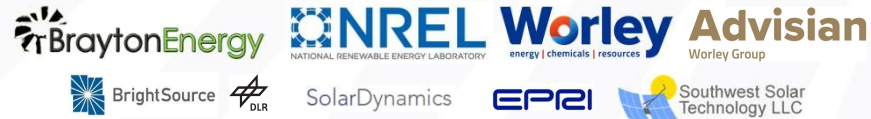




Gen3 sCO₂ Receiver Thermo-Mechanical Design

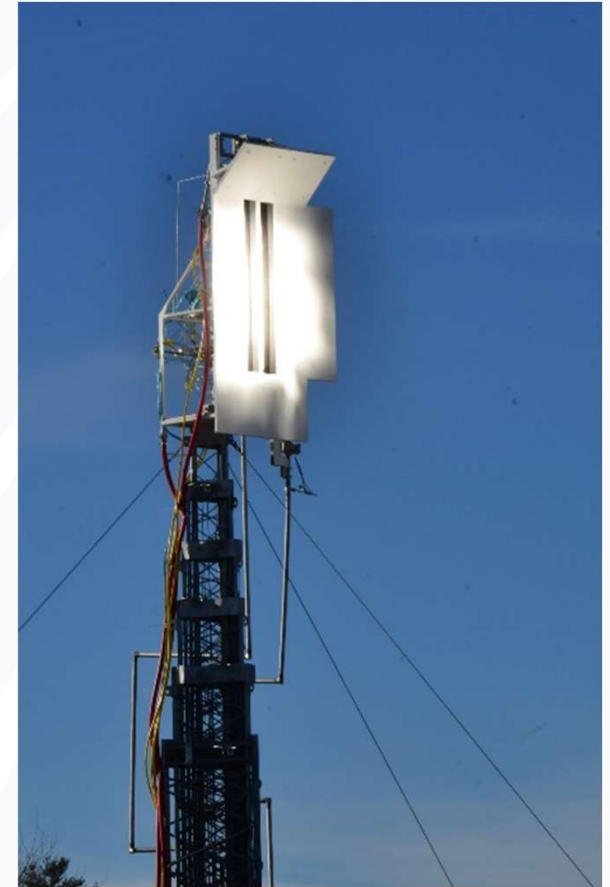
Gen3 CSP Summit



Jake Boxleitner, jake.boxleitner@braytonenergy.com

Outline

- Design Requirements
- Material and Architecture Selection
- Geometry Specification
- Analysis Process
- Life Quantification
- Conclusions



Design Requirements

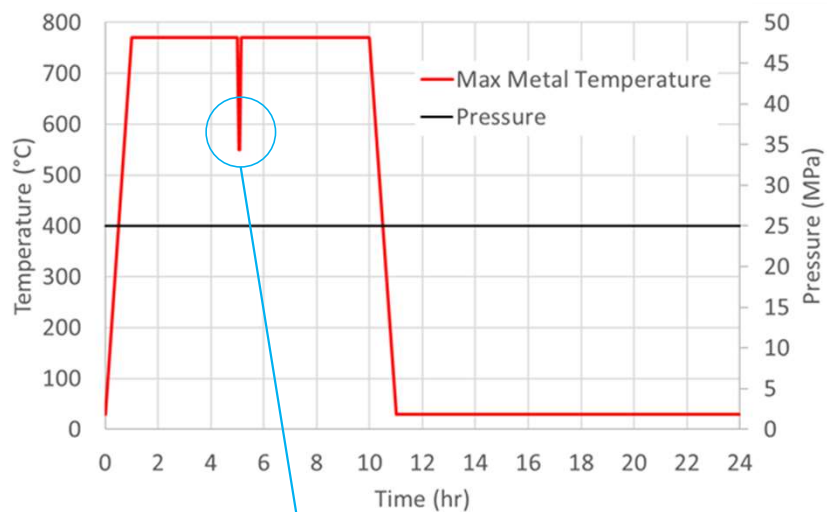
Service life: 100,000 hours (30 years), 10,000+ diurnal thermal cycles

Steady-state: 9 hours of operation at design point, 580-730°C sCO₂ temperatures, 770°C max. metal temp.

