

Designing Fabricating and Testing a P-51 Scoop

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Cozy IV N91KS Subaru EG33

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Introduction

- Radiator and Oil Coolers Benefit from Pressure Recovery Scoops
- Presented By Keith Spreuer
 - ◆ Cozy Builder/Flyer since 1984
 - ◆ 42 year Aerospace Engineering
 - ◆ EAA Tech Councilor Chapter 96

Topics of Discussion

- Why Switch to a P-51 Scoop
- How to Design the Scoop
- Conversion of a Cozy NACA
- Fabrication of Scoop
- Test Data and Measurement Tech.

Why Use a P-51 Scoop

- Radiator Type Heat Exchangers Need as much Delta P as they can get
- NACA Scoops are best at Low Delta P High Flow
 - ◆ Good for relatively unrestricted flow path of Air cooled engines
- P-51 Scoop has Best Pressure Recovery
 - ◆ Roughly 80% of Dynamic Pressure
- Oil Coolers and Auto Conversion Radiators Benefit from a P-51 Scoop

NACA Oil Flow



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Before NACA Scoop



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Before Close Up



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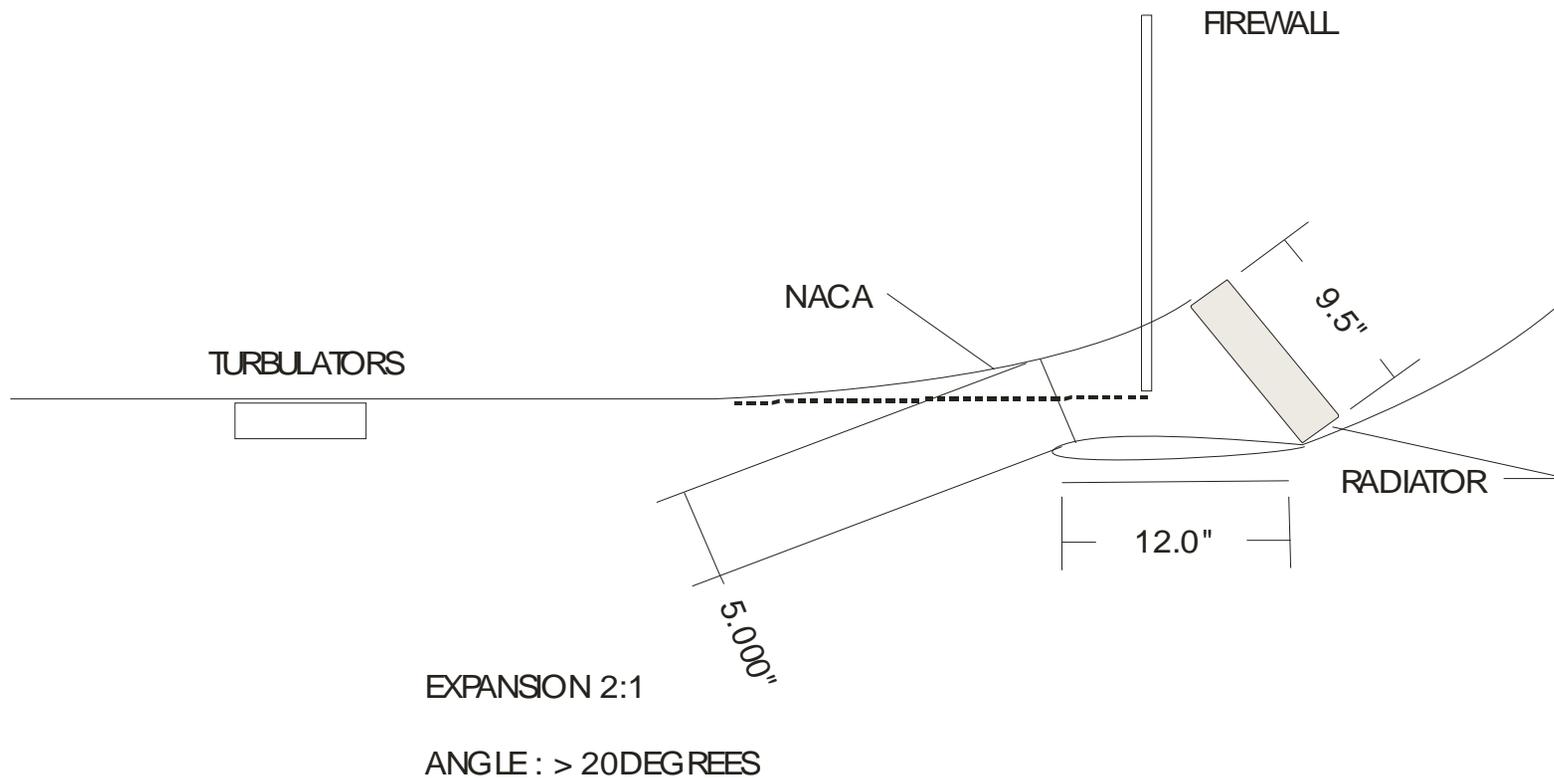
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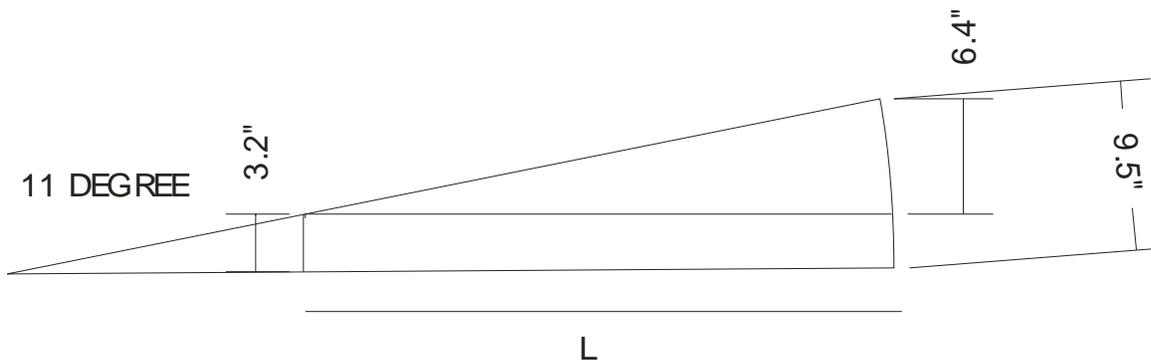
Designing a P-51 Scoop

