DOE Award FE0024067

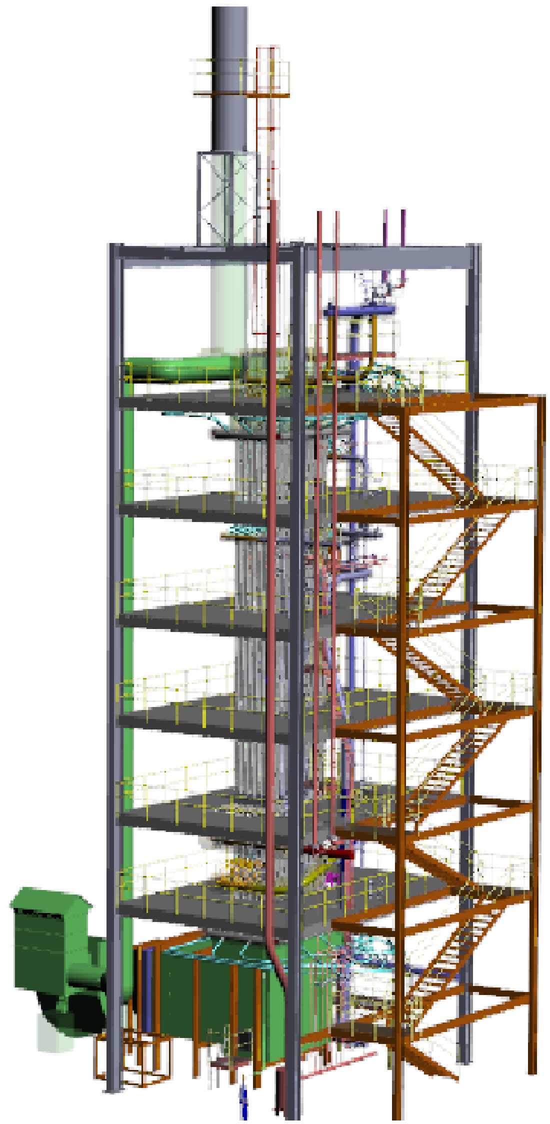
Component Test Facility (ComTest) Phase 1 Engineering for 760C (1400F) Advanced Ultrasupercritical (A-USC) Steam Generator Development

increase temperature to improve efficiency

Pittsburgh, PA - 2016 April 20

Paul Weitzel, P.E.
Technology, New Product Development

AUSC ComTest Superheater Tower



ComTest A-USC Superheater

Project performance load was 133,800 lb/hr.

Oxygenated Water Treatment (OWT) required.

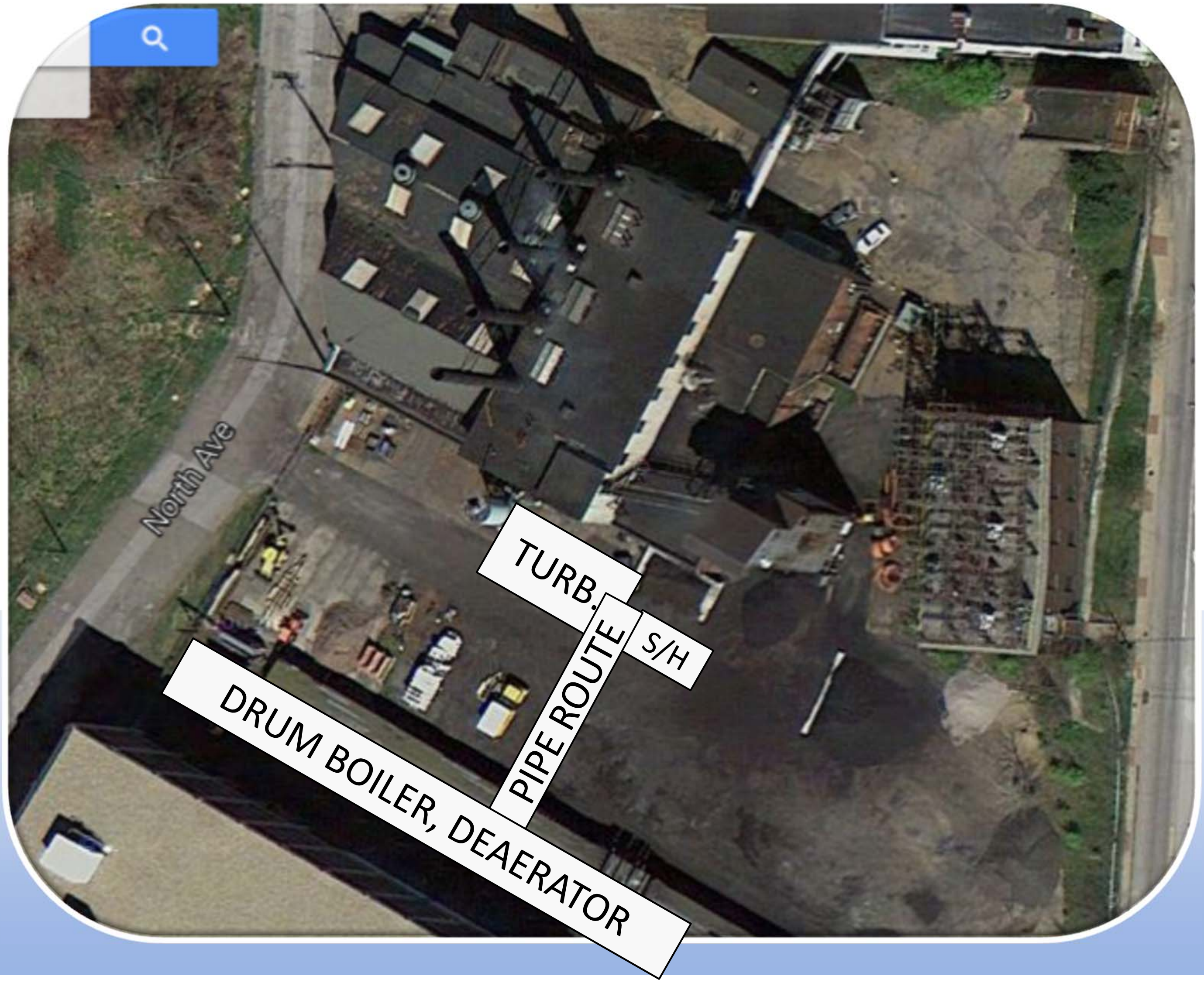
GE steam turbine now requires 119,510 lb/hr 1400F / 620 psia steam and 22,957 lb/hr 1075F+ cooling steam.

Inlet steam is 136,491 lb/hr 770F/940 psia.

Split economizer will heat 5796 lb/hr spray attemperation water (1025 psi).

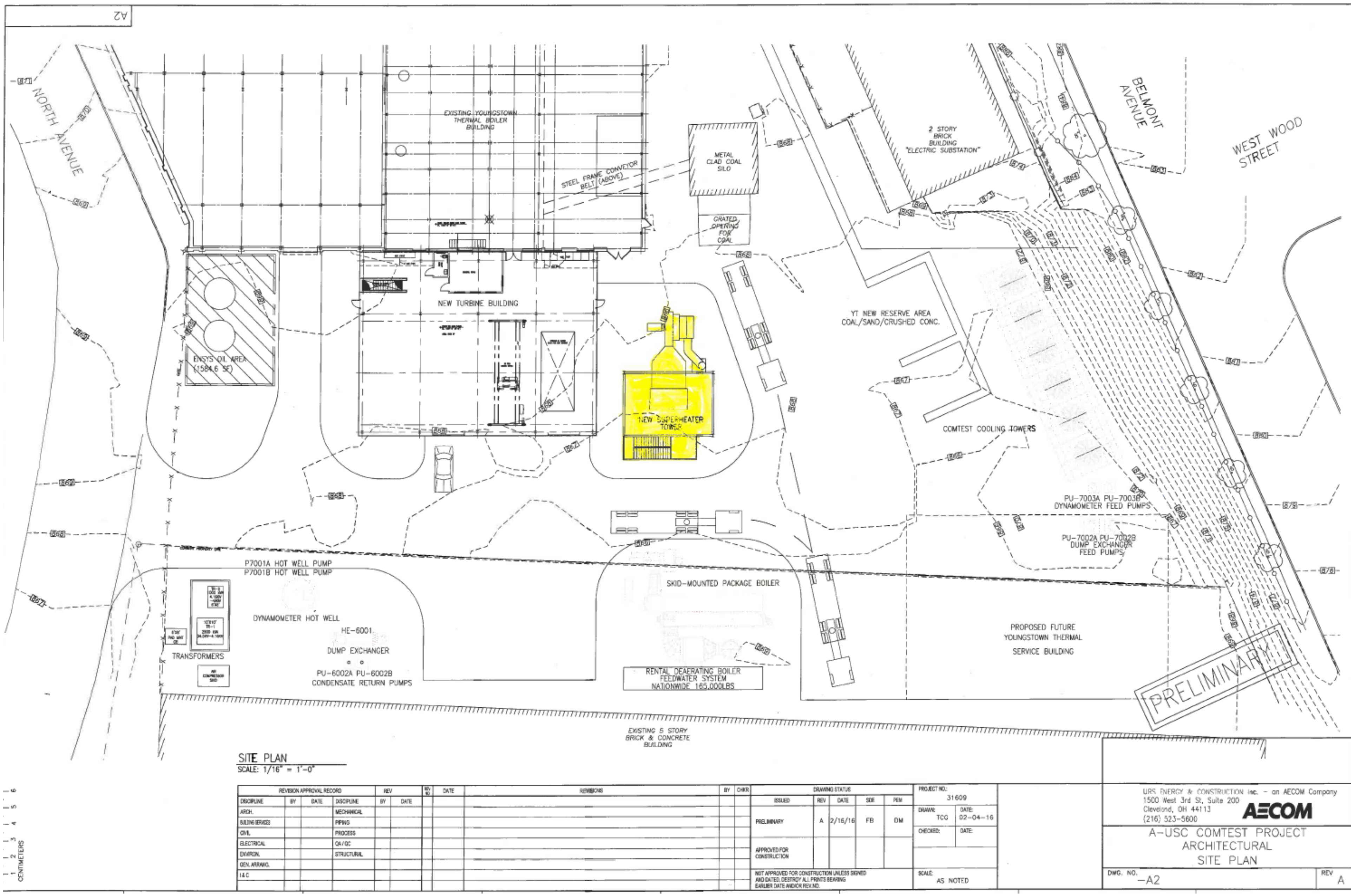
Upper economizer will cool the flue gas.

