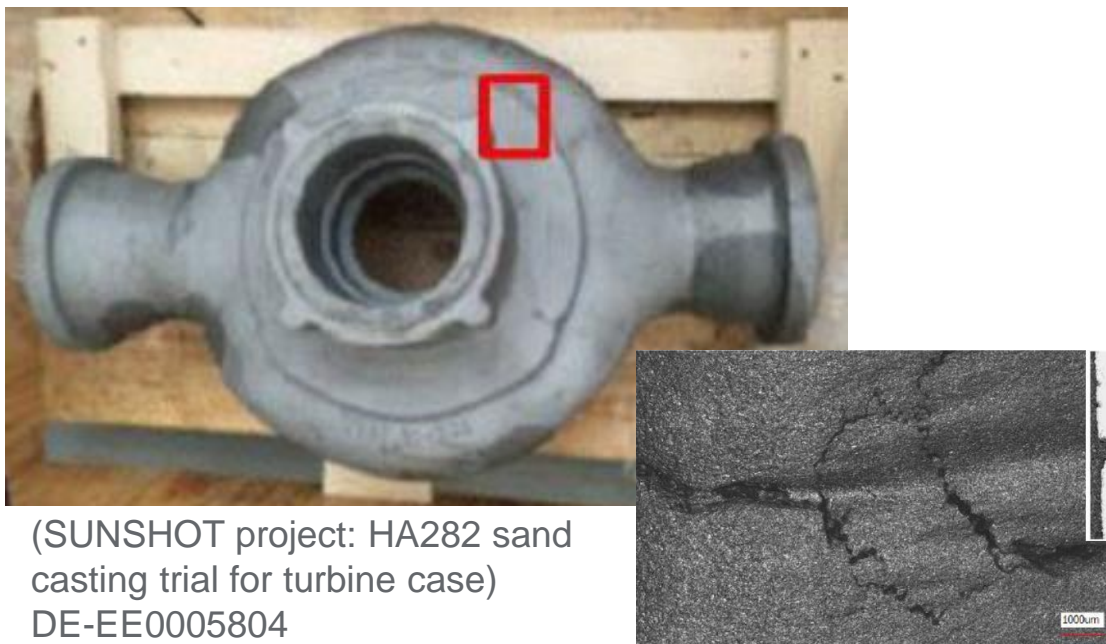


sCO₂ Power Cycle Development

Near Net Shape Hot Isostatic Press (NNS HIP) Manufacturing Modality for Cost Reductions

GE Research in partnership with Synertech PM, Special Metals, EPRI have validated significant cost savings when applying NNS HIP to components utilized in sCO₂ power cycles. Specifically, the high temperature alloys, IN740H™ and Haynes 282™ used in high temperature sCO₂ cycles. Components for validation: elbow (plant pipe component), nozzle ring and turbine case (sCO₂ turbine)

Motivation:



Current solutions:

