard that some of my subgroup members are destroying parts that came off the car.
- If you are labeling stuff then please make sure it is legible and makes sense for reassembly
-

Orders:

- Head gasket
- Need to cut the 4:1 sprockets
- Start looking at how much the big bore engine will actually cost (outsourcing the machining)
- Look at dxf for gas tank
- Order seals for drexler
- Crush washers for exhaust
- Axels??? From last year
- Diff carrier flex???
- IA Plate???
- Brake pads???
- Need to see what stock we have for sprocket and fuel tank

<https://www.ebay.com/itm/267088254590?gQT=2>

9/24/2024

Tuesday, September 24, 2024 8:47 PM

Compression:
Looking into sealing the motor
Increasing compression ratio

Intake 9/18

Wednesday, September 18, 2024 9:54 PM

Test Intake:

Absent from school

Pete redising?

Calculations into test proposal

Be done by friday 9/20

Plenum And Runner Length: Sept 24

Plenum:

Nothing Has Been Done

Locked in current rough dimensions

depending on Runner length

Also Sunday at 6:30

Runner Length:

Nothing Has been done:

Date has been set for Friday at

9:30-10

Ram Pipe: Sept 24th

11in Locked in

CFD

UPdate PP

8/1/24 - ranked priority list

Thursday, August 1, 2024 7:45 PM

8/20/24

Monday, August 19, 2024 4:23 PM

Meeting Agenda:

- Discuss Project Assignments
- Discuss Expectations for Project Proposals
 - Week and half advance for proposals and peer review before presenting to team
 - Well documented PP design brief
- Look over the New PP System
- Time Dedication

Deliverables:

- Filled out Project Tracking:
- Known list of availability

8-27-24 Roles and Responsibilities

Tuesday, August 27, 2024 7:02 PM

Agenda:

- Discuss Responsibilities of Project Roles
- Discuss the finalized Projects

Role Definitions:

Manager-

Mangers will be responsible
for keeping members involved and assigning tasking and keeping the leads informed of progress.

Filling out documentation and keeping tabs on progress and what design task need to be performed.

Scheduling Subgroup proposal reviews with the EnD leads

Determining how many proposals are necessary for the project

Responsible for making sure project meetings are happening and documenting who is putting in work or not

Responsible for setting deadlines for project milestones and completion dates

Communicating with members and End Leads what they need and if they are struggling or can't complete a task

Members-

Fulfilling the task assigned by the project manager

documenting their designs as they move through tasking.

Communicating with project manager and End Leads what they need and if they are struggling or cant complete a task

Meeting Deliverables:

- Every project group should have a hour or 2 a week to discuss project tasking
And every member should be able to go to the meeting.
- This Schedule should be documented in this meeting.
- Schedule meetings with EnD Leads to discuss the ins and outs of the project.

Notes For lead:
Update roles and receptibilities defining how to document the projects and design notes

Look in channels for project tracking.

Projects:

Headers:

Manager- Brenden
Member- Carter Brown
Manufacturing Advisor - Marco

Intake:

Manger - Paddy
Plenum - Anelia and Liz and bryson D
Runner Lengths - Anelia and Liz and bryson D
Restrictor and venturi - Leyth
Manufacturing Advisor - Marco

Muffler:

Manger - Carter Harrell
Member - Rowan

Cooling Iteration:

Manager - Liz
Test Procedure - Matthew D
Rad Selection - Liz
Cooling Curve - Justin
Electronics Integration - Justin

Axels and Tripods(IC and EV):

Manager-
Member-Herbie
Member-Richard
Member-

BSFC:

Manager-
Member-Alexander
Member-John Williams
Member- Matthew D

Chain Selection:

Manager-
Member-Lilly Brozovsky
Member-James Moloney

Pneumatic Shifting:

Manager - Bray (Possibly)
Member-Dominik Klenik
Member- David Thoms

Compression -

Manger- Devon Phillips
Member – Stone Mullins
Member-Victor Salcedo

Exhaust Gas Temperatures

Manger - Bryson D?

9/3/24

Tuesday, September 03, 2024 7:46 PM

- Headers
 -
- Muffler
 - Working on part 1 of the project proposal
 - Contacting Ruhla on helping us do some test on different exhausts
- Intake
 - Presented part 2 on runner length testing
- Cooling Iteration
 -
- Axels and Tripods
 -
- BSFC
 - Need help directions and what to do
 - Talk to group members and make sure they are at meetings
- Chain Selection
 - Still getting information
 - Need to start part 1
- Compression
 -
- Pneumatic Shifting
 -
- EGT's
 -

9/10/24 Meeting Notes

Tuesday, September 10, 2024 7:34 PM

- Headers
 -
- Muffler
 - Working on part 1 of the project proposal
 - Contacting Ruhla on helping us do some test on different exhausts
- Intake
 - Presented part 2 on runner length testing
 - Paddy fixing math on the way up to pitt, and pete was fixing cad
 -
- Cooling Iteration
 - Waiting on testing
 - Test prop. Is done
 - Waiting on parts to run test
- Axels and Tripods
 -
- BSFC
 - Need help directions and what to do
 - Talk to group members and make sure they are at meetings
 - Starting PP
 - Need to find old files
 - Need to get in contact w/ John
- Chain Selection
 - Still getting information
 - Need to start part 1
 - Just about finished w/ part 1
 - Review once we come back from pitt
- Compression
 - Filled out excel on parts
 - Start test prop.
- Pneumatic Shifting
 - Need to gather group members
 - Need to talk to Bray to make sure it is happening
 - Need to start on part one
- EGT's
 -

Things To do this week:

- FINSH HEADER BUNG DRAWING
- Start packing up EnD stuff for pitt making sure we have spares and have tanks etc
- Feel like the car is doing well. May try and retune with id Brenden is available
- Recheck driveline
- Go through Mech tech
- Double check driveline
- Start cleaning shop
- Start cleaning trailer
- Move Ic aero to dyno
- Get wheel back on
- Find and charge all lv batteries
- Check over dyno/clean
- Will be leaving for pitt Thursday so no one will be in the shop

9/17/24

Tuesday, August 27, 2024 8:28 PM

- Start getting proposals out
- See where we are at w/ plenum, runners and , ram pipe (plenum and runners should be one doc, and ram pipe separate) need done by Friday to meet the 24th deadline
- Rad characterization is on track make Matlab may get thermocouples from summit money
- Need to get bungs for pie cut headers
- Want headers on the car for Michelin
- Tune car on Thursdays
- Look into what it would take to fix the ECU
- Clean up tape jobs
- Fix stops on the rack
- Find an insert for the steering clevis
- Look at flipping the diff
- Look at the softer springs
- Friday Class
- This weekend motor and ets
- Contact night owles to let them know we will dynoing and working on the motor saturday at 4
- Hold people accountable
- Give achievable deadlines
- Look into getting a fuel sock for pump (new member)
- Look into fixing the dyno start/stop

10-15-24

Tuesday, October 15, 2024 8:02 PM

Intake:

- Need finish CFD of Runner Length for both plenums
- Finalize CAD
- Finalize Manufacturing Plan

Headers:

- Finalize CAD
- Finalize Manufacturing Plan

Muffler:

Pneumatic Shifting:

- Finishing Part 1
- CAD is done for Larger Tank
- Cylinder Position Sensor have been acquired

BSFC:

- MATLAB Script is done for the theoretical values @ MEP

To Do:

- Experimental MATLAB for BSFC
- Full Proposal Need to be started

Compression:

- Full proposal needs subgroup review

Chain Selection

- Part 1 is done
- Part 2 is being worked on
- Need to do FEAs

Cooling Iteration

- Test plan is done
- Math is still needed
- Need to see if we use MFR

Axels and Tripods

- Need to make the skelton sketch for both cars
- Need the weight transfer math to measure the displacement of the diff