ComTest Youngstown Thermal



Ability to reorient the SH tower layout

Youngstown Thermal Site Plan



ComTest A-USC Superheater
Terminal Performance Parameters

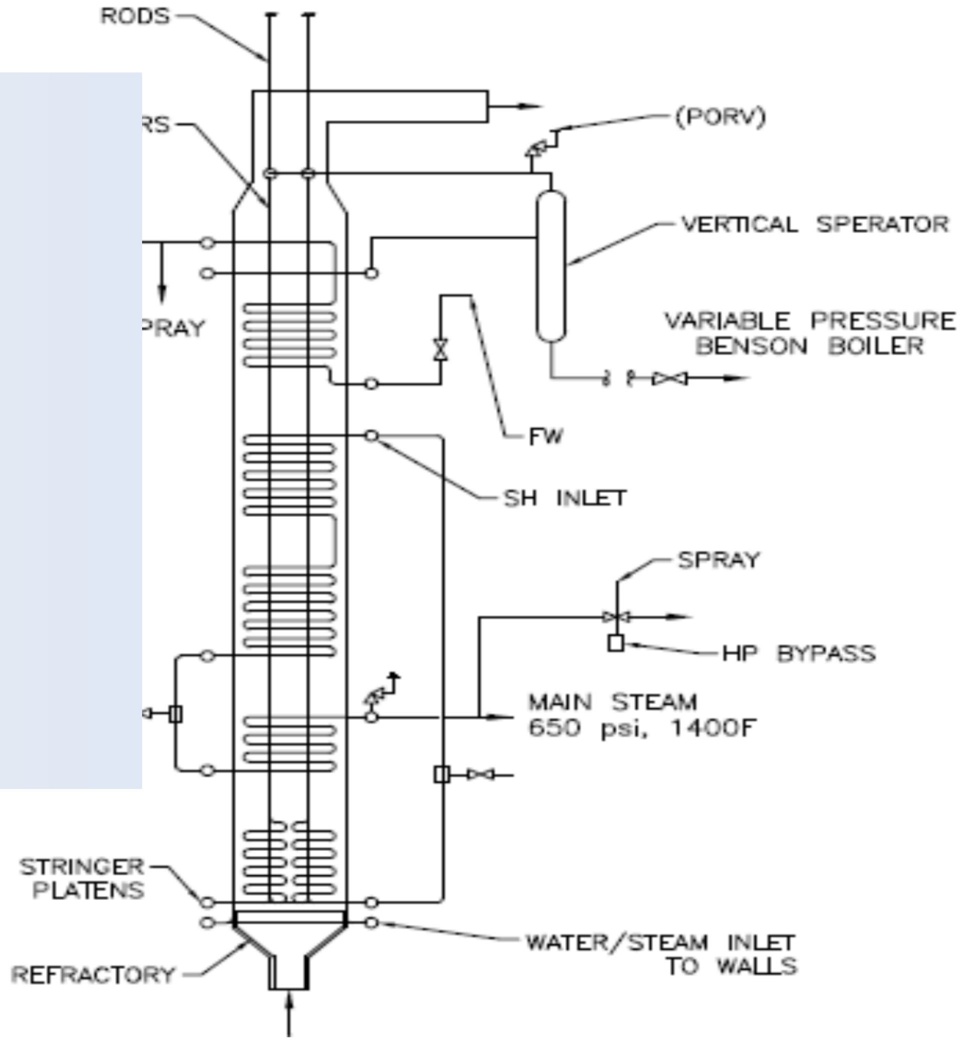
System	Nominal Flow lb/hr	*Maximum Flow lb/hr	Nominal Pressure *psig	Design Pressure *psig	Nominal Temperature °F	Design Temperature °F
Rental Boiler(s)	**133,800 *136,491**	**150,000**	***975**	***1075**	***770**	***825**
A-USC Feedwater	**150,000**		***1075**	***1350**	**225**	**700**
A-USC Spray Water	**6,690 *5976**	**12,000**	***1075**	***1350/4500**	**500**	**700**
A-USC Superheater Enclosure Inlet	**127,110 *136,491**	**142,500**	***925**	***1150/4500**	**770**	***800 inlet *947 outlet**
***A-USC Cooling Steam**	***0 to 22,957**	***25,000**	***800**	***1150/4500**	***1047 - 1100**	
A-USC Superheater Outlet	**133,800 *119,510**	**150,000**	**625 *605**	***1150/4500**	**1400 +/-15**	**1415**
Turbine Valve Inlet	**133,800**	**150,000**	***585**	**4500**	**1400**	**1415**

ComTest "Superheater"
@ Host Youngstown Thermal

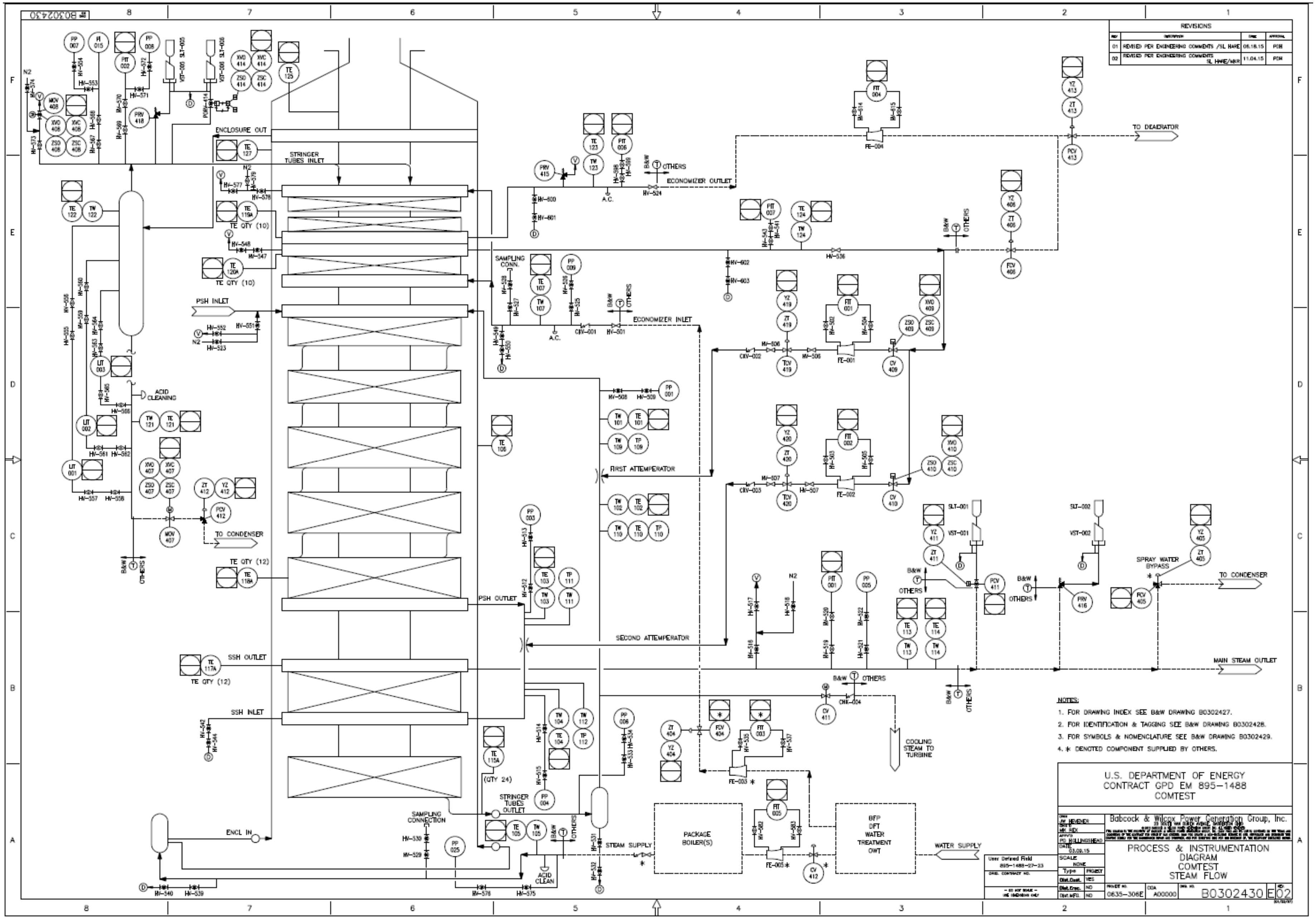
T-92 Enclosure wall fab, field welding, PWHT, initial service, high temperature operation
2 walls 10.25ft x 60ft
2 walls 3.75ft x 60ft