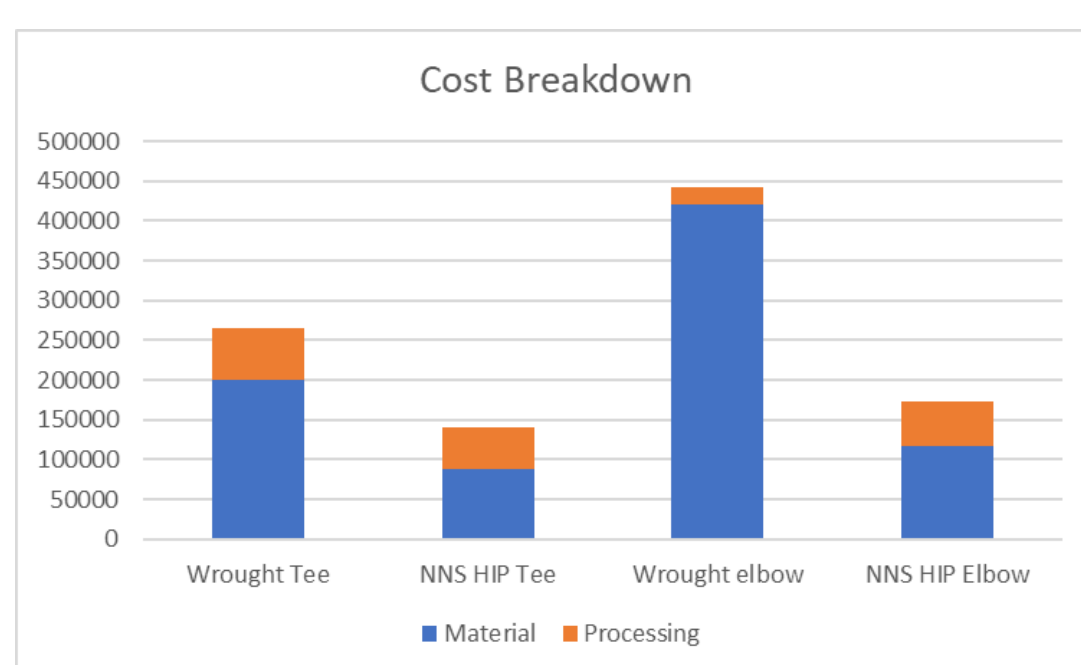
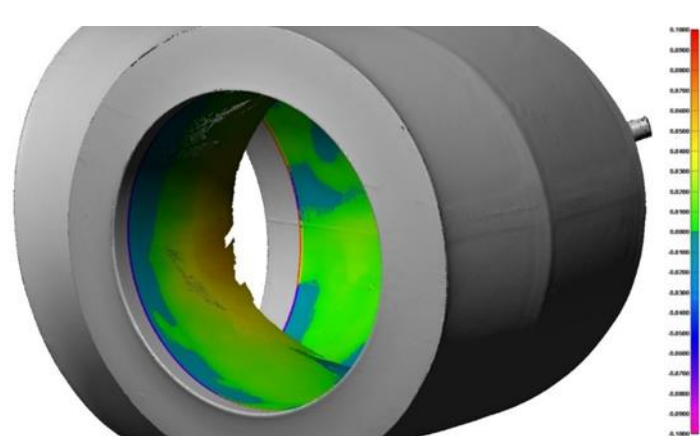
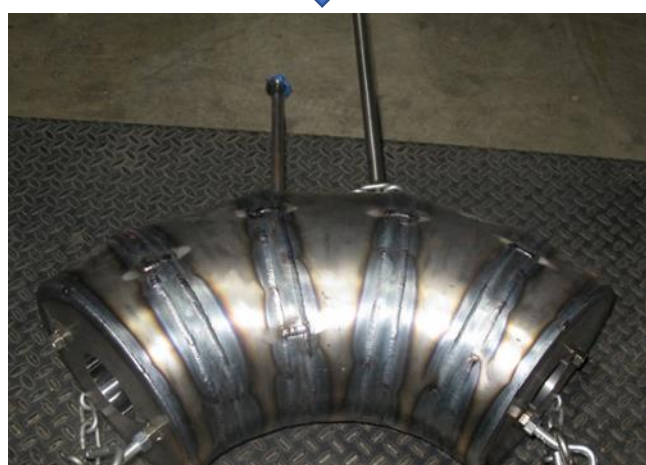
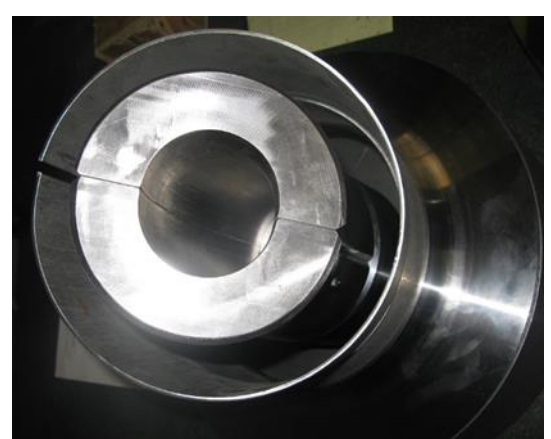
- Forging + machining: expensive, high material waste
- Sand casting: defects, extensive weld repair

Alternative manufacturing modality (NNS HIP):

- Reduced 2~3X volume of material vs wrought
- Reduced machining costs
- Reduce welds & weld repair
- Chemical & structural homogeneity
- Ultrasound inspectability