10-22-24

Tuesday, October 22, 2024 11:56 AM

Manufacturing:

COTS:

Bent tubes:

3D prints

Sheet Metal Parts:

3D Parts:

Headers

Pneumatic Shifting:

Design Matrix:

More resolution

CAD:

Updated CAD Photos:

Radiator:

11-19-24

Tuesday, November 19, 2024 7:03 PM

Engine Rebuild

- Plastigauge Clearances
- Fully assemble
 - o Pistons
 - o Torques spec
 - o etc

Testing:

ETS: james, Ben, Bray?, david, john

Bolt the dyno into the concrete
Sheathe Harness
Rebuilt ETB
Rerun Pneumatic Shifting
Find PDU
Reinstall Radiator
Fuel Cell

Rad Characterization: Matthew D, James

Order For in
Water Bucket test
Perform Test

Raptor Listing

Clean Engine
List Engine
Money Spread

Intake Testing

Manufacture Squish Plates
Finish ETS
Perform Test

Drexler Rebuild

Engine Dyno

Figure out the amp clamp
Figure out the pendent issues

Design Notes

Tuesday, August 27, 2024 7:02 PM

Updated Deadline 10 /3/2024

Thursday, October 3, 2024 6:00 PM

Diff integration - Priority A

Part 1 8th

Headers - Priority A

Part 1 and 2 This week - subgroup review

Part 1 and 2 15 - chief review

Part 3 15 - Subgroup review

Part 3 22 - Chief review

Mufflers - Priority A

Part 1 and 2 This week - subgroup review

Part 1 and 2 15 - chief review

Part 3 15 - Subgroup review

Part 3 22 - Chief review

Intake - Priority A

Part 1 and 2 8th - Chief Review

Part 3 15th - subgroup review

Ram pipe -

Part 1 and 2 8th - Chief Review

Part 3 15th - subgroup review

Cooling iteration - Priority B

Axels and tripods _ Priority B

BSFC - Priority C

Chain Selection - Priority C

Pneumatic Shifting - Priority A

EGT - Priority c

Compression - priority B

This week completed proposal

Headers

Tuesday, August 27, 2024 7:02 PM

Headers - Meet after Monday Meeting

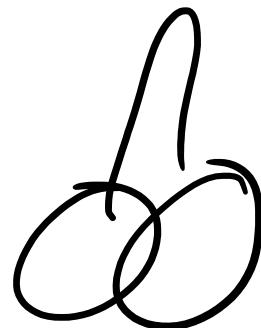
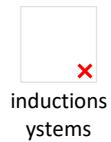
Mufflers

Tuesday, August 27, 2024 7:03 PM

Intake

Tuesday, August 27, 2024 7:03 PM

Meeting Times:
Wednesday at 8pm



1

Runner Length CFD

Wednesday, October 2, 2024 9:22 PM

	Straight	45	180
3.705in	.1839		
4.117			
5.7			
4.631			
5.293			
6.175			
7.41			
9.262			



Intake

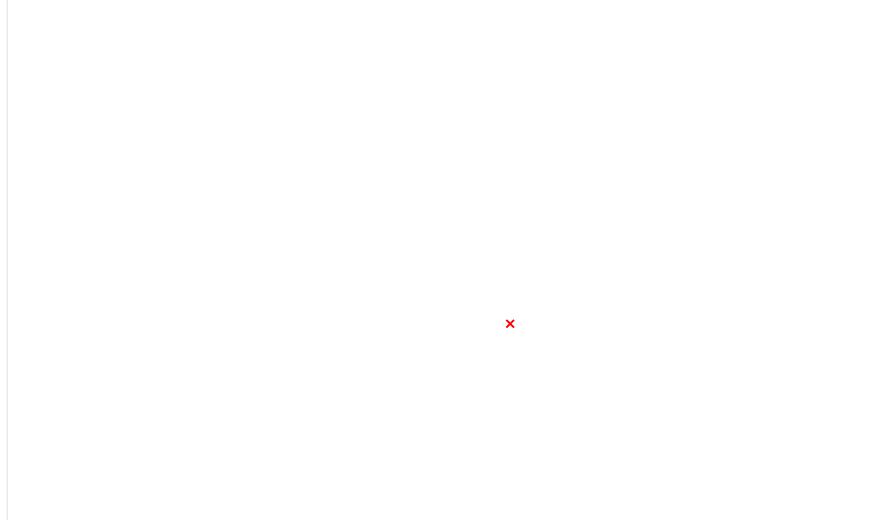


Parameters:
Goals

5.7in with 45 degree angle

Goals:

Surface goal Mass Flow



Ram Pipe Subgroup Review

Tuesday, October 1, 2024 8:57 PM

Under function talk about what a venturi is

8/28/2024 - Intake

Wednesday, August 28, 2024 8:01 PM

GOALS

Increase area under Dyno graph/HP curve
Reducing aero drag / lift impact

Maintain weight
Material changes

Throttle body:
ETB?
Size?
Springs for rule IC 3.3.2
Idle position set screw (Lawn mower)
KSS throttle body research:

Venturi:
Max flow velocity
Distance from throttle body

Plenum:
Volume vs throttle control
Equal Distribution of air into the plenum
Geometry

Runners:
Maximize air speed into engine
Consider timing bounces

Next Wednesday:
Part 1 of PP - everyone
Parametric CAD - Everyone
Plenum Geometry
Ram Pipe
Runner length

Constraints

IC 1.2 - 4.9
Placement

Design Methodology:

The first thing to do is to design the Venturi, Plenum, and Runner Lengths in Lengths in Parallel. This will then be integrated into a system and optimized together. There will be 3 different proposals. One for the Restrictor, one for plenum and runner lengths and, and one for the system

Deadlines

Test DOC: 30th
Ram Pipe: before test day
Testing: TBD
Sept 3: PP Updates
Project Proposal Document Deadline: sept 24
Plenum, runner, ram pipe: oct 1

Entire system review: oct 22

Intake 9/25/24

Wednesday, September 25, 2024 8:14 PM

Runner Length Task:

- MATLAB script - James - 09/27
- Parametric Runner Length- Bryson D and anelia - SoClik -09/27
- CFD for runner length- intake group as a whole - 10/2
- Proposal
- Concerns

-We need to get boundary conditions from the plenum cfd to use for cfd runner length

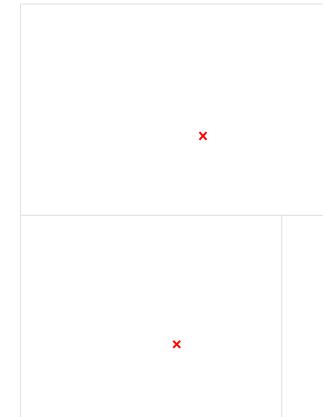
Plenum:

- Carbon Fiber - CFD - brenden - 09/27
- Aluminum Cad -CFD
- Experiment with plenum
- Proposal



Intake Testing:

- Cad:
 - Ram pipe needs to moved - pete or Paddy 09/27
 - Plenum Volume - Cad - austin - 09/27
 - In section
 - Drawings need to be made
 - flange plates
 - Throttle Body
 - Intake bungs
- Proposal:
 - Budget
 - Matlab Script



Cooling Iteration

Tuesday, August 27, 2024 7:03 PM

Rad Characterization:
Weekly Meeting Times
Thursday's at 8 pm

Updated test process for Rad Characterization

1st Make sure that the thermocouples placed on the inlet and outlet of the radiator are measuring accurate water temperature readings.