- No Included Angles >11 Degrees
- 3:1 Expansion

NACA SIMI SUBMERGED SCOOP



P-51 DESIGN SIDE VIEW



3:1 EXPANSION

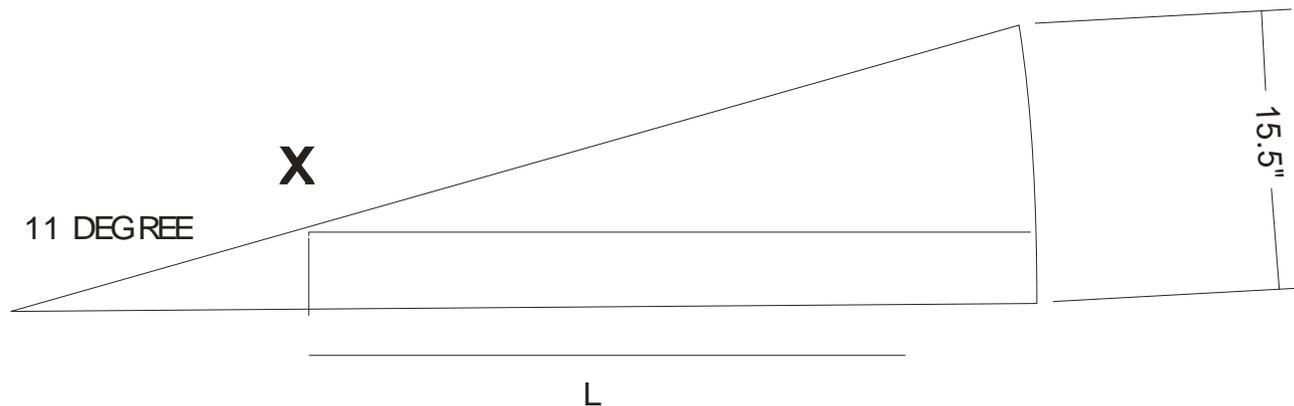
RADIATOR AREA 147.3 SQ IN.