Piping Components

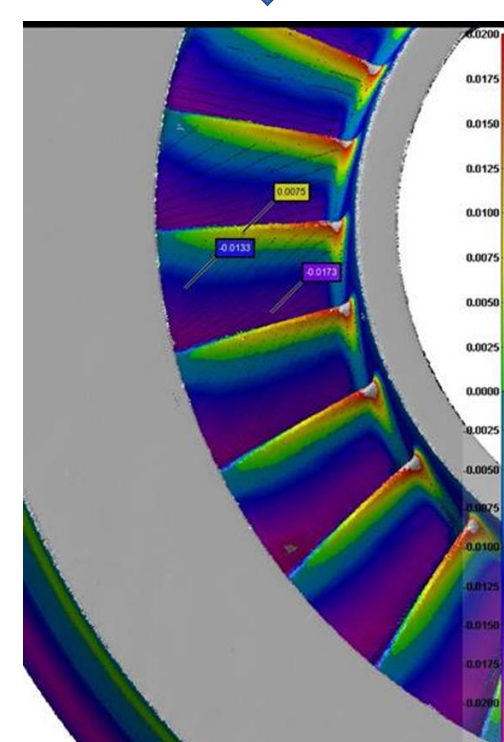
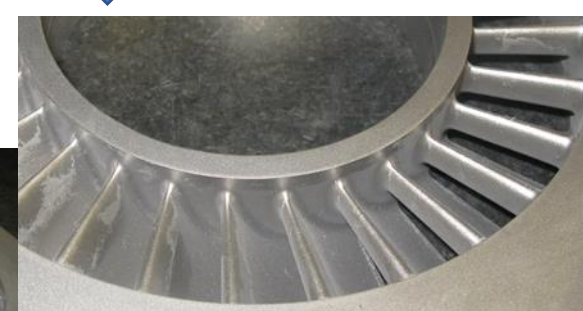
- Alloy: IN740H, Special Metals
- Powder atomization: Wyman-Gordon
- Weld development: SMC
- 8" Sch 160 elbow, 120 lbs



Costs provided should be interpreted as relative and not a vendor commitment

sCO₂ Turbine Nozzle Ring

- Alloy: HA282, Haynes International
- Powder plasma atomization: AP&C (GE Additive)
- 9" OD, 3" width, 20 lbs



HIP canister constructed from common low cost materials

HIP canister filled with powder and sealed ready for HIP

Hardware after removal from HIP canister

Dimensional evaluation with excellent results

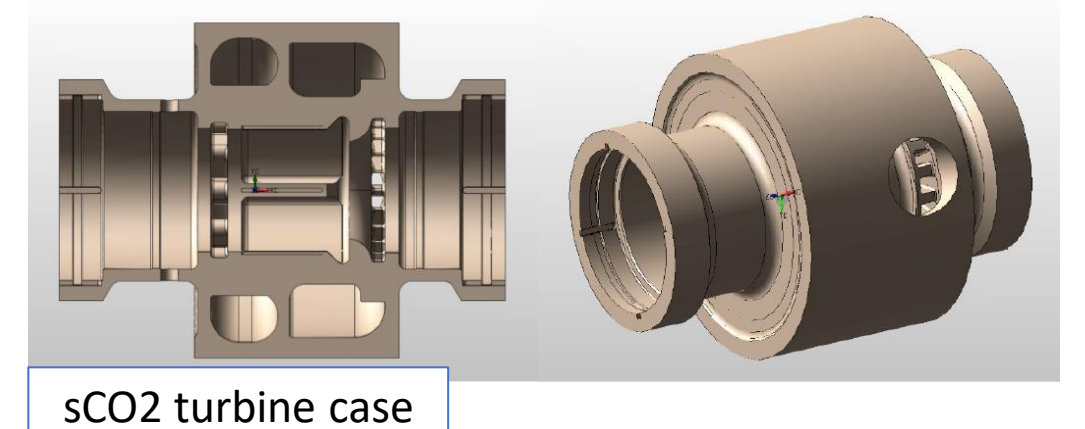
Value story

Material	\$33,124.70
Machining	\$375,000.00
Total:	\$408,124.70

Powder cost	\$3,933.60
NRE	\$30,000.00
NNS HIP	\$83,500.00
Post-processing	\$22,500.00
Total	\$139,933.60

sCO₂ Turbine Case

- Alloy: HA282, Haynes International
- Powder plasma atomization: AP&C (GE Additive)
- 33" long, 37" height, 1600 lbs