2nd Place thermometers in front and behind the radiator. Infront of the radiator should just be the ambient temperature, and when measuring the exit air temperature of the radiator, try to measure at different distances ex; 5 cm, 10cm, 15cm, and 20cm. See if there is much of a discrepancy between these values. Ideally you do not want to be too close where you get the radiation off the radiator but you can't be too far where you do not get an accurate temperature reading. The exit temperature of the radiator will be used for calculations.

3rd Once all four temperatures have been collected it is time to do some math.

First we find the rate of heat transfer (Qdot)

Current Radiator Size/Specs:

The temperature of the inlet and outlet of the radiator are being used for this initial calculation only. Specific heat hardly ever changes its value but would be useful to know it will slightly vary at different temperatures. For the purpose of this test, the flow rate of the water pump will not change. It will be assumed that close to the max flow rate of the pump will be used.

4th After solving for the rate of heat transfer, we will use this next equation that solves for the logarithmic mean temperature difference:

5th Now you should have both T_{in} and $Qdot$, with this information we will plug it into our final equation where we can find the overall heat transfer coefficient (U). The area will be of the current radiator.

8/29/24 - Cooling Iteration

Thursday, August 29, 2024 1:28 PM

Justin, Matthew, Elizabeth

Goals:

- To correctly size the radiator on the IC car
- Possibly change the location of the rad
- Determine effective way of controlling mass flow rate of the water pump via ECU
- Create MATLAB scripts that help determine area and optimal water flow according to temperature of the car

Timeline/Deadlines

- Test Proposal
Tuesday Sep 3rd for End Meeting
 - Testing
Thursday Sep 12th
 - Calculations
Tuesday Sep 17th
 - MATLAB Script (Including change in heat dissipation and area of the radiator and the flow rate of the water pump)
Tuesday Sep 24th

Restrictions

- No rules requirements

Notes:

32mm core will be staying the same.

MATLAB/Notes:

Given the current flow rate and area we will determine the best heat dissipation when needed. Find an optimal area that will match a changing flow rate. If we need the car to warm up quicker than the flow rate should decrease and vice versa

Side Quests:

Finish test proposal

Updated BOM

Order parts

Find more about pump performance

Create Excel sheet for data collection testing

Look at the math

Find heat transfer coefficient

Look into thermostat options for cooling rather than downsizing the radiator size

Current OD of ideal hose is 1.375"

Water pump is EWP 80

<https://daviescraig.com.au/electric-water-pumps>

Good Radiator Document:

<https://www.irjet.net/archives/V6/I3/IRJET-V6I318.pdf>

Radiator Website:

<https://www.pwrna.com/product-category/aluminum-radiators/universal-radiators>

Bungs:

<https://pittsburghpower.com/products/bung?srsltid=AfmBOopdC3rcJkgzYrf0esPoKlzTgv8zNqRZvp-NvSctgev1WRV2TJL>

https://www.auberins.com/index.php?main_page=product_info&products_id=178

Same bungs but cheaper on McMaster

https://www.grainger.com/product/Coupling-304-Stainless-Steel-2UA49?guicid=N:N:PS:Paid:GGL:CSM-2295:4P7A1P:20501231&gad_source=1&gclid=CiOKCQiwu-63BhC9ARisAMMTLXOKXV6GULM_J60H2JB82UZWEmMEZhTmsBf_bxYqLBih7MF_B3VEaAk8rEA1w_wcB&gclsrc=aw.dshttps://www.mcmaster.com/products/bungs/pipe-fittings~/medium-pressure-stainless-steel-threaded-pipe-fittings-8/

Thermometer:

https://www.amazon.com/Laboratory-Thermometer-305MM-Scientific-Home/dp/B01ND4CARX/ref=sr_1_9?crid=25Ii4Ui3XD2N&di=eyJ2ljoimMSj9.A1TNaJ1rH4NVVwQI-lvWh8S-YxUljgcQval5aCflKGmFawTD4js3E1aXktllC45MopeCxmiUf1akXvUU-a24Hu1nBvDB-7tO5QriQCstrzYICr9EOLRB2jgA013ai8-VvnzlkN2zkDy9P2B9QOVj5i2UPW2zDrkje1wlyhMccnDcjgmpmkq25v_IWlnYmtE6piP7cQylbu2a-MgmNnQ4U-zKutDNJ1YUm59aeXM6js.7YtYxkf7VHSWw5jRNFAZEFljyS89qvY_Dx-_pQbjLnjk&db_tag=se&keywords=thermometer+lab&qid=171997298&sprefix=thermometer+lab%2Caps%2C96&sr=8-9

Thermocouples:

https://www.amazon.com/dp/B07W6PFCXF?ref=cm_sw_r_cso_cp_apin_dp_5WM1J21HVAPRX10FTPAnH&ref_=cm_sw_r_cso_cp_apin_dp_5WM1J21HVAPRX10FTPAnH&social_share=cm_sw_r_cso_cp_apin_dp_5WM1J21HVAPRX10FTPAnH&starsLeft=1&skipTwisterOG=1

10/01/2024

Thursday, September 26, 2024 8:11 PM

Updating test proposal:
Currently math needs to get figured out.

Axels and Tripods

Tuesday, August 27, 2024 7:03 PM

BSFC

Tuesday, August 27, 2024 7:03 PM

Tuesday after END Meeting

Chain Selection

Tuesday, August 27, 2024 7:04 PM

Proposal

Compression

Tuesday, August 27, 2024 7:35 PM

- Compression ratio with stock internals: 13.1:1
- Bore: 67.0
- Stroke: 42.5
- "185psi is MINIMUM spec for a stock R6 engine (without thinner gasket)" forums say
- During compression test engine was making 125psi on all four cylinders

Compression Ideas

-Resealing the engine to raise compression and find the true psi

-Find Concrete numbers to work with to find what parts we need to look for replacement **IE= CAMSHAFT / VALVES**

-Leak down test
-compression test without muffler
-valve lapping

https://docs.google.com/document/d/1PC_e0bxmmf6MP6GwbTffftXfckLLfmvkHbGjSAzus/edit?usp=sharing

Pneumatic Shifting - mechanical

Tuesday, August 27, 2024 7:35 PM

- Currently we are running between 110-120 psi

Exhaust Gas Temperatures

Tuesday, August 27, 2024 7:35 PM

notes

Friday, August 30, 2024 8:19 PM

12/10

Tuesday, December 10, 2024 8:53 PM

Engine Rebuild: Carter, Stone, James, Ben

- Assemble Bottom end
- Check on the head gasket
- install head
- install accessories

Side quest:

- Motor mount critical fastening

ETS: ben, david, James, Cam, Micah, Stone

- Wires Depinned
- Sheathe wires
- find the pneumatic
- Find the teensy
- ECU repair
- Drill holes
- Install studs
- Install ETS Components
- Install Rad
- Install Fuel Cell
- Throttle Body

Compression Engine: stone, victor,

- Make a order Sheet for parts
- Use proposal

Rad Charactization:

- Order parts
- Perform the test

Headers:

- Add in the merge collector
- Make the cone
- Get new gaskets
- Fabricate 90 to muffler
- Test and Tune

