Design Basis Document / Owner's Technical Specification for Nitrate Salt Systems in CSP Projects

Award Number DE-EE0009810

May 12, 2022

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Acknowledgement

This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office Award Number DE-EE0009810.This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office Award Number DE-EE0009810.

The authors would like to acknowledge insights into the failure mechanisms provided by the engineers at SolarReserve, the National Renewable Energy Laboratory, the Colorado School of Mines, Virtualmech, Vast Solar, Contratos y Diseños Industriales, and Crescent Dunes.

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Project Summary and Goals

Develop a Design Basis Document / Owner's Technical Specification for nitrate salt systems in commercial parabolic trough and central receiver projects

- A Design Basis Document is to a project what a heat exchanger specification is to a heat exchanger
- Extensive commercial experience in salt equipment and system design, much of it gained through mistakes and associated expenses
- Distill the successful experience with nitrate salt systems from as many commercial projects as possible
- Starting from 7 historical Design Basis Documents, compile a consensus description of commercial equipment and system designs

Project Summary and Goals - Continued

- From the consensus description, bring the information presented in previous Design Basis Documents up to date
- Up to date information topics include, among others, receiver tube materials, intergranular stress corrosion cracking in nickel alloys, stress relaxation cracking in 300-series stainless steels, stainless steel weld filler materials, instrument types, maximum allowable receiver film temperatures, recommended heat exchanger fabrication techniques, heat trace design criteria, storage tank foundation types, storage tank floor buckling analysis, storage tank inlet distribution piping layouts, flex joint impedance heating, and parabolic trough receiver freeze recovery.

Project Summary and Goals - Continued

- Provide technical bases for equipment design and selection that an owner can impose on an EPC contractor, and thereby prevent a recurrence of previous mistakes and failures
  - The projects in which the Owner has a thorough knowledge of the technology, and in which the Owner does not rely on the EPC contractor to make all of the design decisions, are the most successful
- Compile this information in one location to provide guidance on salt systems that is as broadly applicable to as many projects as possible
- Work toward an industry consensus on a Design Basis Document, following the approach used on NREL's Best Practices study
  - Distribute drafts to an industry group consisting of project developers, EPC contractors, equipment vendors, and users of nitrate salt technology
  - Incorporate industry comments where reviews agree
  - Where reviews disagree, describe alternate views for resolution in future revisions to the Design Basis Document

Historical Design Basis Documents

- 7 historical Design Basis Documents on which to start the project
- In 2001, at the completion of the Solar Two project, Bechtel developed a Design Basis Document for a follow-on tower project in Spain, tentatively called Solar Tres. Solar Tres evolved into the Gemasolar project, which was designed, constructed, and is currently under operation by SENER
- In 2010, Abengoa conducted a study for DOE, entitled Development of Molten Salt Heat Transfer Fluid Technology for Parabolic Trough Solar Power Plants. One of the tasks was the development of a plant Design Basis Document
- In 2011, Abengoa conducted a study for DOE, entitled Development of a Baseload CSP - Advanced Nitrate Salt Central Receiver Power Plant. One of the tasks was the development of a plant Design Basis Document

Historical Design Basis Documents - Continued

- In 2017, SolarReserve started the development of a Design Basis Document for the Redstone tower project in South Africa. However, technical and financial problems with the Crescent Dunes project precluded the financial closure under SolarReserve, and the associated Design Basis Document was never finished
- In 2019, Worley-Parsons, under contract to Solar Dynamics, developed a Design Basis Document for nitrate salt as the heat transport fluid and thermal storage medium in parabolic trough power plants
- In 2019, Sargent & Lundy, under contract to Solar Dynamics, developed a Design Basis Document for nitrate salt as the receiver coolant, thermal storage medium, and heat transport fluid in a central receiver power plant
- In 2020, TerraPower began development on a next-generation nuclear power project. The reactor is cooled with sodium, and heat is transferred to a nitrate salt loop for thermal storage and steam generation. In support of the program, Solar Dynamics prepared a Design Basis Document for the nitrate salt systems.

Project Summary

- 12 month study
- Principal Tasks
  - 2: Functional Requirements: What the salt systems need to do
  - 3: Operating Modes, and Transitions Between Modes: How the salt systems operate in cyclic service
  - 4: Risk Analysis: Equipment items with the highest risks
  - 5: Operating Requirements: Limits on temperatures, pressures, flows, heat transfer, and rates of change
  - 6: Functional / Prescriptive Specifications: Functional specifications provide design flexibility; prescriptive specifications prevent a repeat of past mistakes
  - 7: Current State of the Art: Commercial plant characteristics
  - 8: Alternate Designs: Potential revised designs
  - 9: Industry Review: Work toward a consensus
- Questions?