1/3 AREA = 49.1 SQ IN

RICK OPENING HEIGHT, 3.2 INCH

$L = (9.5 - 3.2) / \tan(11) = 32$

P-51 DESIGN TOP VIEW



3:1 EXPANSION

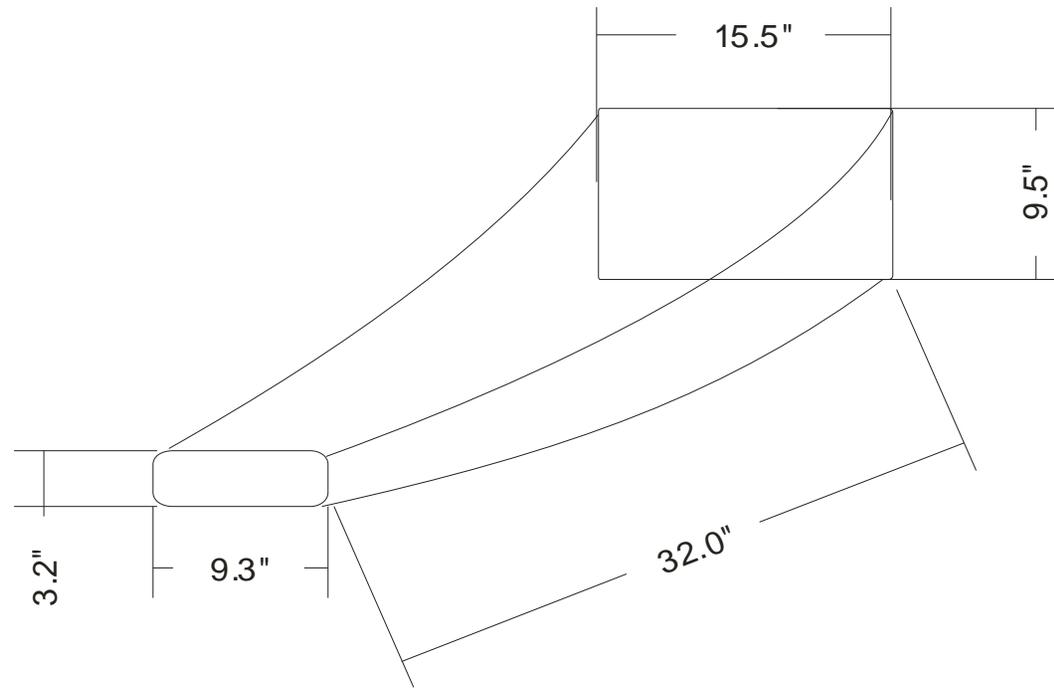
RADIATOR AREA 147.3 SQ IN.

1/3 AREA = 49.1 SQ IN

USING L FROM PREVIOUS = 32 INCHES

$X = 15.5 - 32 \tan(11) = 9.3$ INCHES

P-51 ISOMETRIC



CONVERSION OF NACA

- No Alteration of NACA
- Cover Fits in Front of New Scoop Over Old NACA
- Started By Covering Entire Area with Packing Tape
- Used Blocks of PVC Foam to Fill NACA and Oversize of P-51
- Layed Out Inlet 32" Ahead of Radiator and Off Skin 1.5" for BLD

Modified Cowl

- Lowered Lip of Cowl to Same WL as Inlet Lip
 - ◆ Cut from Lip Sides to Radiator Bottom on Lt and Rt
 - ◆ Spaced Lip down, Filled Gap with Foam
- Carved Inlet to 1/2" Outside Desired size to Produce a Lip

Inlet Lip



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Quarter View



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Scoop Side View



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Fabricating the OML

- Removed Foam Between Inlet and Belly for BLD Back a few Inches
- Carved OML to Mate with Cowl Lip Location With Streamlined Shape
- In Front of Inlet Carved Foam for a Flat Cover Over NACA Nose
- Microed and Glassed One Bid over OML, Second Bid On Flanges and Cover, Peel Ply

