ArevaEPRDCPEm Resource

From: WELLS Russell D (AREVA NP INC) [Russell.Wells@areva.com]
Sent: Tuesday, March 31, 2009 6:47 PM
To: Getachew Tesfaye
Cc: Pederson Ronda M (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 106, FSAR Ch 10, Supplement 1
Attachments: RAI 106 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided responses to 4 of the 7 questions of RAI No. 106 on November 26, 2008. The attached file, "RAI 106 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to the remaining 3 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 106 Question 10.02-5 (Parts I, II and III).

The following table indicates the respective pages in the response document, "RAI 106 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 106 — 10.02-5 (Parts I, II and III)	2	3

This concludes the formal AREVA NP response to RAI 106, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

(Russ Wells on behalf of)
Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
New Plants Deployment
AREVA NP, Inc.
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From: Pederson Ronda M (AREVA NP INC)
Sent: Wednesday, November 26, 2008 2:05 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 106 (1265, 1262),FSAR Ch. 10

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 106 Response US EPR DC.pdf" provides technically correct and complete responses to 4 of the 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 106 Questions 10.03-1 (Part I), 10.03-1 (Part II), 10.03-1 (Part III) and 10.03-1 (Part IV).

The following table indicates the respective page(s) in the response document, "RAI 106 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 106 — 10.02-5 (Part I)	2	3
RAI 106 — 10.02-5 (Part II)	2	3
RAI 106 — 10.02-5 (Part III)	2	3
RAI 106 — 10.03-1 (Part I)	4	8
RAI 106 — 10.03-1 (Part II)	4	8
RAI 106 — 10.03-1 (Part III)	4	8
RAI 106 — 10.03-1 (Part IV)	4	8

A complete answer is not provided for 3 of the 7 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 106 — 10.02-5 (Part I)	March 31, 2009
RAI 106 — 10.02-5 (Part II)	March 31, 2009
RAI 106 — 10.02-5 (Part III)	March 31, 2009

Sincerely,

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, October 28, 2008 2:08 PM
To: ZZ-DL-A-USEPR-DL
Cc: Devender Reddy; John Segala; Peter Hearn; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 106 (1265, 1262),FSAR Ch. 10

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on October 20, 2008, and on October 28, 2008, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this

information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 362

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Response to

Request for Additional Information No. 106, Supplement 1

10/28/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 10.02 - Turbine Generator
SRP Section: 10.03 - Main Steam Supply System
Application Section: FSAR Ch. 10

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

Question 10.02-5:

I. FSAR Tier 2 Section 10.2A.2.9, "Overspeed Protection," states that two independent electrical over-speed devices are provided, one of which may be a conventional mechanical type device located on the turbine control shaft or an electrical overspeed protection system. The criteria specified in Items 2.C and 2.D of Section III, "Review Procedures," of SRP Section 10.2 states that a mechanical overspeed trip device will actuate the control, stop, and intercept valves at approximately 111 percent of rated speed. If the COL applicant selects the overspeed control system with two electrical over-speed trip devices, instead of one mechanical and one electrical, please address the following in the FSAR:

   a. Justify the diversity of the two electrical over-speed systems.

   b. Justify the utilization of the a second electrical device in lieu of a mechanical device.

   c. Confirm that the two systems do not share any common components or process inputs. If they do, provide an evaluation of the impact of failures of any such components.

   d. Describe any software used for the triple processors or performing trip logic actuation.

   e. Explain the diversity and defense-in-depth used to defend against a common cause failure (CCF) of the triple processor functions.

   f. Confirm the objectives of Test #174 are correctly described.

   Also, the reasoning is not clear for describing the two electrical trip devices in this alternate turbine design. With the two electrical trip devices for the emergency overspeed control, describe the differences of this alternate option from the primary design. The staff requests the applicant to clearly define in the FSAR the alternate design, and provide justification to call this an alternate design.

II. SRP Section 10.2, "Turbine Generator, Subsection II, "Acceptance Criteria," Item 1.C, states that the TG should have the capability to permit periodic testing of components important to safety while the unit is operating at rated load.

   FSAR Tier 2, Section 10.2A.2.12, Turbine Inservice Inspection and Testing," states that the main steam stop and control valves, reheat stop and intercept valves, and steam extraction no return valves are exercised on a frequency consistent with turbine manufacturer recommendations. However, the application did not state whether or not valve design is such that monthly exercising can be performed at full load per the SRP. Therefore, the staff requests the applicant to clarify in the FSAR the capability of the EPR turbine to be tested for each valve for a full stroke closed at 100 percent full power.