740H nickel tubes, header, thick piping

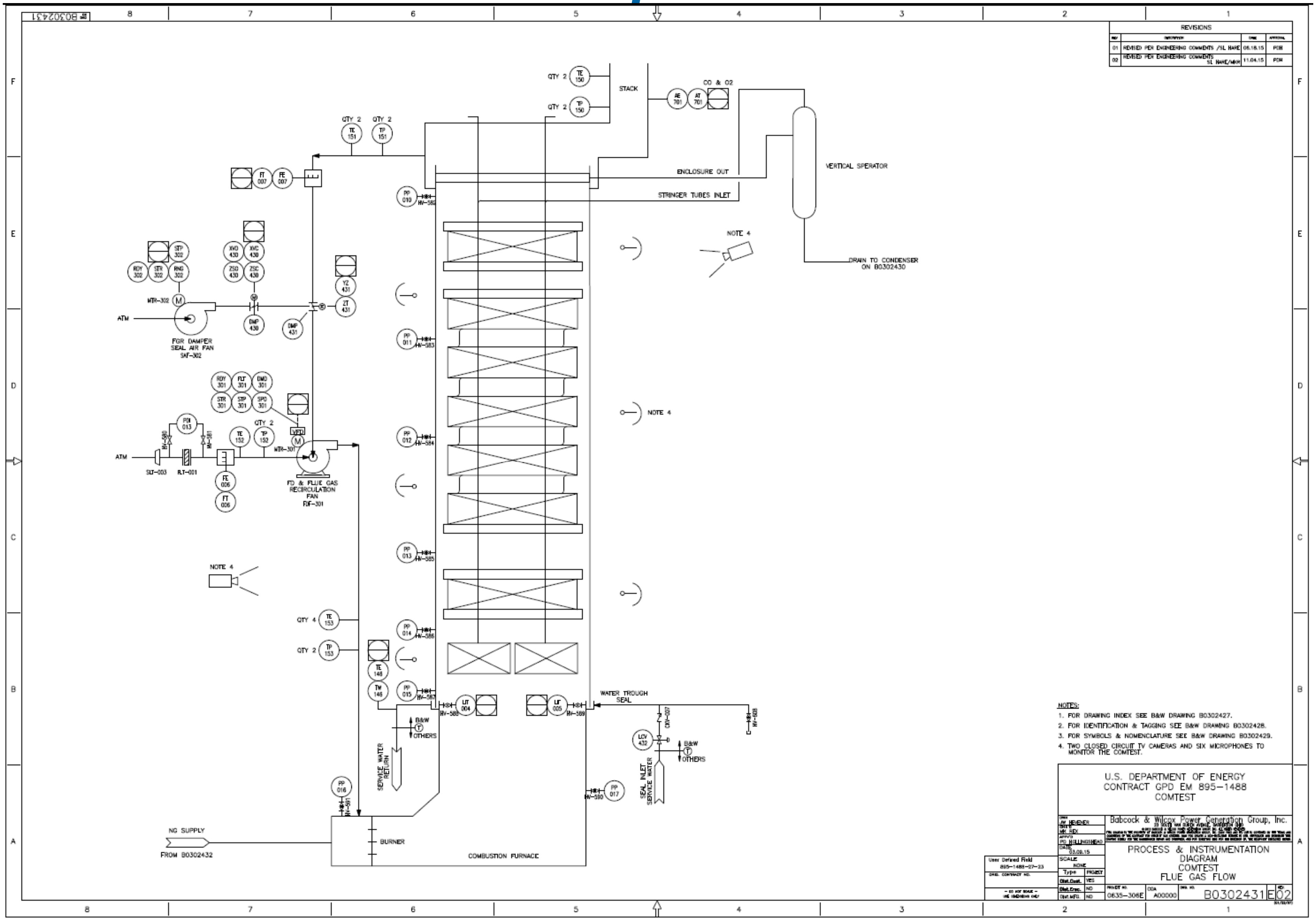
Supply chain- nickel valves, accessories