NACA Nose Cover



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Fabricating the IML

- After Cure, Cut Both Sides From Lip to Cowl Lip Thru Glass and Foam
- Separated Lower Half Of P-51 Scoop Forward of Cowl
- IML is Contoured With Smooth Lines to Mate with Cowl IML and Rear Edge of Old NACA At Top

IML Photo



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Cowl Section



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Shaping IML

- Shape IML of Cowl Portion
- Takes Several Iterations of Cowl on and Off, and P-51 Halves Together and Not to Match Shape of IML
- Once Roughly Matched Assemble Cowl and Scoop on Airframe
- Bond Lower Scoop to Upper with Pour Foam

Joining Halves Together

- Apply One BID Over Lip Area a Couple Inches on to OML and in to IML
- Cover Lip and OML with Another BID and Peel Ply
- After Cure Separate from Fuselage and Cowl

Glassing IML and Top

- The IML Will Need Final Shaping Due to Shifting
- Micro and Glass IML with 2 BID
- After Cure the Top Can be shaped to Save Weight and Make a Good Shape
- Leave a Flange to Mate With Belly
- Glass Top With One BID

Attaching to Airframe

- Reinstall Scoop and Cowl with 5 Min Glue to Hold in Place
- Drill 3/16th Attach Holes in Scoop Portion Into Belly of Fuselage
- Remove Scoop
- Open Holes in Belly to 1/4" and Use Counter Bore to Make 5/8th Holes
- Make 5/8" Aluminum Inserts with Flats on Sides and a Circular Groove with Rough Surface
- Bond Flush With Belly with Flox