III. In order to meet the GDC 4 criteria, FSAR Tier 2 Section 10.2A.2.12, states that TG valves are exercised periodically and observed for valve motion. Tier 1 Figure 2.8.1-1 indicates that exercising a single control or stop valve would result in the isolation of flow from a steam line and steam generator.

   However, it is not clear from the FSAR, whether the TG stop or control valve in each of the main steam lines are arranged such that by closing a valve will allow diverting its steam flow to the other three. Therefore, the staff requests the applicant to describe in the FSAR, the details on the steam flow path during stop and control valve testing. Also, state in the FSAR, whether normal operation will utilize either full or partial arc control.

Response to Question 10.02-5:

The alternate turbine-generator design described in U.S. EPR FSAR Tier 2, Section 10.2A is no longer part of the U.S. EPR design. The following changes will be made to the U.S. EPR FSAR:

- Revise U.S. EPR FSAR Tier 2, Section 1.2.3.6.1, Section 10.0, Section 10.2, and Section 10.4.7.
- Delete U.S. EPR FSAR Tier 2, Section 10.1A, Section 10.2A, and Section 10.4.7A.
- Revise U.S. EPR FSAR Tier 2, Table 1.8-2—U.S. EPR Combined License Information Items and Table 10.3-3—Main Steam Branch Piping (2.5 Inches and Larger), Downstream of MSIV.
- Delete U.S. EPR FSAR Tier 2, Figures 1.2-29, 1.2-31, 1.2-33, 1.2-35, 1.2-38, 1.2-39, 1.2-41, 1.2-44, 1.2-45, 1.2-47, and 1.2-49.

FSAR Impact:

U.S. EPR FSAR, Tier 2 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

The onsite power system is described in further detail in Section 8.3.

1.2.3.6 Power Conversion Systems

1.2.3.6.1 Turbine-Generator

The turbine-generator (TG) converts the thermal energy supplied by the main steam system into electrical energy. It is designed for base load operation, but has load change characteristics compatible with the I&C system which coordinates TG and reactor operation. The TG is designed to accept a sudden loss of full load without exceeding design overspeed.

RAIs 91-S3, 100-S2, & 106-S1

~~Two turbine options are described in Chapter 10 for selection by the COL applicant that references the U.S EPR design certification.~~ The ~~first~~ turbine ~~option~~ design presented in Section 10.2 consists of an 1800-rpm single-flow high-pressure element and a single-flow intermediate-pressure element (HP/IP) in a common casing and three double-flow low-pressure elements in tandem. ~~The second turbine option design presented in Section 10.2A consists of an 1800 rpm double-flow high-pressure element and three double-flow low-pressure elements in tandem.~~ Moisture separation and reheating of the steam are provided by two, combined moisture separator reheater (MSR) assemblies. The generator is coupled directly to the turbine shaft. The generator has a hydrogen cooled rotor and a water cooled stator. It is equipped with a collector for the static excitation system directly coupled to the generator shaft.

The TG is described in further detail in Section 10.2.

1.2.3.6.2 Main Steam System

The main steam system (MSS) routes the steam produced in the four SGs through individual lines to the high pressure (HP) turbine stop valves. Each main steam line has a main steam isolation valve (MSIV) located just outside containment. A bypass line is provided around each MSIV for warming the piping system downstream of the valve during startup. Overpressure protection on each main steam line is provided by a MSRT and two main steam safety valves (MSSV). Each MSRT consists of a quick-opening main steam relief isolation valve (MSRIV) and a downstream main steam relief control valve (MSRCV).

During power operation, steam flow is a function of turbine load. In the case of an imbalance between turbine load and core power, excess steam is dumped to the condenser via the turbine bypass valves. Upon turbine trip, the reactor trips and the MSS removes residual heat by steam dump to the condenser via the turbine bypass or to the atmosphere via the MSRT until RHRS entry conditions are reached.

The MSS is described in further detail in Section 10.3.