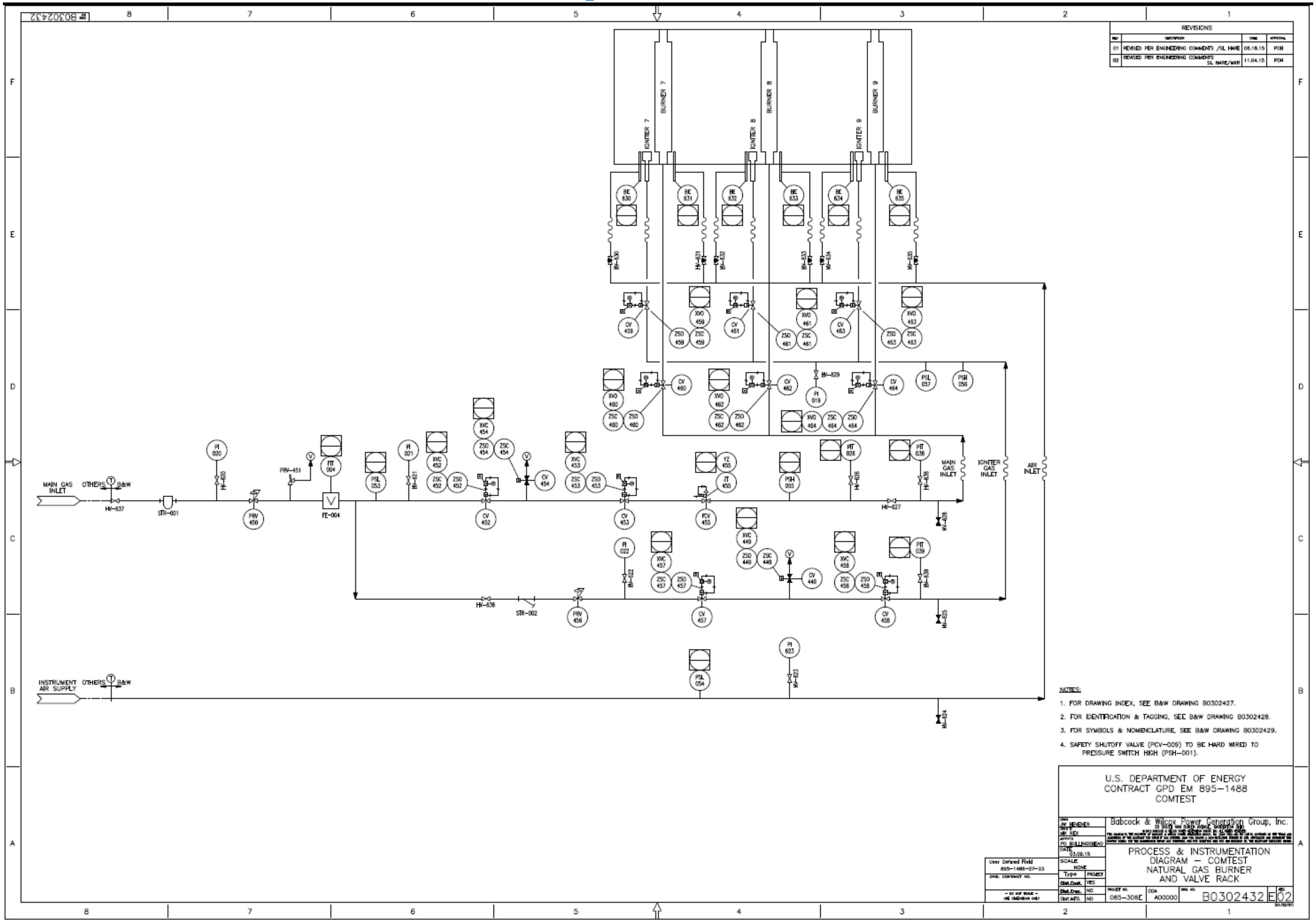
AUSC ComTest Superheater –Steam Flow



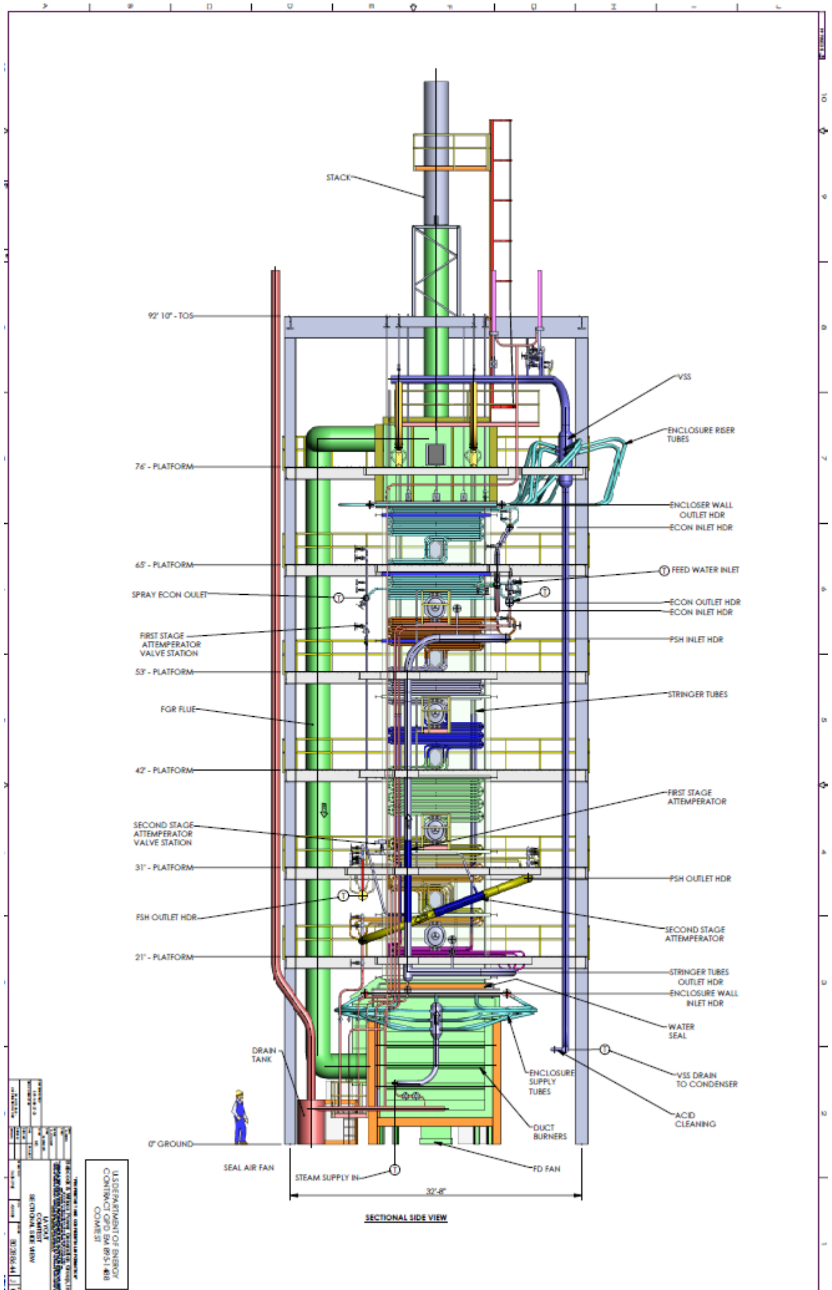
AUSC ComTest Superheater –Gas Flow

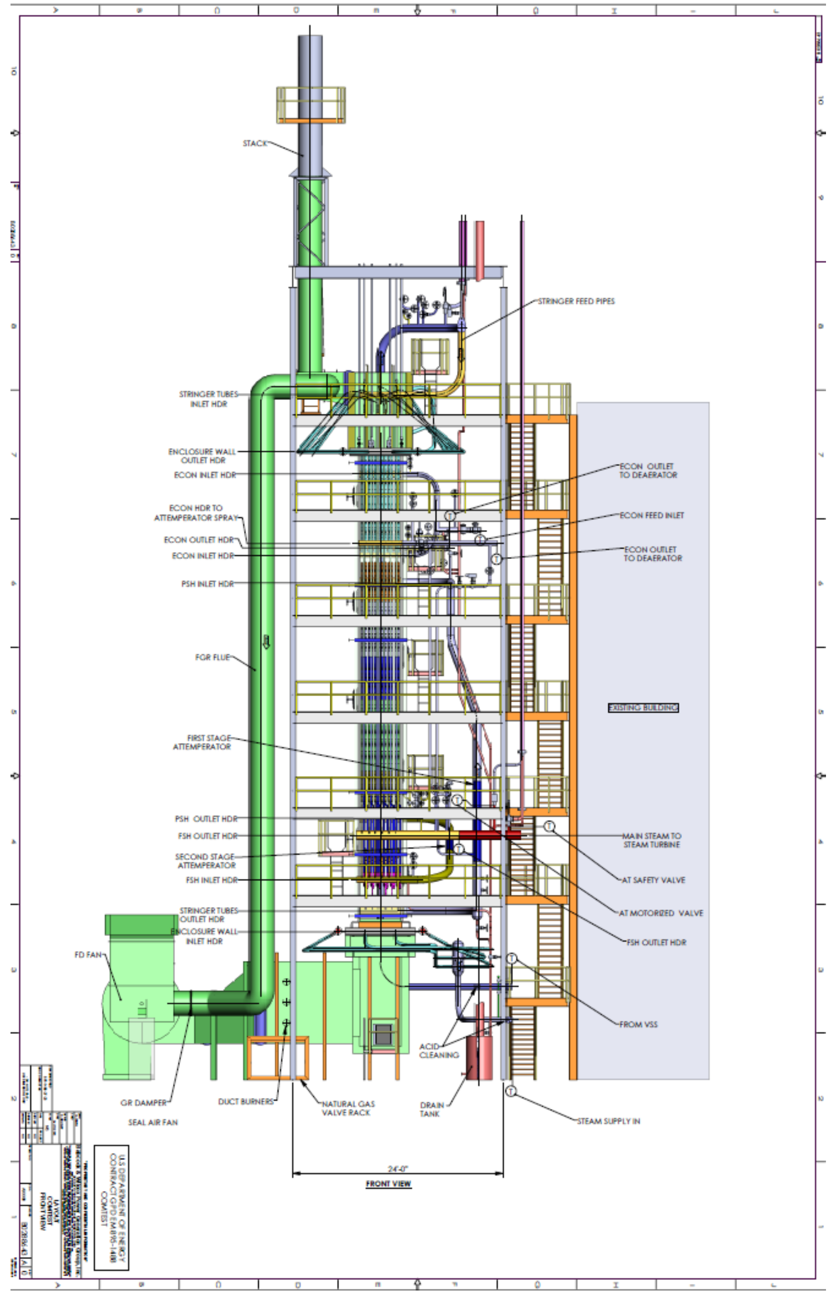


AUSC ComTest Superheater –Natural Gas

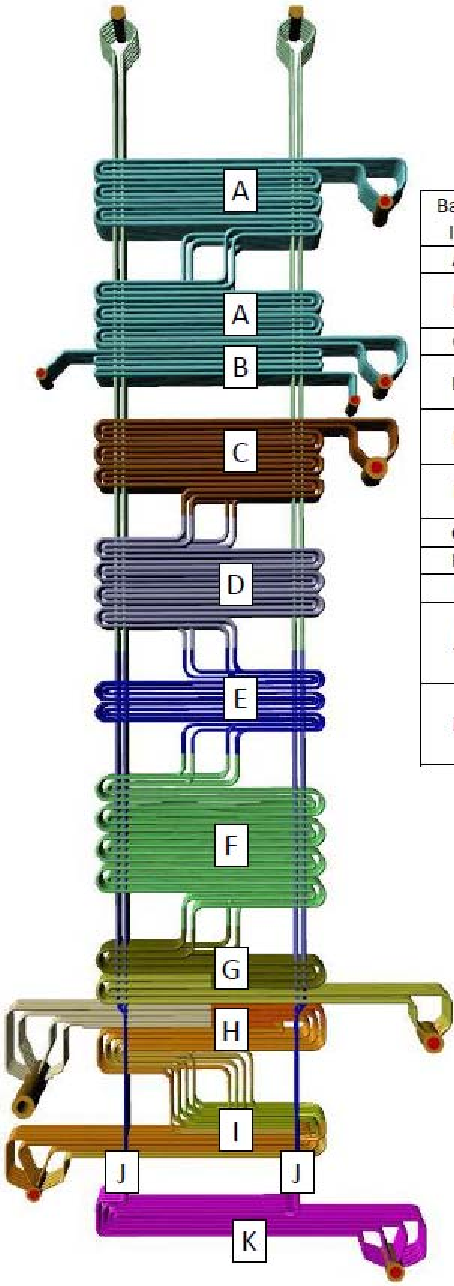


A-USC ComTest Superheater Youngstown Thermal





A-USC ComTest Tube Banks

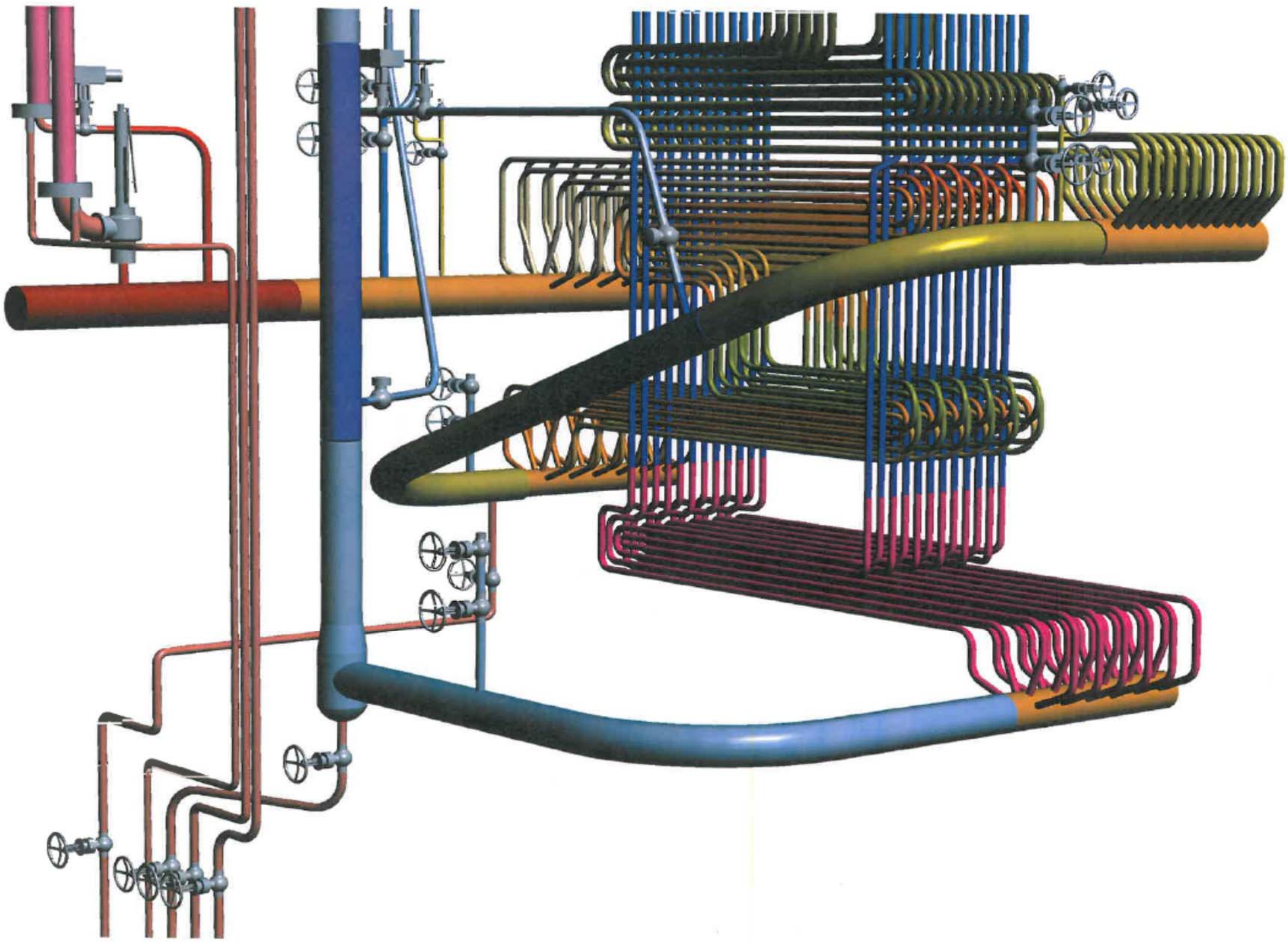


Bank ID	COMPONENT	TUBE OD	TUBE MAT'L	DESIGN PRESS.
A	Economizer	2.50"	SA210A1	1050 psig
B	Economizer for Spray Water	2.50"	SA210A1	1050 psig
C	Pri. SH Inlet	2.50"	SA213T92	4500 psig
D	Pri. SH Intermed.-1	2.50"	SA213TP 310HCbN	4500 psig
E	Pri. SH Intermed.-2	2.25"	SA213TP-310HCbN	4500 psig
F	Pri. SH Intermed.-3	2.25"	IN740H	4500 psig
G	Pri. SH Outlet	2.25"	IN740H	4500 psig
H	Sec. SH Outlet	1.75"	IN740H	4500 psig
I	Sec. SH Inlet	1.75"	IN740H	4500 psig
J	Stringer Tubes	2.00" & 2.25"	SA213T92 & SA213TP-310HCbN	4500 psig
K	Stringer Bank	2.00"	SA213TP-310HCbN & IN740H	4500 psig

ComTest Superheater Pipe Estimate

MATERIAL	TTL LF	TTL LBS
-		
IN740H	54	11007
SA106B	384	16342
SA335P22	679	35243
SA335P91	17	911
SA335P92	228	37041
Total	1362	100543

Convection Pass lower end



Replace some P92 with P22

PROJECT: 0306E ASME Section I Calculation Results
CUSTOMER: OCDO DOE A-USC ComTest Youngstown Thermal
DATE: 08/27/15
REV: 0

New Design Pressure for some sizes - ~1150 psi

HEADERS & PIPING	PRESS	TEMP	QUANTITY HEADERS	QUANTITY PIPES	OD (inch.)	THICK Order (inch.)	SCHD	MATL	CONN
Critical Piping - Feedwater Inlet	1375	700		1	6.625	0.6280	Sch 160	SA 106B	
Main Economizer Inlet Header	1150	700	1		6.625	0.6280	Sch 160	SA 106B	Single End Inlet
Main Economizer Outlet Header	1150	700	1		6.625	0.6280	Sch 160	SA 106B	Single End Outlet
Spray Econonmizer Inlet Header	1150	700	1		6.625	0.6280	Sch 160	SA 106B	Single End Inlet
Spray Economizer Outlet Header	1150	700	1		6.625	0.6280	Sch 160	SA 106B	Single End Outlet
Spray Water Piping, Attemp-1 HV-606 Valve	1150	598		1	2.375	0.1910	Sch XS	SA 106B	
Spray Water Piping, Attemp-2 HV-607 Valve	1150	598		1	2.375	0.1910	Sch XS	SA 106B	
Critical Piping - Feedwater Outlet	1150	700		2	6.625	0.6280	Sch 160	SA 106B	
Critical Piping - Steam Inlet	1075	800		1	8.625	0.4380	Sch 80/XS	SA 106C	
Inlet Bottle to Enclosure Inlet Headers	4500	800		1	10.750	1.7500		SA335P22	