Transient: start-up/shut-down (ambient to 770°C), cloud pass and heliostat defocus (770°C to 580°C)

Failure mechanisms: steady-state = creep, transient = fatigue

Foremost priority: hardware reliability



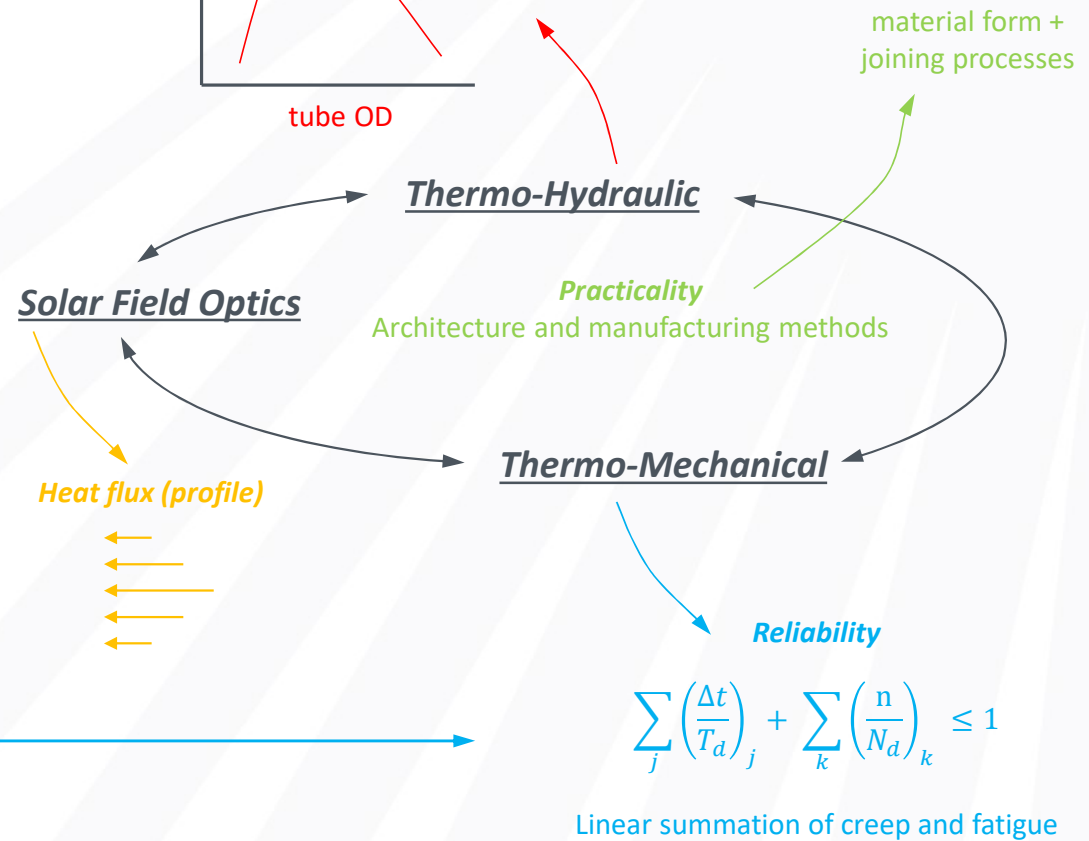
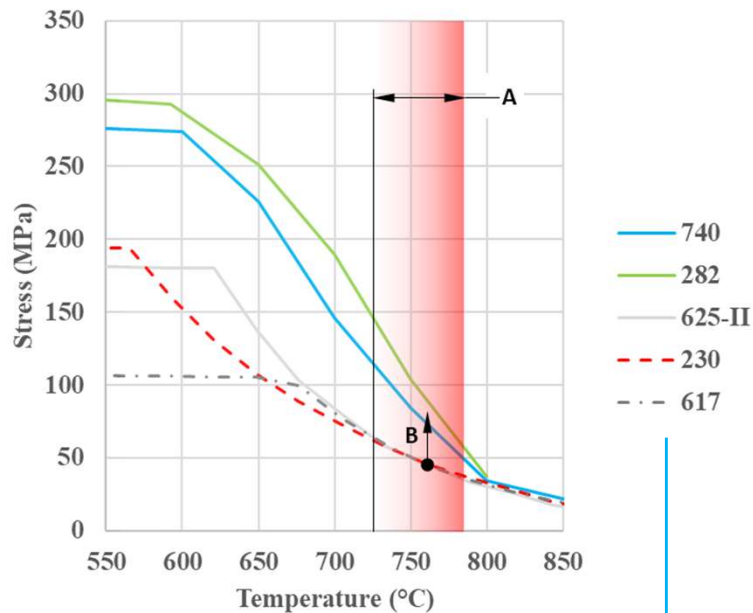
Cloud pass or heliostat defocus