KS8C Combustion Problems

Tuesday, March 18, 2025 7:46 PM

- Throttle Cable (03/17/2025)
 - o Was soldered on
 - Electrical Solder does not have adequate tensile strength to support the applied forces
 - Silver solder is recommended for use on stainless steel.
 - Acid based flux should be used for bonding between stainless and brass.
 - o Bad hardware
 - The steel cable should not be soldered directly to the barrel connection.
 - It is better to solder the cable to a nipple insert that rests inside of the barrel connection.
- Clutch cable (03/17/2025)
 - o Binding really bad
 - Discovered the tubing had melted internally causing a high resistance
 - Steel cable began internally fraying causing tension forces that exceed the tensile strength of the electrical solder that was used.
 - o Not returning
 - Partially due to the internal resistance inside the clutch cable
 - o Clutch Cable 2 (03/19/2025)
 - Replaced clutch cable
 - Cable was not properly tensioned
 - Engine was fully warmed up and a clutch dump was performed.
 - This loosened the clutch and lowered the resistance. This is inherent to motorcycles that use a wet clutch.
 - No clutch engagement at all.
 - The clutch are initial position was not set at the end the clutch play.
 - Hard to explain, but the clutch has a certain degree of free rotation which has almost no resistance.
 - The initial (neutral or position without any applied force) should be positioned at the end of the free degrees of movement (rotated fully counter clockwise).
- Lower compression in cylinder 3 (rebuilt motor) (March 2025)
- Discovered wheels would spin freely in 1st gear but worked properly in other gears.
 - o Drained oil and removed the oil pan for inspection on 3/19/25
 - Discovered 1st gear is missing inside the transmission.
 - Reinstalled oil pan and oil
 - **Oil pan bolts and drain plug need to be torqued to 8.7ft/lb and 22ft/lb respectively**
- 03/24 Car test
 - o Clutch cable continues to break as a result of too much tension in the line.
 - Recommend adding a positive stop to prevent over articulation of the clutch lever, past the maximum travel of the clutch.
 - o Battery's were dying , measured voltage out from rectifier, nothing was outputting
 - Measured the stator fases , inconsistent to the middle "white " connector
 - Measured ac to stator output. White had 5 v other 2 had ~15 -16 v.
 - Measured internal resistance of the coils and compared to spec sheet , middle didn't match . Measured the spare from dyno resistances were fine
 - Conclusion from that is stator bad , replacing tonight
 - The resistance between each of the phases of the new stator are all 0.27 ohms
- 04/07
 - o Note on car from unknown source said starter would not crank over.

- Found that the starter cable was bad
 - When it was being replaced we found that the stud on the starter solenoid for the starter power cable was stripped out and would not come off.
 - Replaced the starter solenoid and the starter cable
 - ◆ Worked well
- Pneumatic shifting had issues
 - It would blow a fuse in the PDU box
 - Found that there was a pinched wire for the Pneumatic board. And had a short circuit to ground
 - ◆ Fixed the broken wire and fuse did not blow anymore
- IC Axles have been grooved and are ready to be installed in the car

Left Diff Carrier Failure

Thursday, March 27, 2025 1:24 PM

- Broke in the lot
- Don't necessarily know when it broke
- Crack propagated from bolt holes
- Didn't necessarily have a lot of torque on the motor mount

ETS rebuild 03/31

Monday, March 31, 2025 4:44 PM

-Engine system issues

- Sprocket for engine chain tensioning is the wrong pitch size
 - Not sure what size the sprocket on there is, but it needs to be for a 520 chain, if a 520 chain is to be used
- Engine motor mounts
 - There is a slight gap between the engine and the stand for the front motor mounts
 - Shim it?
 - Weld a spacer on after measuring misalignment
 - Need a welder down there to move the engine mounts and add a spacer to the mounts to prevent bending & poor load distribution
- Dyno sprocket
 - Key way insert is not very good
 - Bought new inserts from autoparts store
 - One of the two set screws for the sprocket is pretty cooked
 - Could drill the hole out and tap a new thread onto it
 - Could also add threads to the keyway insert
 - Helicoil the threads would be a good option
 - Lift the dyno out of its pit & fix it the right way, using shortcuts is a bad idea
- Current sprocket adapter creates significant sprocket misalignment
 - Sprocket adapter had too large of spacing in-between the sprockets.
 - Sprockets are welded onto the shaft at a specific spacing to avoid chain interference
 - We turned down the welds on the lathe, and used the hydraulic press to separate the sprocket from the shaft.
 - After getting the proper spacing, the sprocket was re-welded, but the welds caused the sprocket to warp significantly, too much heat
 - 
- Shifting
 - There is currently no method of shifting independent of the car's system
 - Currently using the pneumatic shifting system used for the KS8
 - Could add a physical clutch cable to control clutch
 - Programable PWM controller
 - Would like to include shifting controls to the main control unit
 - Clutch, up, down. Buttons on the control panel
- Electronic throttle control
 - Needs a servo and a control unit
 - Could be used for programmable dyno pulls
 - Having both an ETB and pneumatic shifting to do programmed shifts

- (Hold 60% throttle for 10 seconds then shift up)
- Cooling
 - There is no water pump for ETS
 - If we still have them, just steal one of the e-car pumps
 - Currently we are using the water pump and some of the coolant lines from the car
 - Radiator *should* be able to handle thermal load but no validation on this has been done
 - Would like to add a bulk tank to allow overpressure expansion from boiling coolant.
- Air intake/fuel system
 - There is no air intake for ETS engine
 - This would also include the custom fuel rail used on the intake
 - Need to purchase more injector rebuild kits for ets engine
 - A new Intake was made for KS8 and could be used for ETS
 - New a new MAP sensor
- Power supply (2 possible routes)
 - Big ahh battery
 - Easy, cheap, quick
 - AC-DC power supply
 - Plugs into buildings power supply
 - "Safer"
 - More reliable

2015 YZF R6 rebuild

Monday, March 31, 2025 11:05 PM

NOTE THIS APPEARS TO BE THE FIRST TIME THIS MOTOR HAS BEEN TORN DOWN

The motor was turned on three separate times

Note: this was the first time revving to 9k rpm reaching peak temp of 125F

X

Note: Ran at idle reaching a peak temp of 180F

X

Note: Ran at idle reaching peak temp of close to 300F

X

-Why did the motor overheat

- While the engine test was running, the coolant pump likely stopped running.
- During the test engine temperatures briefly reached extreme levels, & could have caused significant damage to the engine.
- Compression tests were done after the engine test, & the cylinders dropped significantly in pressure, hitting a high of about 70psi.

-Opening the motor because of overheating

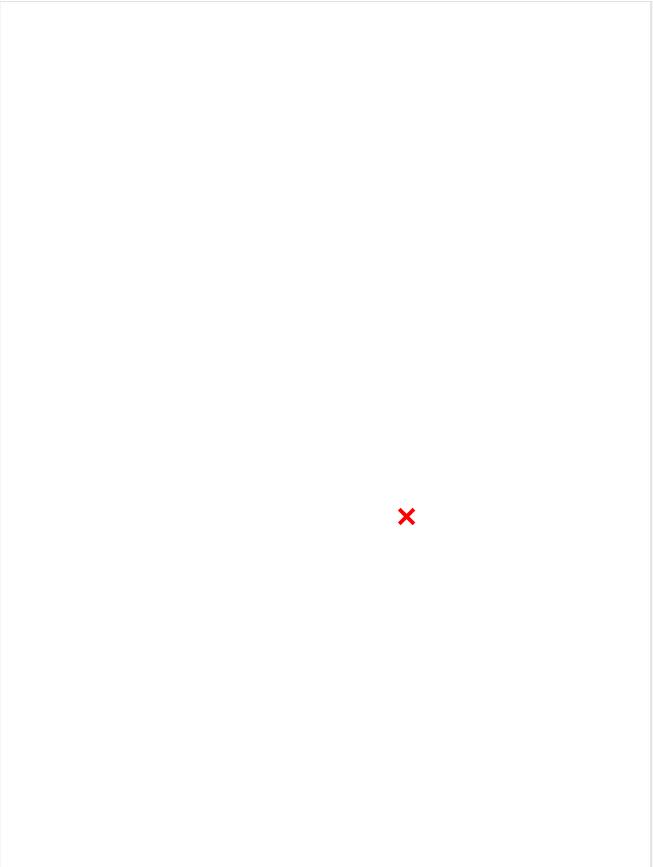
- Oil had coolant in it when pulling drain plug
- An oil testkit was used to get a better understanding of the condition of the engine