Piping Inlet Bottle to Enclosure Inlet Headers	4500	800		11	4.500	0.5900	Sch XXS	SA335P22	
Enclosure Inlet Headers	4500	800	4		10.750	1.9690		SA335P22	Inlet Connections
Enclosure Outlet Headers	4500	947	4		10.750	1.9690		SA335P92	Outlet Connections
Connection Enclosure Outlet to VSS	4500	947		10	4.500	0.5900	Sch XXS	SA335P92	
Vertical Steam Separator	4500	947		1	16.000	2.1880		SA335P92	Inlet Connections
Vertical Steam Separator Drain	4500	947		1	8.625	1.0000		SA335P92	
Piping VSS to Stringer Header before Tee	4500	947		1	10.750	1.2500		SA335P92	
Piping VSS to Stringer Header after Tee	4500	947		2	8.625	1.0000		SA335P92	
Stringer Inlet Header	4500	947	2		8.625	1.2500		SA335P92	Single End Inlet
Stringer Outlet Header	4500	1072	1		10.750	1.7500		SA335P92	Single End Outlet
Attemp-1 Inlet Piping Incl. Attemp.	4500	1072		1	10.750	1.3750		SA335P92	
Spray Water Piping, HV-606 to Check Valve	4500	598		1	2.375	0.3000	Sch 160	SA 106B	
Spray Water Piping, Check Valve to Attemp-1	4500	1072		1	2.375	0.3000	Sch 160	SA335P91	
Attemp-1 Outlet Piping to PSH Bank Inlet	4500	1023		1	10.750	1.3750		SA335P92	
PSH Inlet Header	4500	1023	1		11.750	2.1880		SA335P92	Single End Inlet
PSH Outlet Header	4500	1343	1		11.500	2.0630		S/B N07740	Single End Outlet
Attemp-2 Inlet Piping Incl. Attemp.	4500	1343		1	11.500	1.5630		S/B N07740	
Spray Water Piping, HV-607 to Check Valve	4500	598		1	2.375	0.3000	Sch 160	SA 106B	
Spray Water Piping, Check Valve to Attemp-2	4500	1343		1	2.375	0.3010	Sch 160	S/B N07740	
Attemp-2 Outlet Piping to SSH Bank Inlet	4500	1289		1	11.000	1.3130		S/B N07740	
SSH Inlet Header	4500	1289	1		10.250	1.0630		S/B N07740	Single End Inlet
SSH Outlet Header	4500	1425	1		13.250	2.8130		S/B N07740	Single End Outlet
Critical Piping - Steam Outlet	4500	1425		1	13.250	2.5630		S/B N07740	

* C -Continuous, E - End Plated, G - Prep for Girth Weld

S/B N07740 is SB622 UNS N07740 740H

ComTest Superheater Tube Estimate

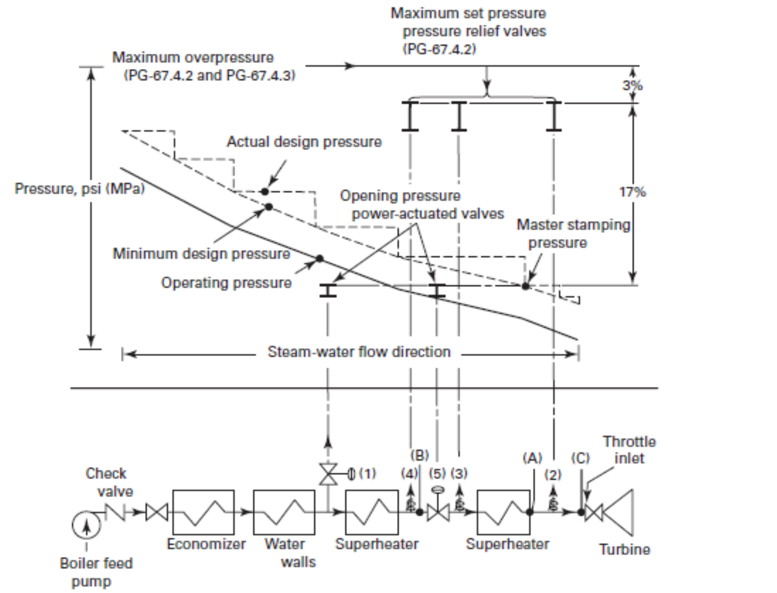
MATERIAL	TTL LF		TTL LBS
SA210C	0		0
SA210C MLR	0		0
SA210A1	4,682		23,525
SA213T2	0		0
IN740H	4,296		28,115
SA213T12	0		0
SA213T22	0		0
SA213T23	574		3,352
SA213T91	0		0
SA213T92	12,005		58,799
SA213TP310HCBN	3,563		27,953
SA213TP347H	0		0
	25,120		**141,744**