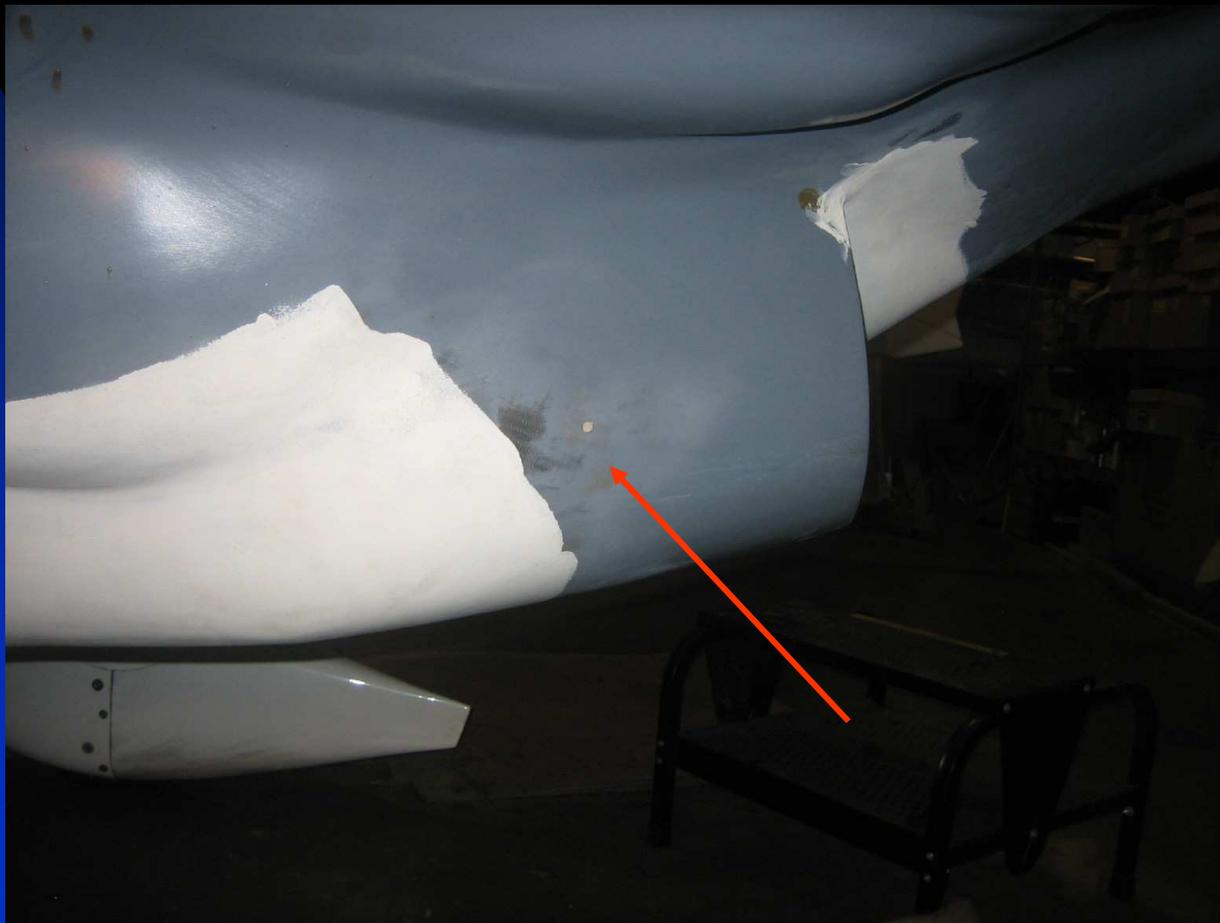
Attaching to Airframe

- After Inserts are Cured Remove Packing Tape
- Sand Insert Area for Glass to Glass Bond Over 3" Diameter
- Cover Insert with One BID
- Put Scoop Back in Place and Drill and Tap Inserts for #10 Screws

Measuring Delta P

- For any Given Heat Exchanger Flow Limits Capacity
- Flow is Proportional to Delta P
- Maximize Up Stream Minimize Downstream
- A/S Indicator is one way
- Digitron Delta P excellent
- Aquarium Stone Good for Omni Directional Pressure