With the initial opening of the head nothing was noticed with the cam shafts

- Timing was loose and was able to pull off the chain by hand

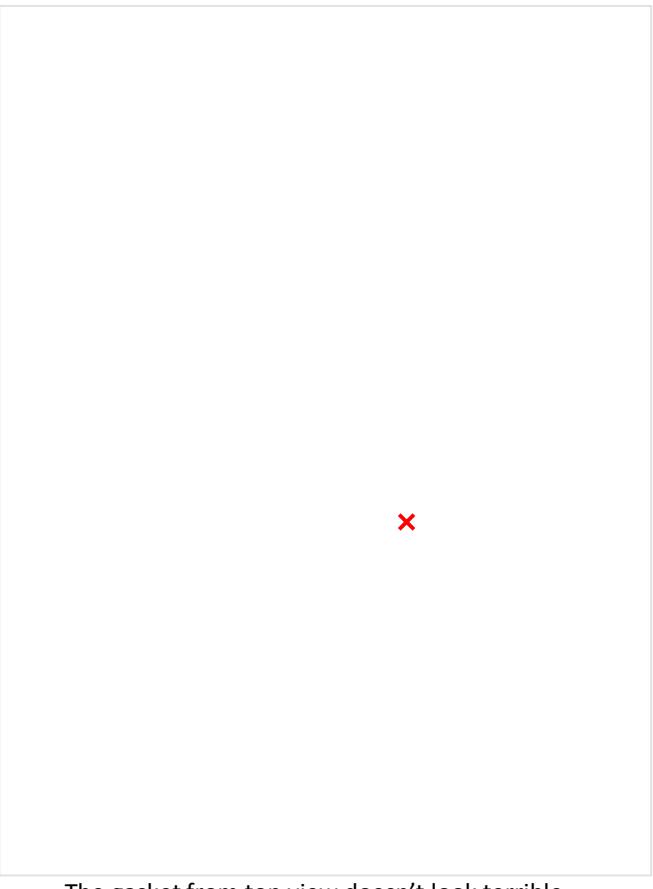
-After getting the head off it was noticed that cylinder one had a foreign body on the piston head, Carter noted that the cylinder was toast and needed replacement.

- Oil definitely had coolant in it
- A sample was also taken



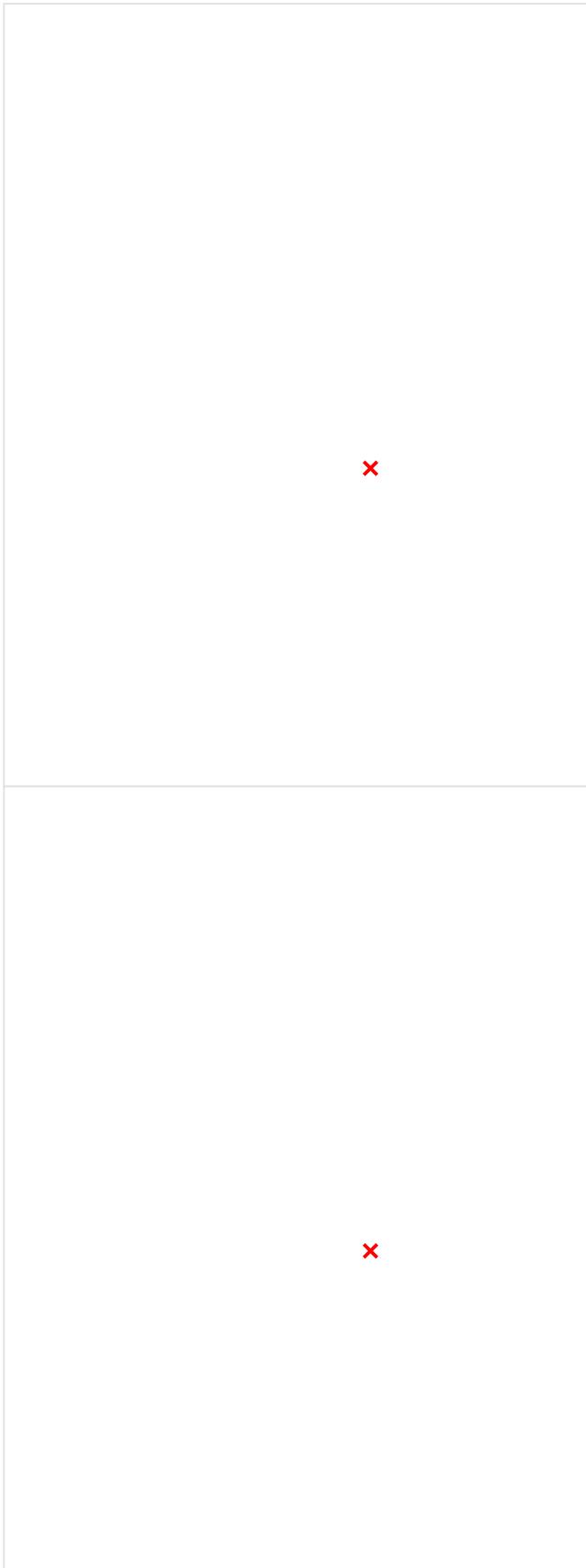
X

The foreign body created an indent on the piston head after removal



X

The gasket from top view doesn't look terrible



IMG_2018



IMG_2018

(ABOVE IS VIDEO OF WATER IN OIL)

Both the block & the head were measured for warping after gaskets & carbon buildup was cleaned off.

- The head had some warping at around 0.0015- 0.002 inches. The manufacturer tolerance was stated to be ~0.002in.
- The Block was in good condition, at less than .0015in which is the smallest feeler gauge we have, & within the manufacturers stated tolerance.

Plan to fix:

Options:

- Send the head out and have it resurfaced and possibly get back in 10-15 days.
- Put in a new head gasket
- Run the motor and hope for the best.

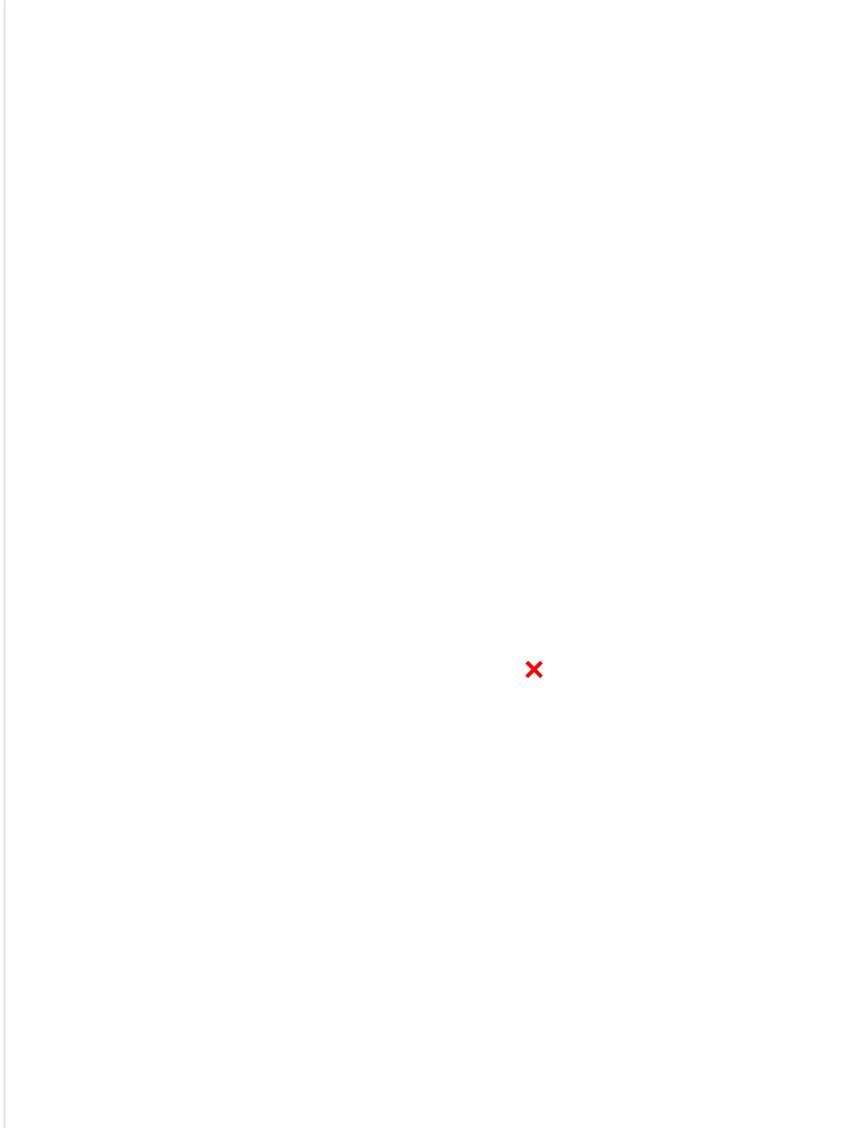
Final Diagnosis:

- Head gasket looked in good condition
- Block surface is in good condition
- Piston walls are in good condition
- Damage to piston head in cylinder 1 due to foreign body
- The other pistons are in good condition
- Valves are in good condition
- Head has very minor warping, not critical but worth taking action on

Update from 3/31

The head was resurfaced by company "Cylinder Head Exchange" <https://cylinderheadexch.com>

- The turn over from drop off was 3 hours (likely a place where the motors will be taken from here on.
- Company informed us that the head was not warped, but had significant scratching on the surface
- 3 thou of material was removed from the surface of the head.



×

Did a leak test on the valves and there was no leaking.

https://cdn.discordapp.com/attachments/866482089845850123/1356763564265705553/IMG_3146.mov?ex=67edc009&is=67ec6e89&hm=6d404eef2d91536ecebbc5975b5317bfff969a9754d6e9290dd976ff8a28b1b3&

(Video of the valves)

-01/02 notes

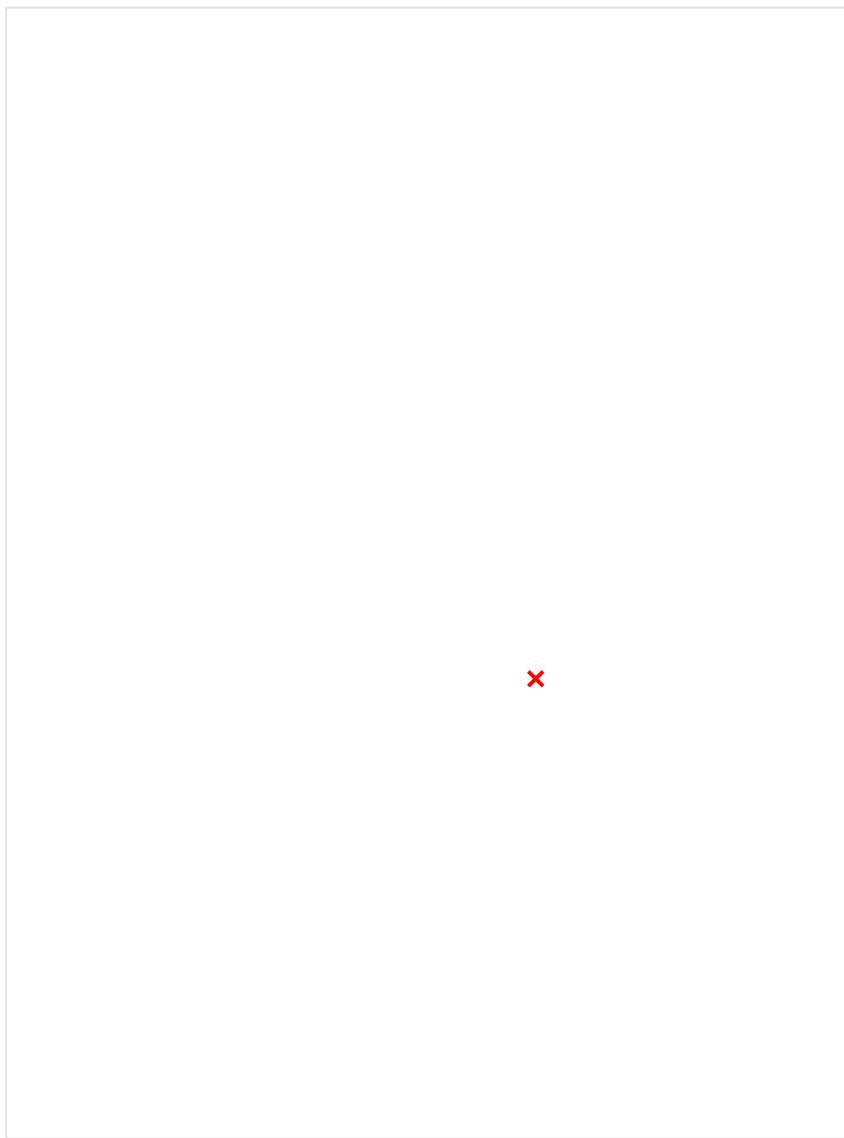
- After surfacing another compression test was done, here are the results:

Cylinder number	Test 1	Test 2	Test 3
1	~60	0	200+
2	~145	~145	~145
3	~150	~150	~150
4	~155	~155	~155

- After discovering that cylinder 1 failed the compression test, we concluded that it is likely a failure with the piston rings
- We then removed the head from the engine, and pulled out the piston in cylinder 1 to replace the piston rings with new ones
 - While replacing the piston rings we measured the tolerance of the actual piston rings, here are the results in mm:

Piston ring	New	Old	Manufactures Spec
Upper Compression ring	~0.27-0.25	~0.45-0.43	0.25-0.35
Lower compression ring	~0.-0.7	~0.80-0.75	0.7-0.8
Upper oil ring	~0.23-0.20	~0.2-0.18	0.10-0.35
Lower oil ring	~0.23-0.20	~0.2-0.18	0.10-0.35

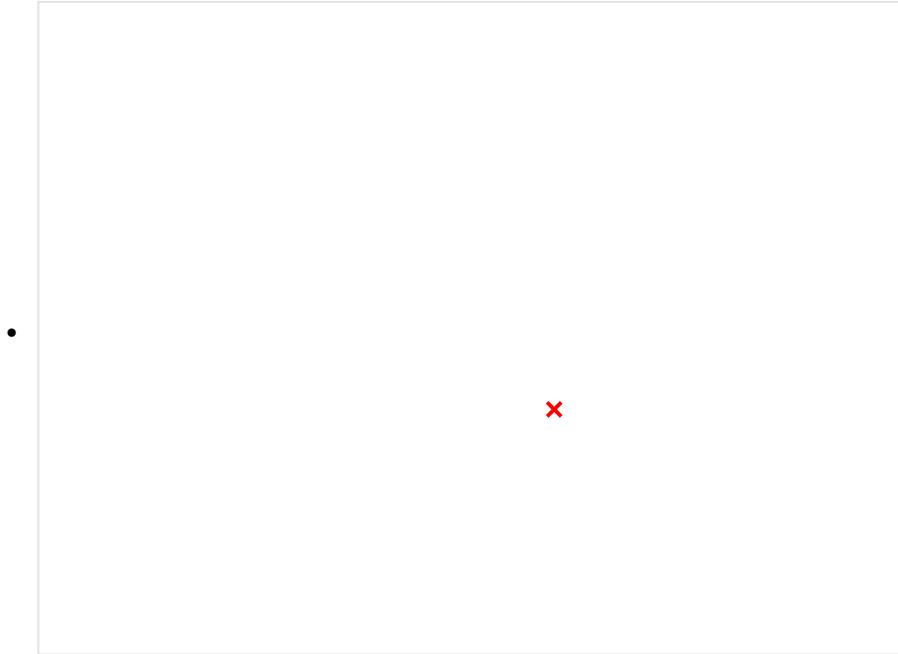
- o Note that the measured tolerances are within a range of values, this is because the feeler gauges we used are in increments & the actual dimension lies within the range