Safety Valve Requirement

PG-68 SUPERHEATER AND REHEATER
PG-68.1 Except as permitted in PG-58.3.1, every attached superheater shall have one or more pressure relief valves in the steam flow path between the superheater outlet and the first stop valve. The location shall be suitable for the service intended and shall provide the overpressure protection required. The pressure drop upstream of each pressure relief valve shall be considered in the determination of set pressure and relieving capacity of that valve. If the superheater outlet header has a full, free steam passage from end to end and is so constructed that steam is supplied to it at practically equal intervals throughout its length so that there is a uniform flow of steam through the superheater tubes and the header, the pressure relief valve, or valves, may be located anywhere in the length of the header.

PG-58.3.1 does not provide relief from the PG-68.1 rule

Figure PG-67.4
Requirements for Overpressure Protection Forced-Flow Steam Generator



Pressure
(A) = master stamping (PG-106.3)
(B) = component design at inlet to stop valve (5) (PG-67.4.4.1)
(C) = turbine throttle inlet (ASME B31.1, para. 122.1.2, A.4)

Pressure Relief and Power-Actuated Valves
(1) = power actuated (PG-67.4.1)
(2), (3), and (4) = pressure relief valve (PG-67.4.2)
(5) = superheater stop (PG-67.4.4)

Pressure Relief Valve Flow Capacity (minimum, based on rated capacity of boiler)
(1) = 10% – 30% (PG-67.4.1)
(2) = minimum of one valve (PG-68.1)
(2) + (3) when downstream to stop valve (5) = that required for independently fired superheaters (PG-68.3)
(2) + (3) + (4) = 100% – (1) (PG-67.4.2)

Pressure Relief Valve Opening Pressure (maximum)
(1) = (A), and (B) when there is stop valve (5) (PG-67.4.1)
(2), (3), and (4) = (A) + 17% (PG-67.4.2)
(5) = (A) (PG-67.4.1)

Alternate Requirements for Pressure Relief Valves

Pressure Relief Valve Flow Capacity (minimum, based on rated capacity of boiler)
(1) = 10% – 30% (PG-67.4.1)
(2) = one valve minimum (PG-68.1)
(2) + (3) when downstream to stop valve (5) = that required for independently fired superheaters (PG-68.3)
(4) = 10% total with minimum of two valves when there is a stop valve (5) (PG-67.5.3.3)
(2) + (4) = 10% with minimum of two valves when there is no stop valve (5) (PG-67.4.3.3)

Pressure Relief Valve Opening Pressure (maximum)
(1) = (A), and (B) when there is stop valve (5) (PG-67.4.1)
(2), (3), and (4) = (A) + 20% (PG-67.4.3.3)
(5) = (A) (PG-67.4.1)

Automatic Pressure Controls (PG-67.4.3)
(a) at (C) for normal operation under load (PG-67.4.3.2.1)
(b) at (A) + 10% to overide control (a) (PG-67.4.3.2.2)
(c) at (A) + 20% to shut off flow of fuel and feedwater (PG-67.4.3.2.3)
(d) pressure relief valves at (4) to shut off flow of fuel and feedwater by "fail-safe" power circuit (PG-67.4.3.4)

Note (2) minimum of one valve (PG-68.1)

Note (2) one valve minimum (PG-68.1)

Safety Valve Requirement

British Standard BS EN 12952-7:2002

5.1 Steam boiler

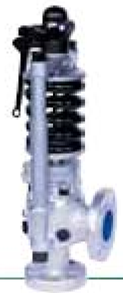
5.1.1 Each steam boiler and each isolatable heated compartment (e.g. reheater, superheater, economizer) shall be provided with at least one suitable safety device which shall ensure against excessive pressure. ..

5.1.5 1) Safety devices in accordance with 5.1.1 located at the superheater outlet shall be of sufficient capacity to prevent the allowable wall temperature of the superheater from being exceeded.

German Technical Rules for Steam Boilers (TRD) TRD 401

10.5 (1) Pressure relief devices rated for at least 25% of the required discharge capacity shall be located at the superheater outlet unless an excess of the allowable wall temperature of the superheater is prevented by another device.

GE Oil & Gas
Dresser Consolidated Safety Valves



Type 1700
Maxiflow* Safety Valve

The 1700 Maxiflow high-pressure safety valve is a premium product that is installed on a majority of power generating stations worldwide to help protect boilers from overpressure conditions.

Type 3500
Electromatic* Ball Valve

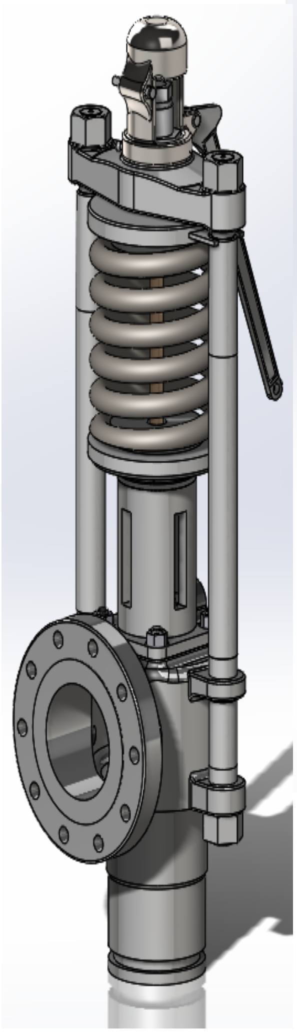
The type 3500 electromatic ball valve offers automatic or manual overpressure protection for steam boiler systems, and can also be used to assist start-up and shut-down venting. The new enhanced design includes a superior coating and manufacturing process that enhances leak free performance, and improves reliability and increases valve life.

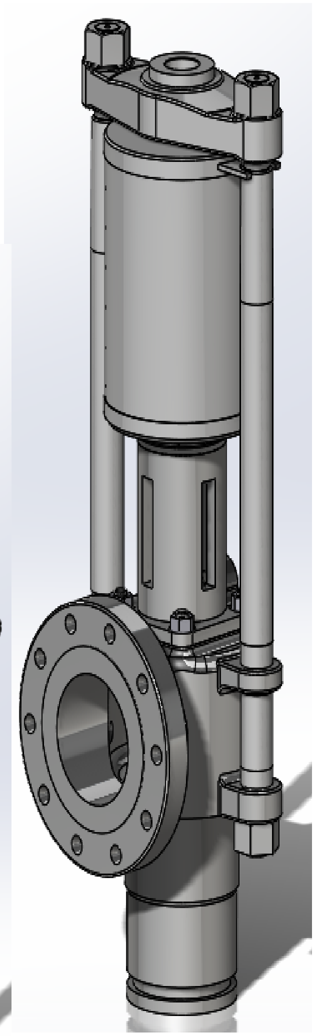
Type 2900-40
Pilot-Operated Safety Relief Valve

The type 2900-40 pilot-operated safety relief valve offers exceptional performance and meets demanding ASME Section I Economizer and Boiler Applications.

Proposed Valve Designs

- **Two valve types proposed.**
  - Spring design – seat leakage risks.
  - Pilot design – 1700 base design with a pilot design.
  - Dual outlet with either of these designs (reaction forces)
- **Similar current product: 1713 valve.**
  - 4500 class inlet, 300 class outlet.
  - 1 ½" Valve with #1 orifice.
    - Theoretical capacity 21 klb/hr @ 750 psig & 1400°F.
    - Superheated correction of 0.590
    - Proposed valves not designed to 4500 class dimensions.
- **Cover plate dome extended to reduce temperature at spring/piston.**
- Seating bushing min. wall thickness per EG045: 0.542 in.
  - Inconel 740H with 6.9 ksi Sy.
  - Current 1713 min wall: 0.102 in.
  - Requires capacity testing.