Brayton Energy Solar Test Facility

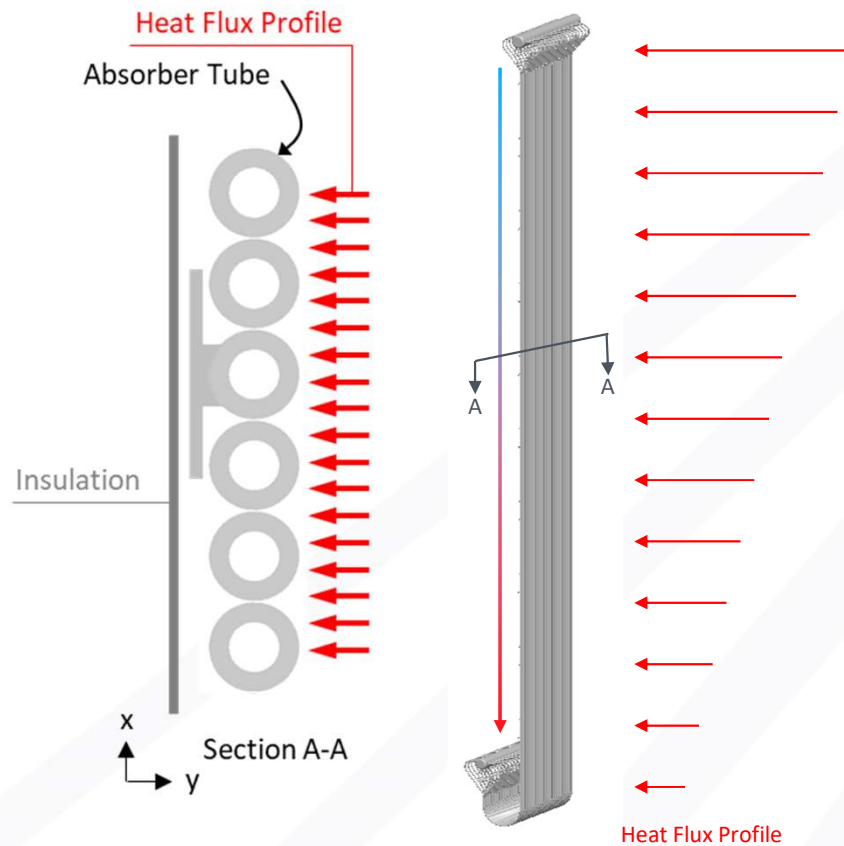
Material and Architecture Selection

Candidate sCO₂ receiver nickel alloys, γ' versus solid solution strengthened



Geometry Specification

Shown receiver tube dimensions:
.375" OD by .080" wall th. by 4.3' perf. length



IN740H Test Article

Geometry Specification



Tube-Header Interface



Backside tube stays

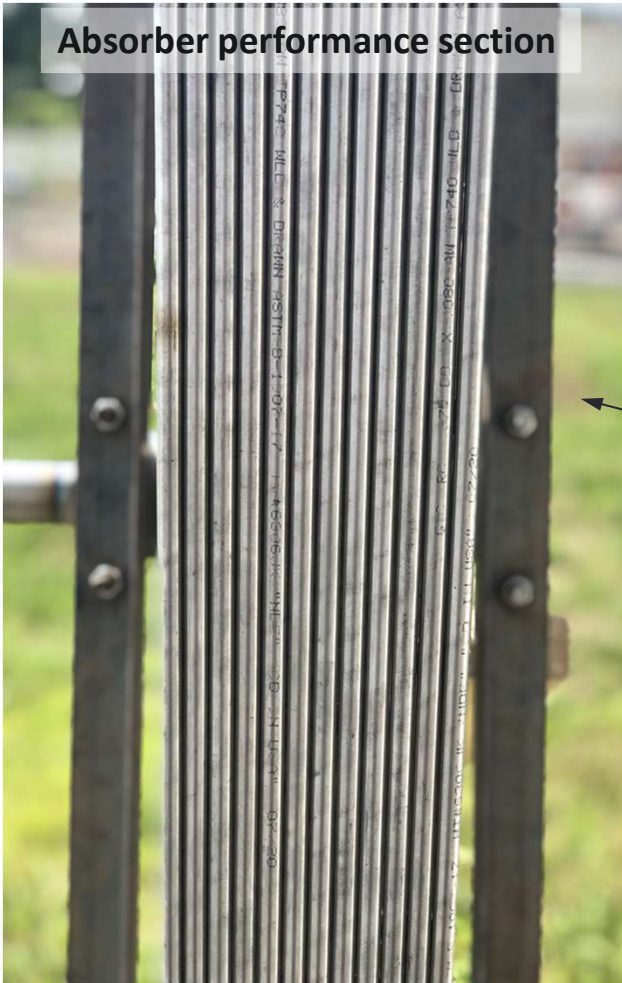