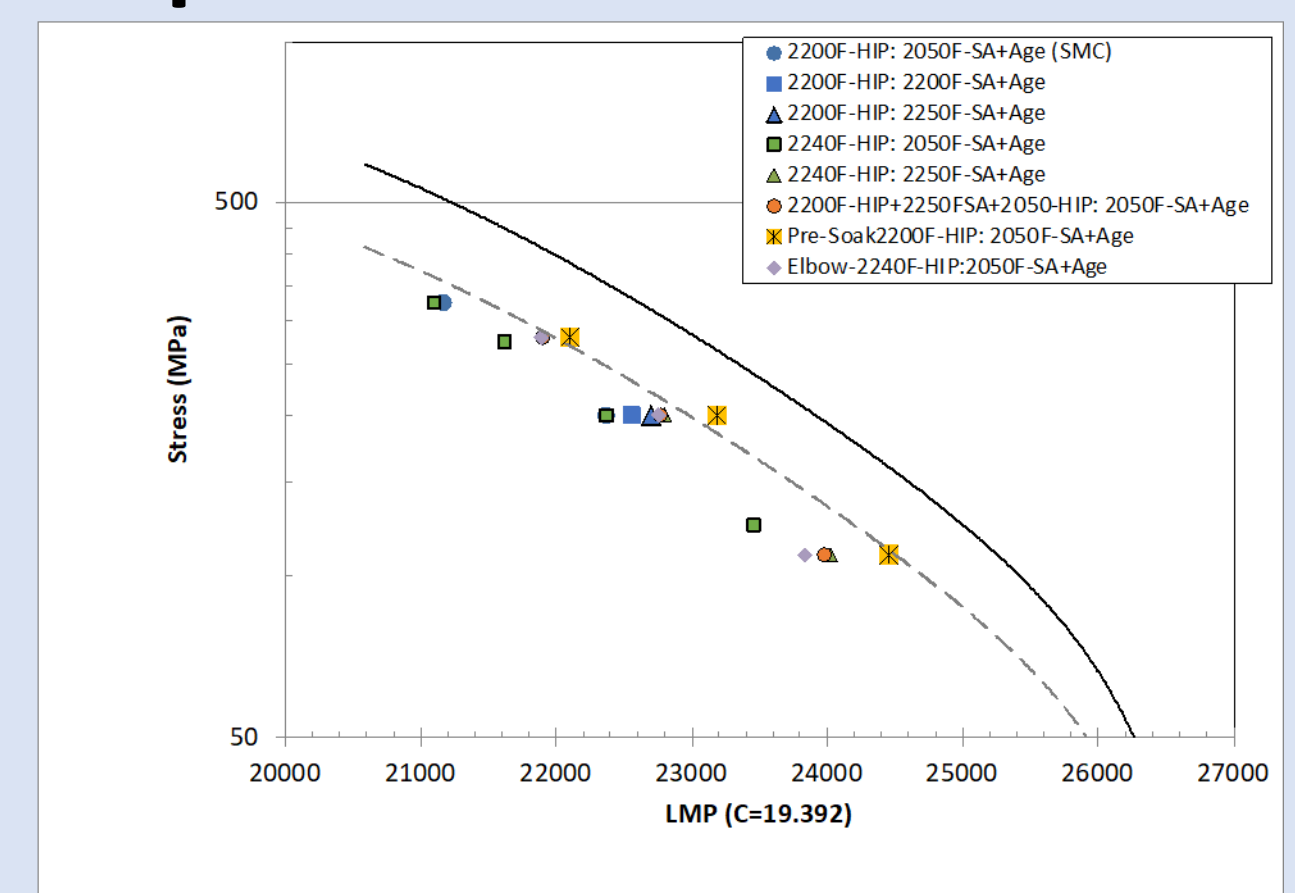
sCO₂ turbine case

HIP canister filled with powder and sealed ready for HIP



Case is being post-processed 1Q2022

Processing steps are critical to cost-performance trade off



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