ISA Turbine Bypass - USA

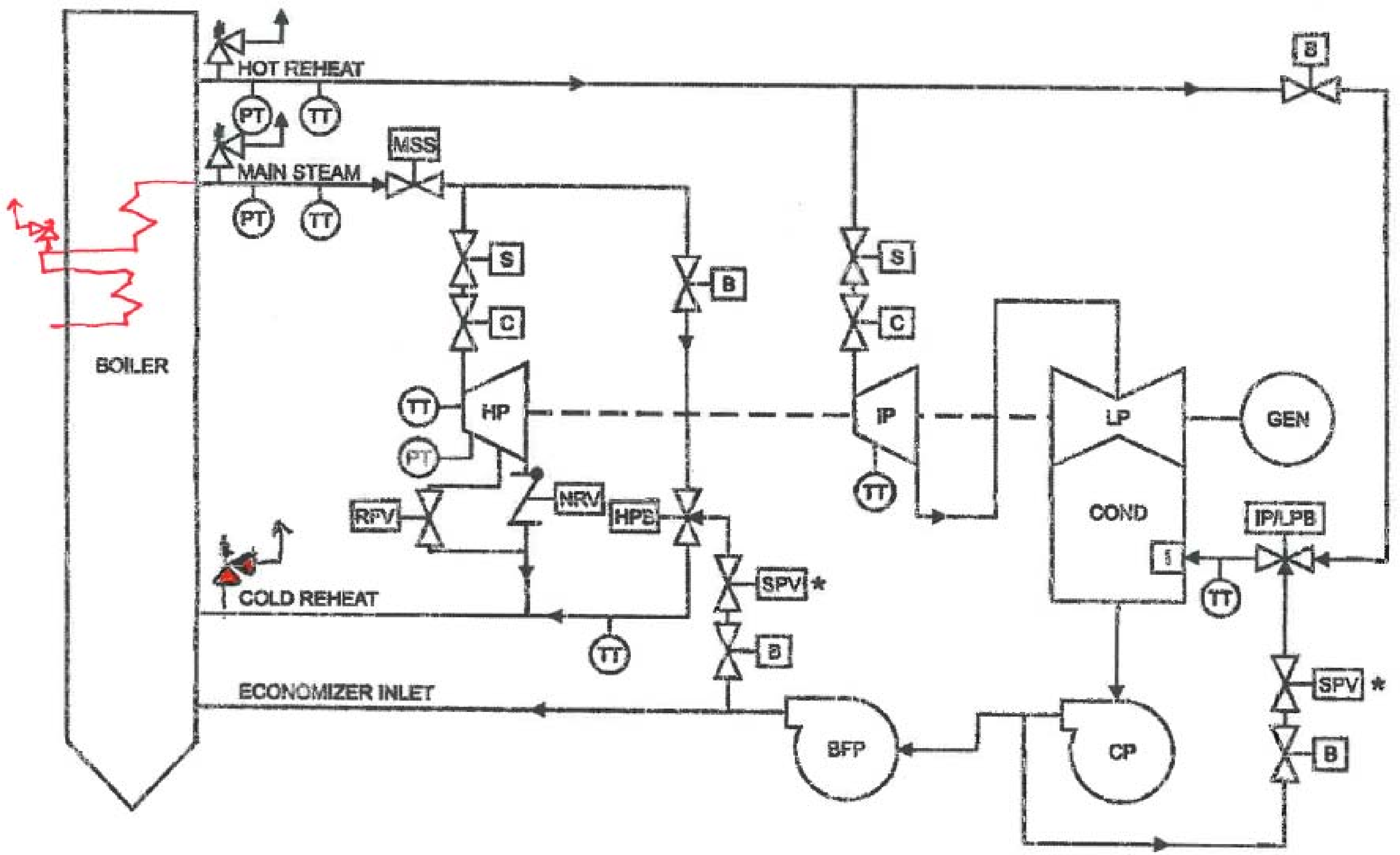
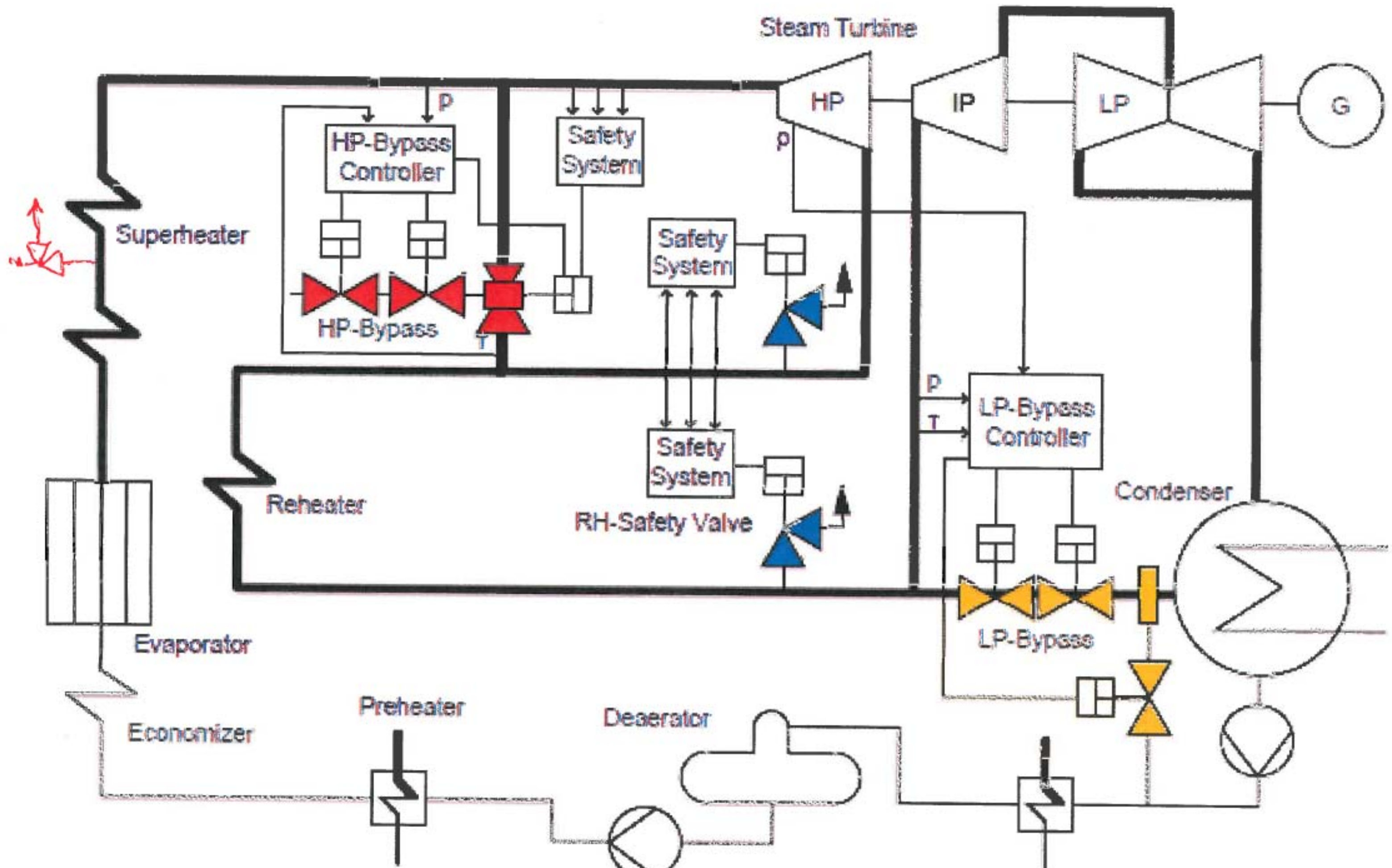


Figure E.2 — Turbine steam bypass system with combined pressure reducing and desuperheating valves