IN740H Test Article



Geometry Specification

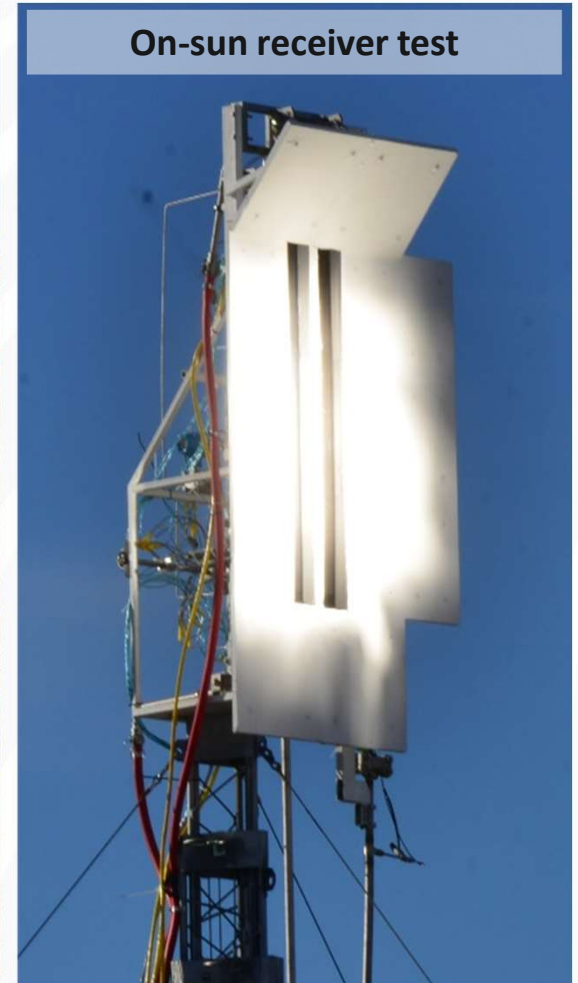
Absorber performance section



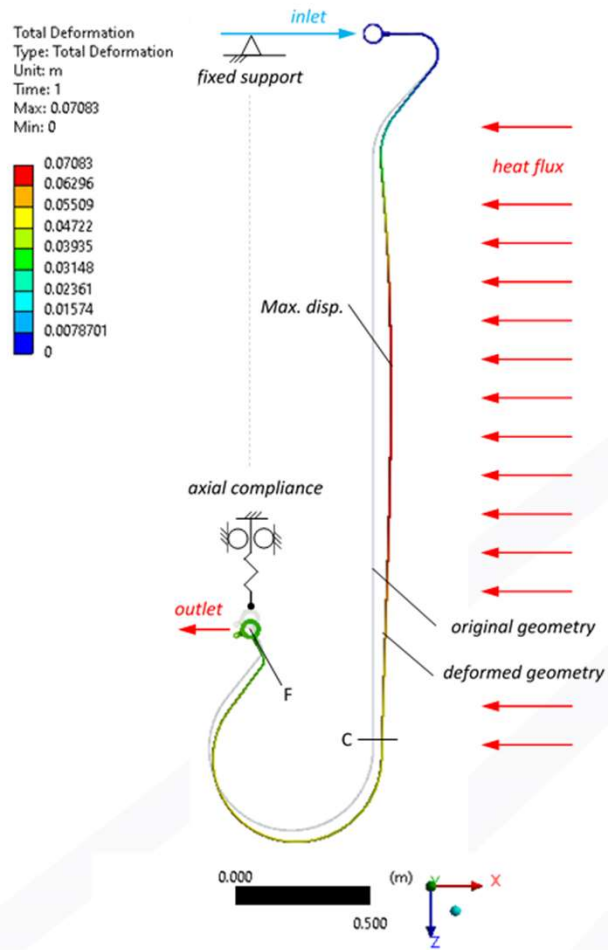
Insulated and mounted receiver



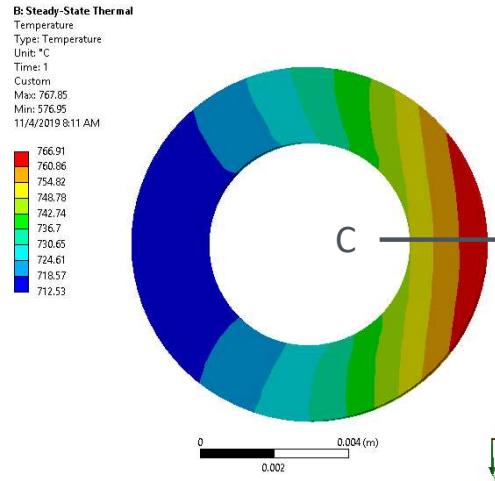
On-sun receiver test



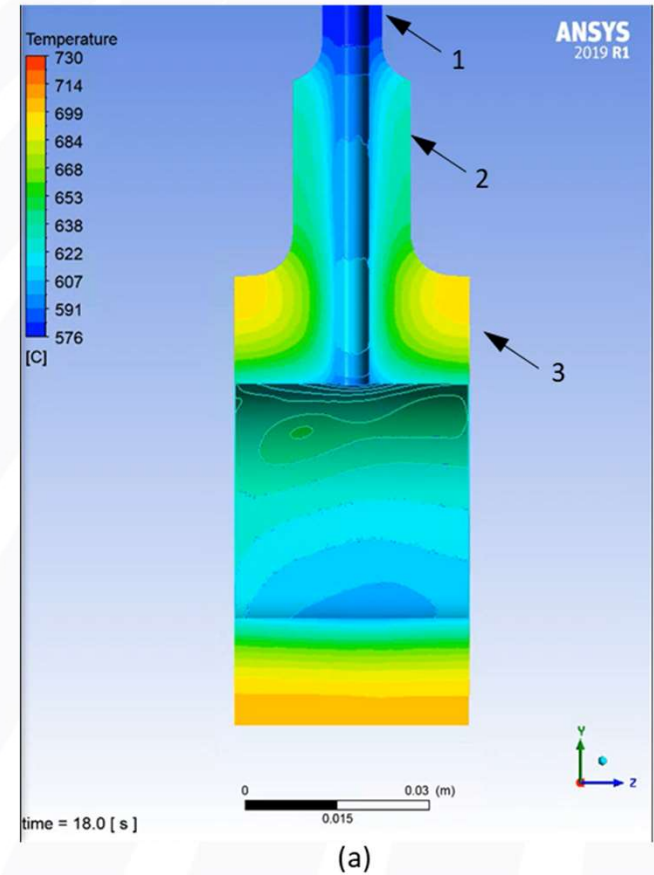
Analysis Process



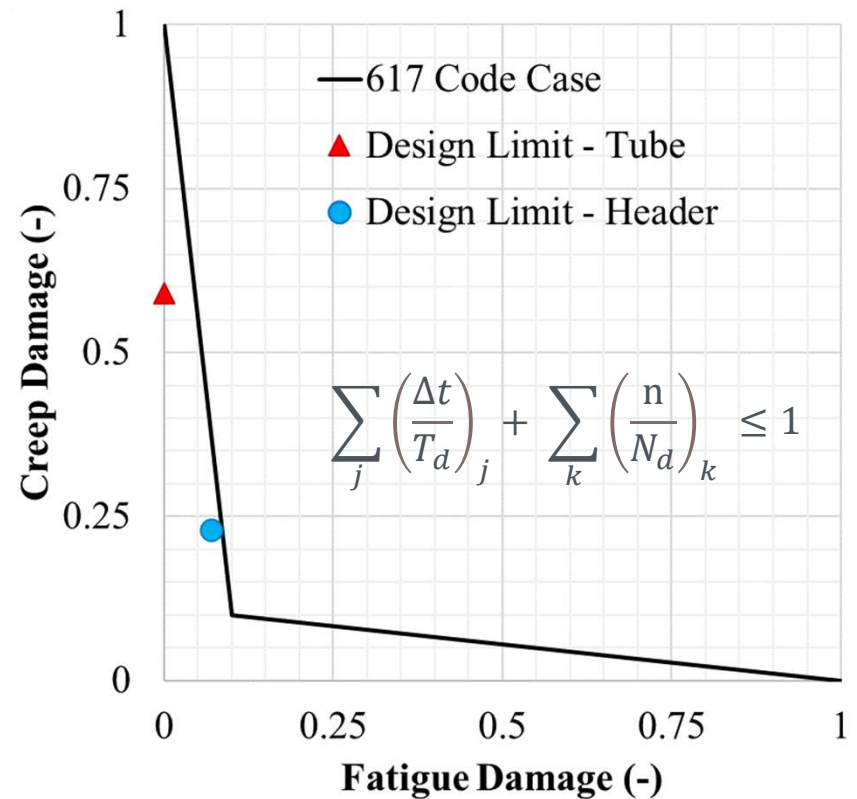
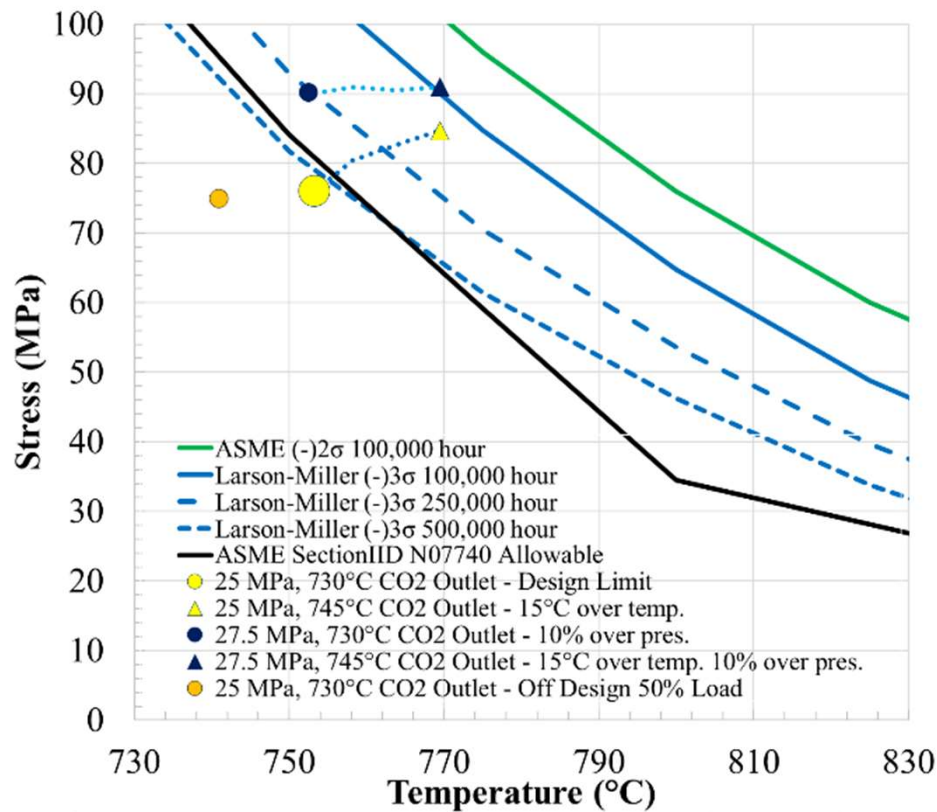
Steady-state temperature gradient



Transient temperature gradient



Life Quantification



Conclusions

- Receiver is design is holistic process including high level details from cycle performance models down to practically implementation of mechanical interfaces
- Inconel 740 and Haynes 282 γ' alloys offer increased strength at temperature
- Significant trade-offs exists between receiver efficiency and lifetime safety factor
- Understanding of reliable manufacturing processes and life quantification methods are required early in the design process

Future sCO₂ receiver work

- Further demonstration under elevated temperature and pressure conditions
- Incorporation of real-time measurements and accrued lifetime damage
- ...

Thank you DOE, funding for this project was provided to Brayton Energy by the U.S. Department of Energy under Contract No. DEEE0008368.