- We also measured the cylinder walls to make sure they are in spec and to check for excessive egging & wear
 - o Bore gauge diameter was measured at 2.6388 in. and the manufacturers stated diameter is 2.6383 and the manufacturers tolerance is 2.6383-2.6378 in.
 - o This means the bore diameter is ~.0006in out of spec, however the device used to measure has a .0005 precision so this number is not entirely accurate
 - o 2.6373 is the diameter of the actual piston
 - o Subtracting these numbers, we have a piston to wall clearance of 0.0015, and the manufacturers spec is 0.0004 - 0.0014 with an upper limit of 0.0022
 - o This means we cylinder 1 is out of spec by 0.0001.
 - o Engine cylinder is not an egg
 - o

-04/02 Notes

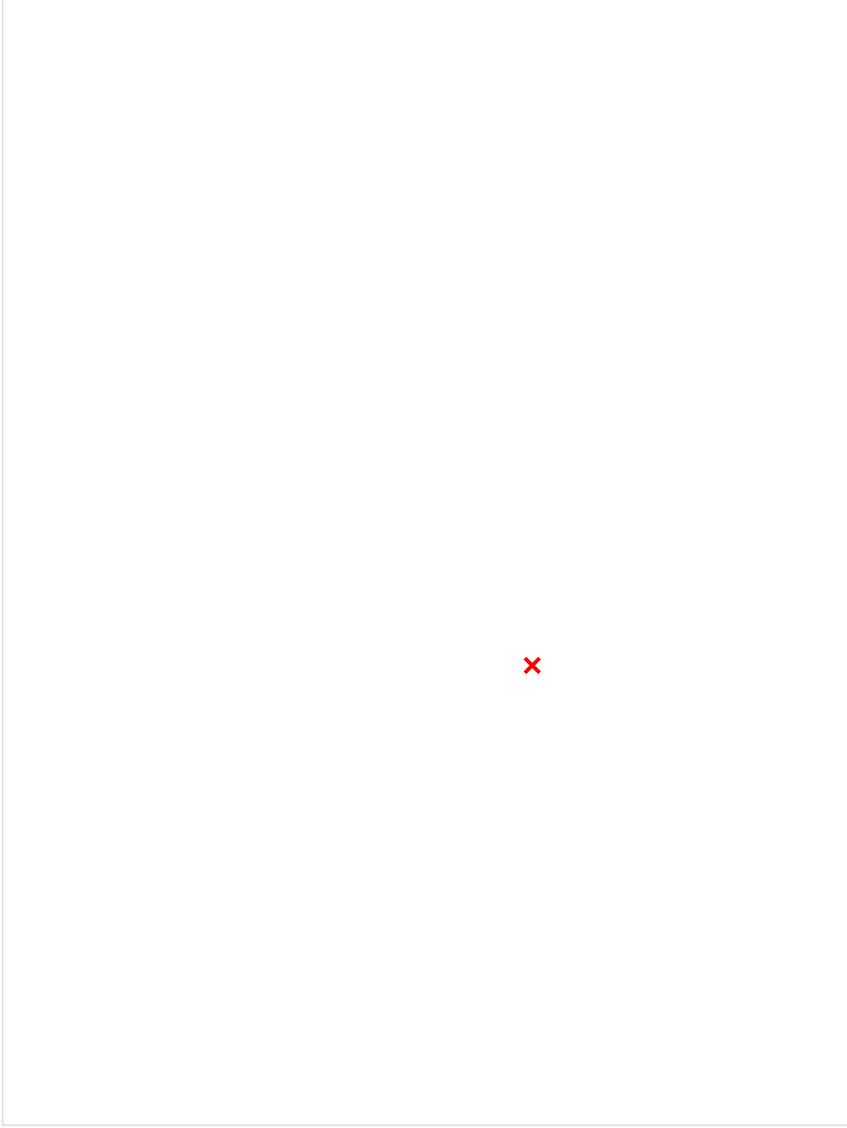
- Decided to split the case to get the crank cap back onto the engine
- Had an oopsie while removing the engine from the stand, & the engine was accidentally dropped on the ground



- - Bad idea to only have two people to do this, recommend having more people
- Measured the bearing gap on crankshaft at .0015, manufactures spec is 0.0015-0.0024
- Results of final compression test

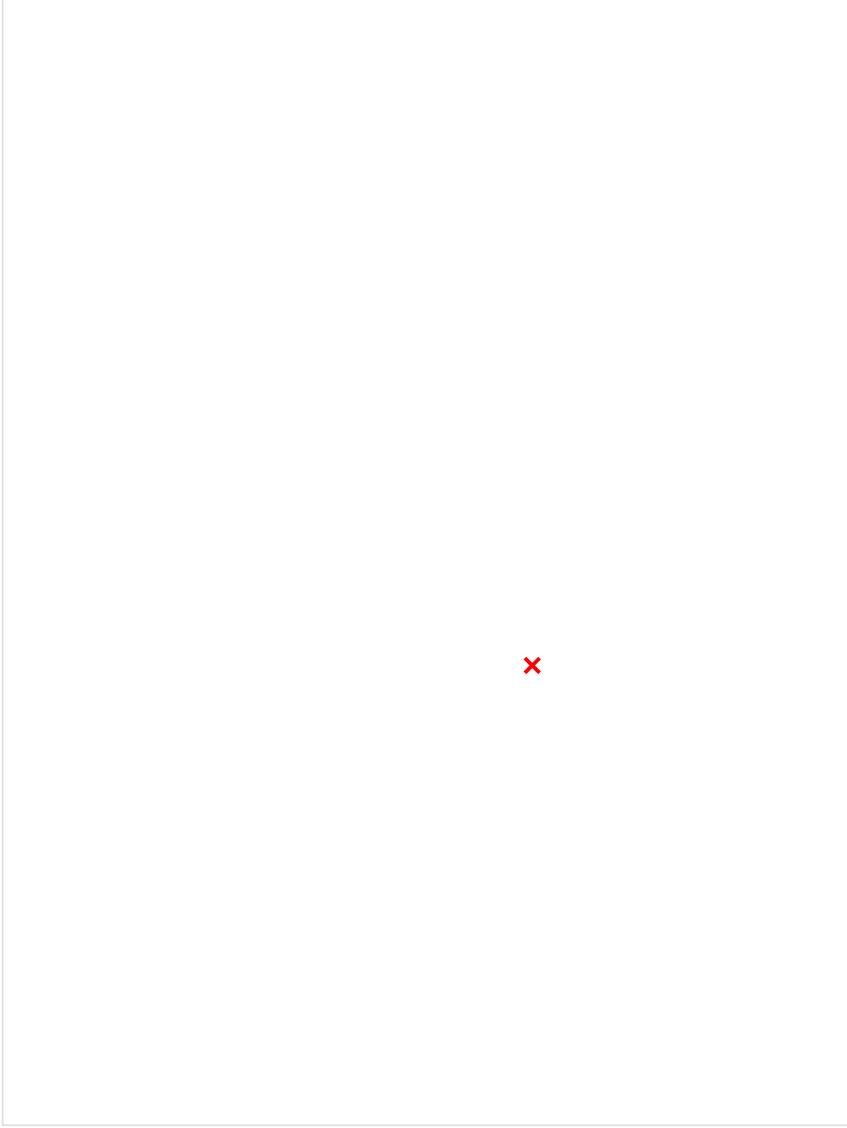
Cylinder #	Compression (psi)
1	200
2	155
3	155
4	160