Cowl Static Location

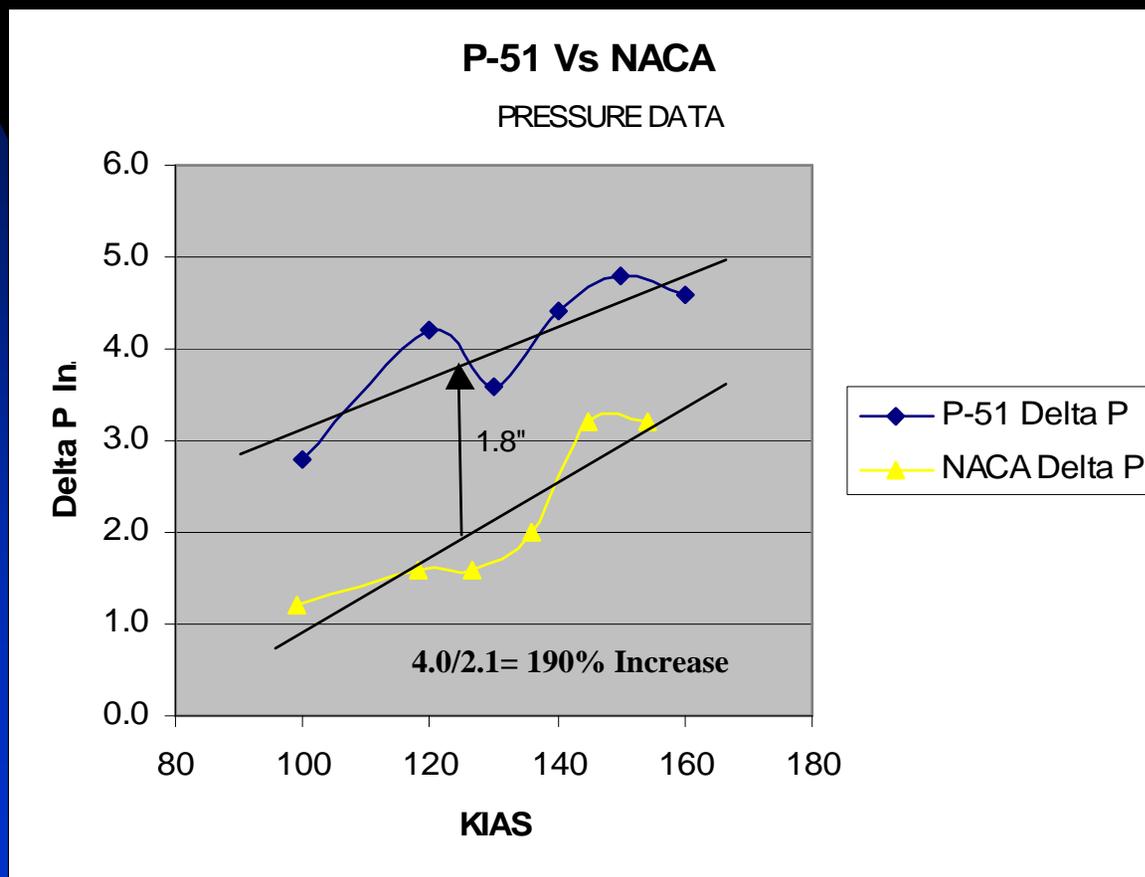


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