Turbine Bypass - Europe



Typical coal fired supercritical plant schematic e·on | Engineering

PP700 – WGFH TECHNICAL MEETING

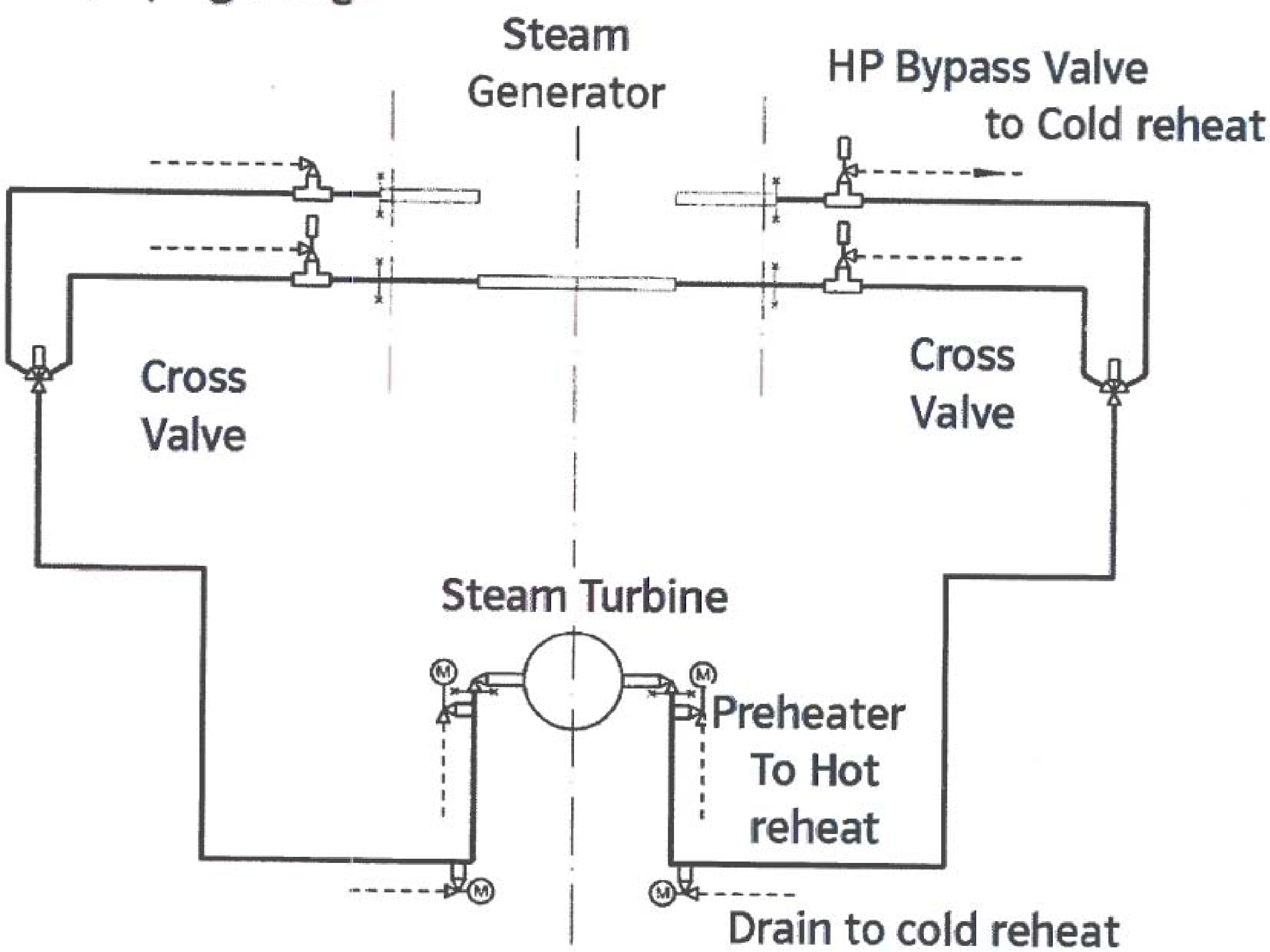
CRITICAL PIPING SYSTEMS

03. December 2008

Jörg Rainer Thümer, E.ON Engineering GmbH

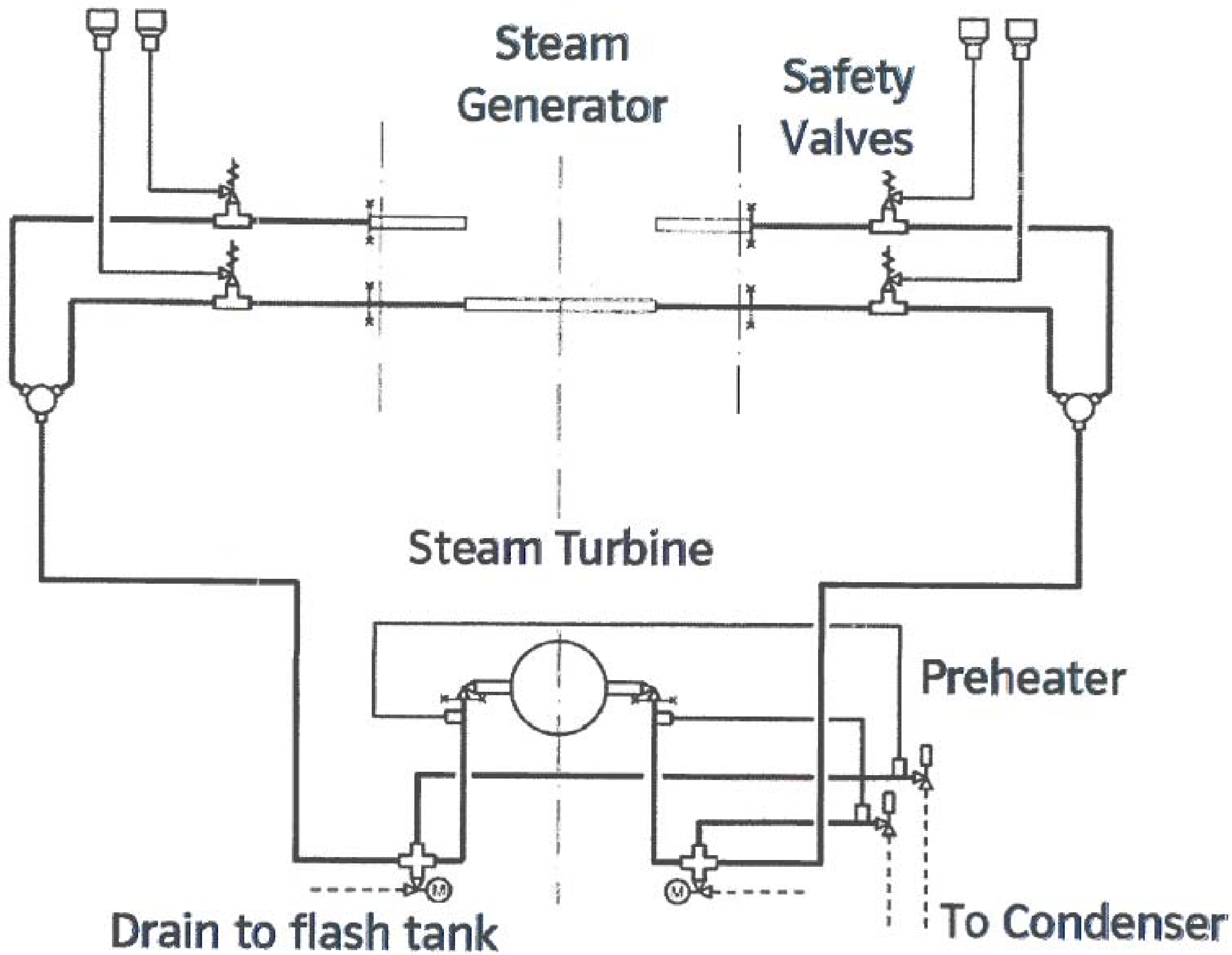
1. HP Steam System, Piping Design

Diagram



3. Hot Reheat System, Piping Design

Diagram



Conclusions

The AUSC ComTest Superheater design is deemed workable, provided a safety valve at 1400F can be obtained

or an exception called “Ohio Special” is allowed,

when an item in the design does not fit within the ASME Section I code.

Weitzel, Paul S

From:	Energy-Tech Magazine [editorial=woodwardbizmedia.com@mail67.atl71.mcdlv.net] on behalf of Energy-Tech Magazine [editorial@woodwardbizmedia.com]
Sent:	Tuesday, March 01, 2016 6:17 PM
To:	Weitzel, Paul S
Subject:	EXTERNAL: News to Know - ComTest facility phase 1 engineering for 760°C A-USC steam generator development

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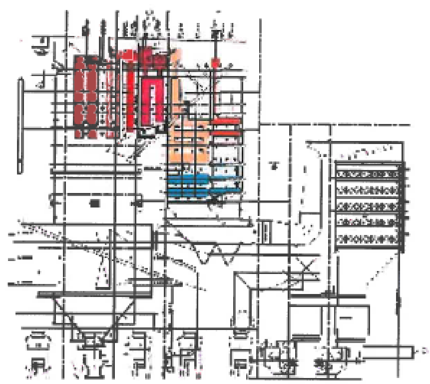
ERGY- TECH

Dedicated to the Engineering, Operations & Maintenance of Electr

016: Energy-Tech E-Newsletter

ASME: ComTest facility phase 1 engineering for 760°C A-USC steam generator development

By Paul S. Weitzel, P.E., Babcock & Wilcox Power Generation Group, Inc.



Babcock & Wilcox Power Generation Group, Inc. (B&W) has proposed and won a contract (DE-FE0024067) with the U.S. Department of Energy (DOE) to perform a pre-front-end engineering design (Pre-FEED) study for an advanced ultra supercritical (A-USC) steam superheater capable of producing (760°C) 1400°F steam as part of a planned Component Test Facility (ComTest). ComTest is a project that is being developed by the A-USC Boiler Materials Consortium (Consortium) which is made up by members including Alstom, B&W, Foster Wheeler, Babcock Riley, Electric Power Research Institute (EPRI), Energy Industries of Ohio (EIO) and the DOE. ComTest also includes General Electric as the remaining member of the A-USC Turbine Materials Consortium. Both consortiums meet jointly. The work of the two consortiums is supported by the members, the Ohio Coal Development Office (OCDO) and the DOE.

The goal of ComTest is to attain reliable operation at 760°C (1400°F) inlet steam conditions to a turbine integrated with the boiler superheater and other high temperature components requiring high alloy materials. The improvement to plant heat rate with A-USC is expected to be about 12% above the current state-of-the-art 600°C (1400°F) power plant and about 30% above the current U.S. fleet average. The project work by the consortium members has been conducted in a pre-competitive manner in order to develop the general data needs of the industry on these new alloy materials required for A-USC. A major purpose of ComTest is to put the materials and the plant components into first practice and provide an exercise of the supply chain and plant component design, fabrication, and construction using the alloy materials and accessories. The ComTest host site is planned to be at the Youngstown Thermal (YT) heating plant facility in Youngstown, Ohio. Europe, Japan, China, and India have all constructed or are in the process of developing component testing facilities for A-USC. The proposed U.S. ComTest would be the only program with a steam turbine and would provide a means of new design developments for US boiler and turbine suppliers and a training facility for operations and maintenance personnel. A utility advisory committee has been formed to review and council concerning ComTest planning. American Electric Power, Duke Energy, FirstEnergy, Southern Company and Tri-State Generation are members of the advisory committee.

Read more here ...

Thank You!

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330-860-1655