- Cylinder 1



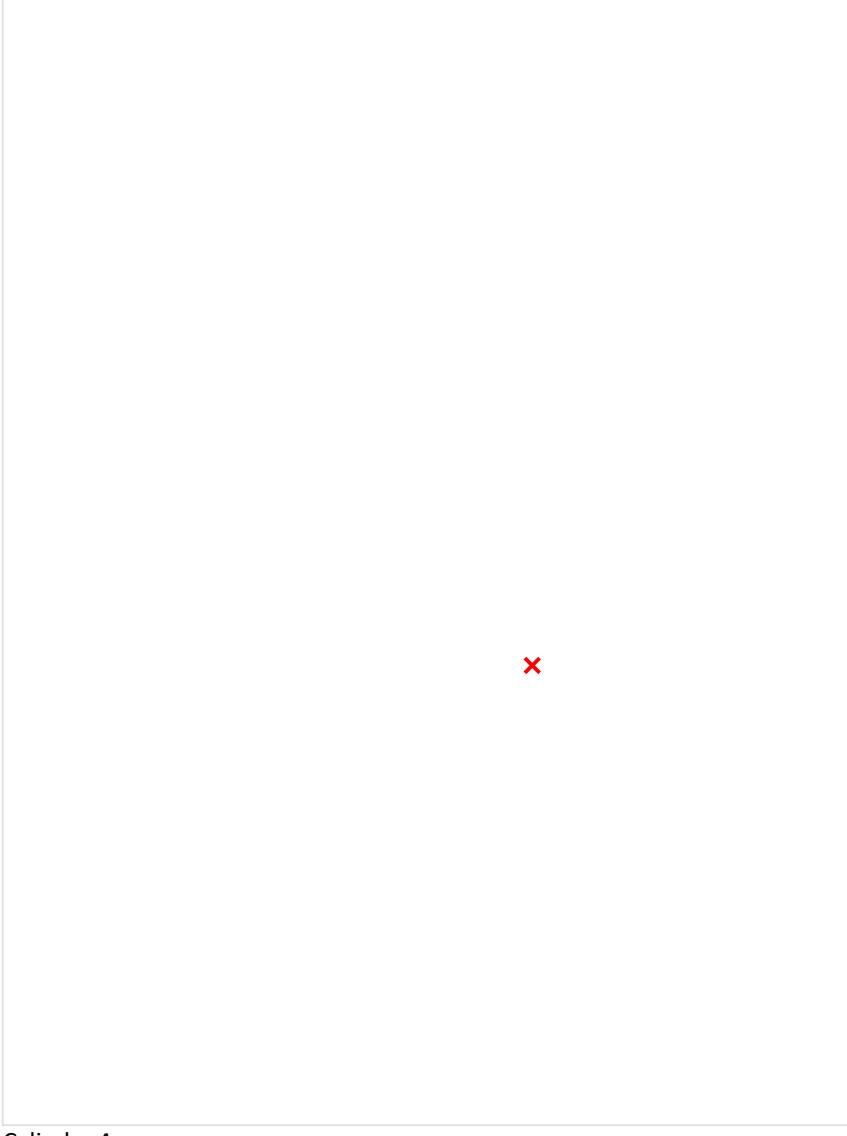
X

- Cylinder 2



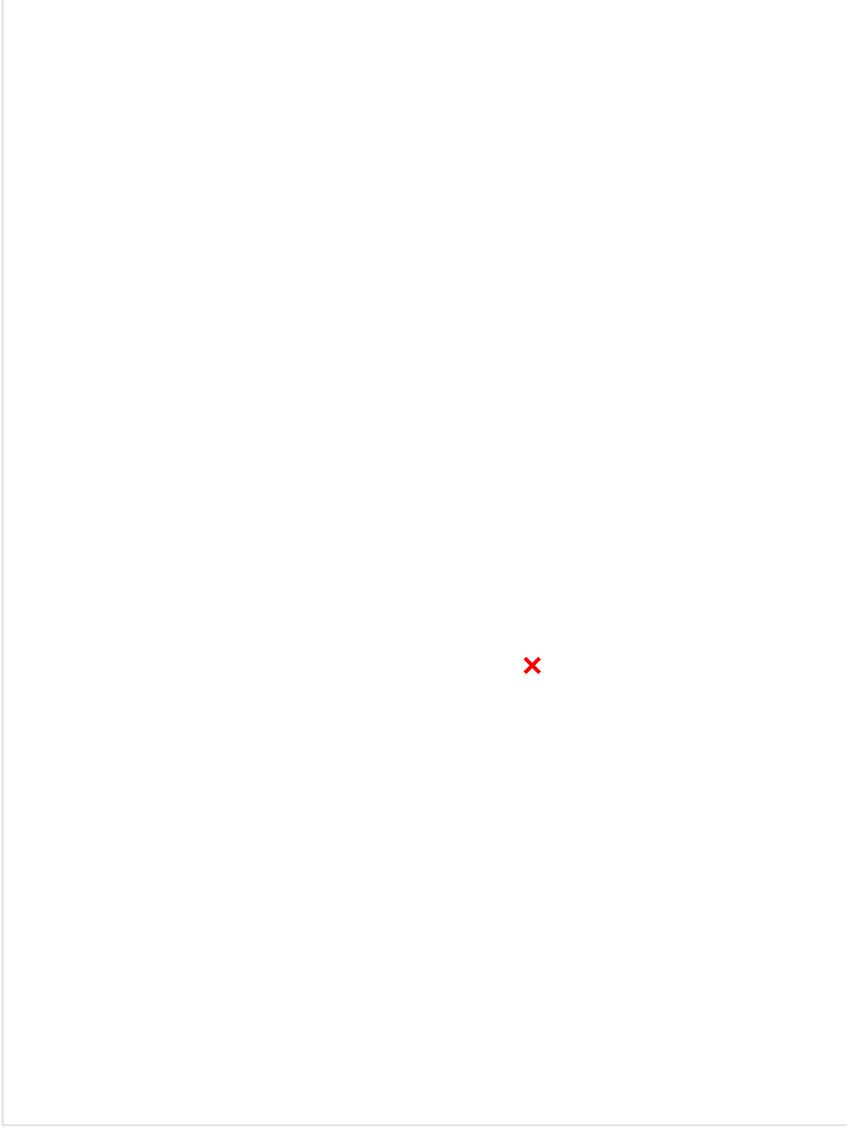
×

- Cylinder 3



X

Cylinder 4



×

- **IMPORTANT NOTES FOR IC REASSAMBLY**
 - Front sprocket on engine needs to be torqued down
 - Oil drain plug is missing the crush washer
 - Cam position sensor is not bolted in
 - Engine will likely smoke on first start, this is fine and will hopefully stop smoking pretty quickly
 - Piston #1 has new rings and should be properly broken in by running the engine at idle and periodically measuring compression
 - Some of the header studs were very rusty & were pulled out of the block, should clean off the rust & throw them back in with some thread locker

Stuff Moved to Ecar

Wednesday, April 16, 2025 11:51 AM

- Differential Bearing