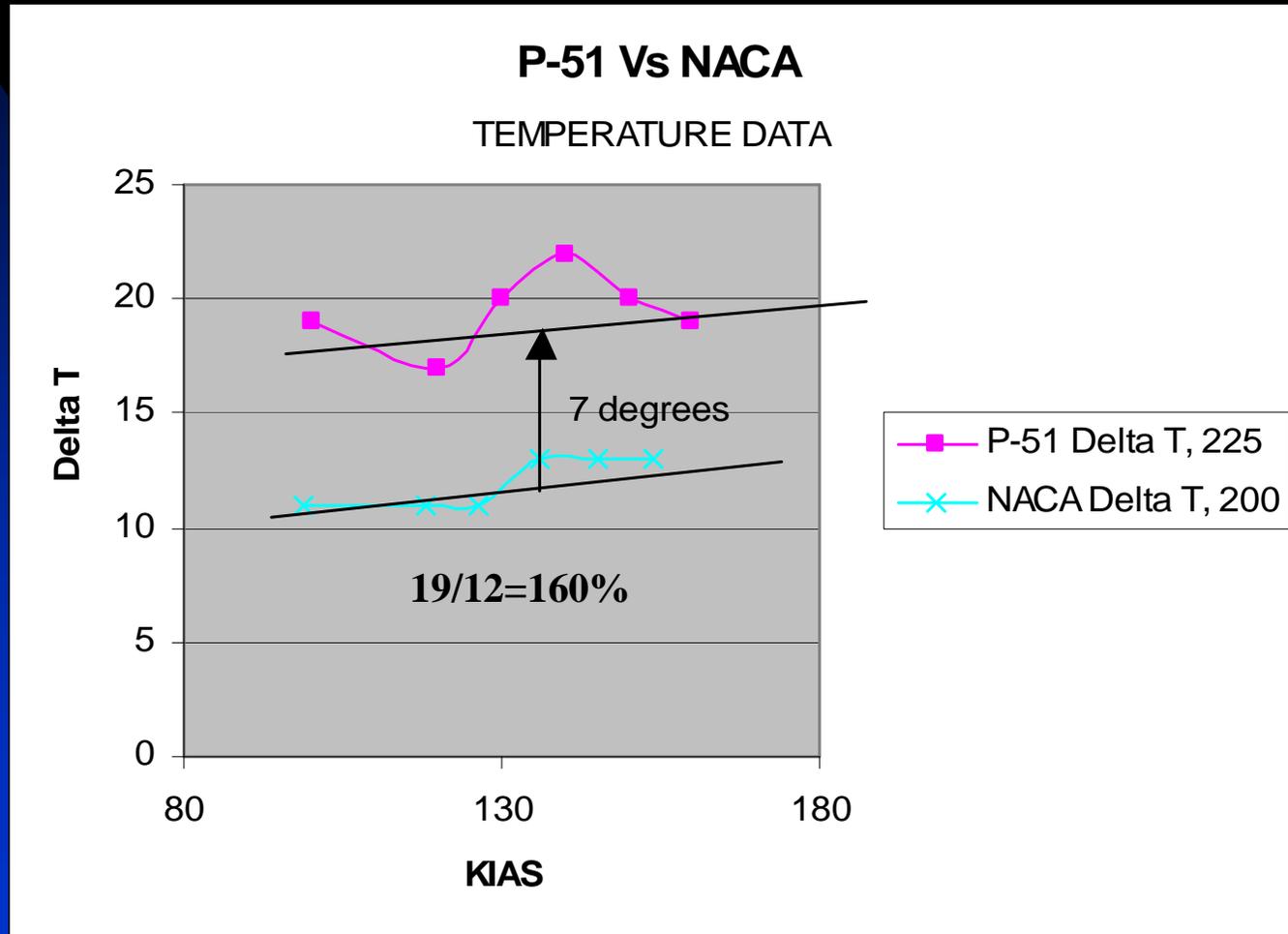
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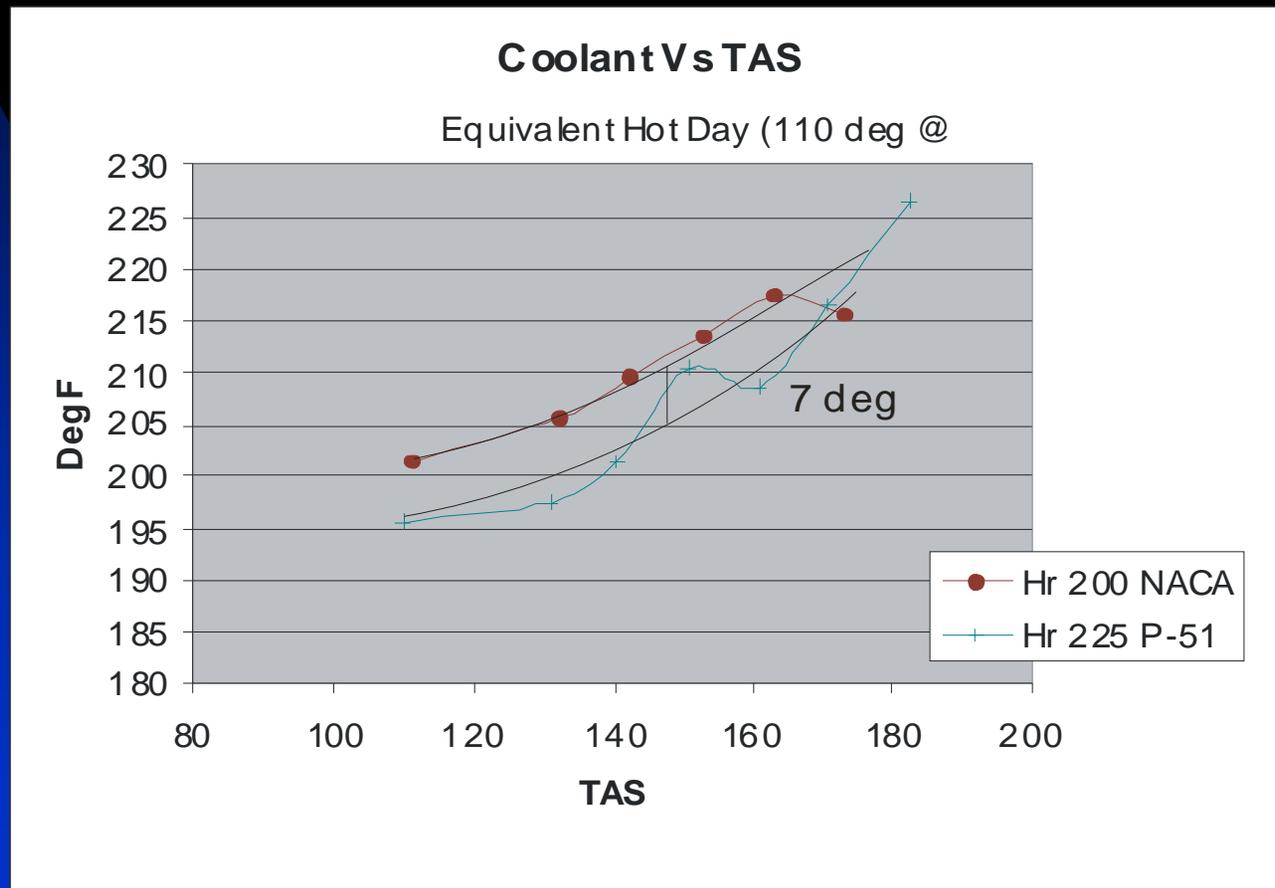
Pressure Increase



Delta T Improvement



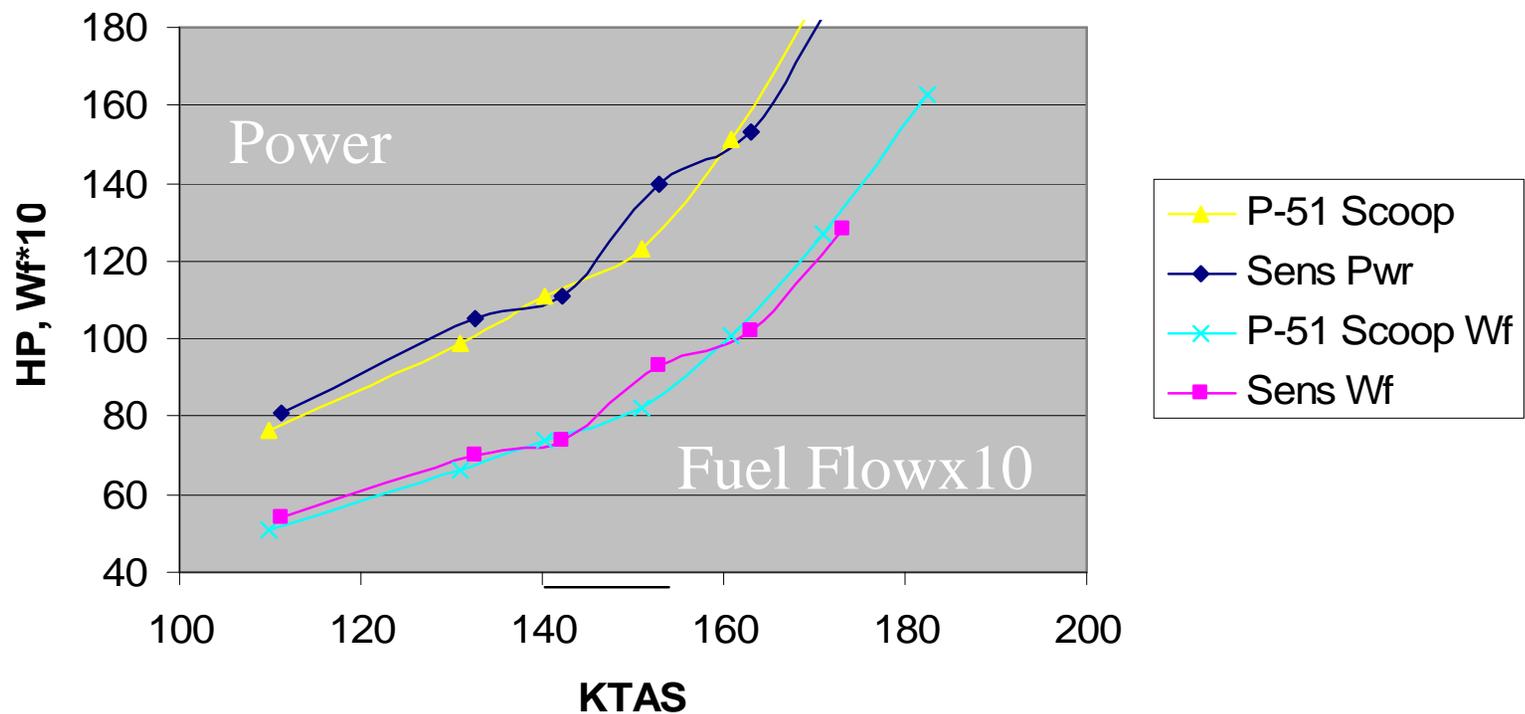
Temp Vs Speed



Power Vs Speed

Flt Hr 157 Vs 225

Speed Power



SUMMARY

- Not Difficult to Convert a NACA to P-51
- P-51 Improved Flow, Delta T
- Lowered Coolant Temp 7 deg
- No Speed Reduction
- Weight about 10 lbs