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-29—~~[[Turbine Building General Arrangement Plan View Elevation ( )43' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-31—~~[[Turbine Building General Arrangement Plan View Elevation ( )23' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-33—~~[[Turbine Building General Arrangement Plan View Elevation 0' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-35—~~[[Turbine Building General Arrangement Plan View Elevation 38' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-38—~~[[Turbine Building General Arrangement Plan View Elevation 65' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-39—~~[[Turbine Building General Arrangement Plan View Elevation 65' 0" with Equipment (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-41—~~[[Turbine Building General Arrangement Plan View Elevation 162' 0" (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-44—~~[[Turbine Building General Arrangement Section A-A (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-45—~~[[Turbine Building General Arrangement Section A-A with Equipment (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-47—~~[[Turbine Building General Arrangement Section B-B (Alternate)]]~~Figure Deleted

Figure Deleted

RAIs 91-S3, 100-S2, & 106-S1

Figure 1.2-49—~~[[Turbine Building General Arrangement Section C-C (Alternate)]]~~Figure Deleted

Figure Deleted

10.0 Steam and Power Conversion System

This section describes the steam and power conversion system for the U.S. EPR.

~~Depending on site-specific data, equipment availability and utility requirements, alternative designs for the steam and power conversion system may be considered by the applicant for a combined license (COL). An optional design description for portions of the U.S. EPR steam and power conversion system is provided in alternative Section 10.1A, Section 10.2A and Section 10.4.7A. These alternative sections outline the changes in the steam and power conversion system configuration to support the use of an optional turbine-generator design. Those areas of the U.S. EPR steam and power conversion system not affected by selection of the optional turbine-generator design are so identified within the alternative sections. Only one of the design descriptions are used by the applicant within the site-specific FSAR.~~

~~A COL applicant that references the U.S. EPR design certification will select Section 10.1, Section 10.2 and Section 10.4.7 or Section 10.1A, Section 10.2A and Section 10.4.7A for inclusion in the COL FSAR as applicable to the chosen turbine-generator design option.~~

RAIs 91-S3, 100-S2, & 106-S1

10.1 Summary Description

The steam and power conversion system removes energy from the reactor coolant in the steam generators and converts it into electric power in the turbine-generator. The steam and power conversion system comprises the following process systems:

- Turbine-generator (TG).
- Main steam supply system (MSSS).
- Main condensers.
- Main condenser evacuation system (MCES).
- Turbine gland sealing system (TGSS).
- Turbine bypass system (TBS).
- Circulating water system (CWS).
- Condensate cleanup system.
- Condensate and feedwater system.
- Steam generator blowdown system (SGBS).
- Emergency feedwater system (EFWS).

~~10.1A~~ ~~Summary Description~~

~~This section is the same as Section 10.1 with the exception of the last paragraph which is revised as follows:~~

~~Figure 10.1A-1 – Design Heat Balance for Steam and Power Conversion System Cycle, provides an overall system flow diagram of the power cycle and the design heat balance. Figure 10.1A-2 – Valves Wide Open Heat Balance for Steam and Power Conversion System Cycle, provides the valves wide open (VWO) heat balance for the steam and power conversion cycle. Table 10.1A-1 – Major Steam System Parameters and Turbine-Generator Design Data, provides the major steam system parameters at rated thermal power along with TG design data.~~

~~10.1A.1~~ ~~General Description~~

~~This section is the same as Section 10.1.1 with the exception of the first paragraph which is revised as follows:~~

~~Steam generated in the four SGs is supplied by the MSSS to the high pressure (HP) turbine through stop and control valves which regulate steam flow. After expanding across the HP turbine blading, exhaust steam is reheated in two moisture separator reheaters (MSR). The MSRs supply the three low pressure (LP) turbines through stop and intercept valves.~~

Section Deleted

RAIs 91-S3, 100-S2, & 106-S1

~~Table 10.1A-1—Major Steam System Parameters and Turbine-Generator Design Data~~

~~Major Steam System Parameters~~	~~Values~~
~~Steam pressure~~	~~1110.9 psia~~
~~Steam flow~~	~~20,684,700 lb/hr~~
~~Steam enthalpy~~	~~1186.6 btu/lb$_m$~~
~~Feedwater temperature~~	~~446°F~~
~~Turbine-Generator Design Data~~	~~Values~~
~~Operating speed~~	~~1800 rpm~~
~~Frequency~~	~~60 hz~~
~~Generator output~~	~~1710 MW~~
~~Power factor~~	~~0.90 lagging~~
~~Voltage~~	~~27 kV nominal~~

RAIs 91-S3, 100-S2, & 106-S1

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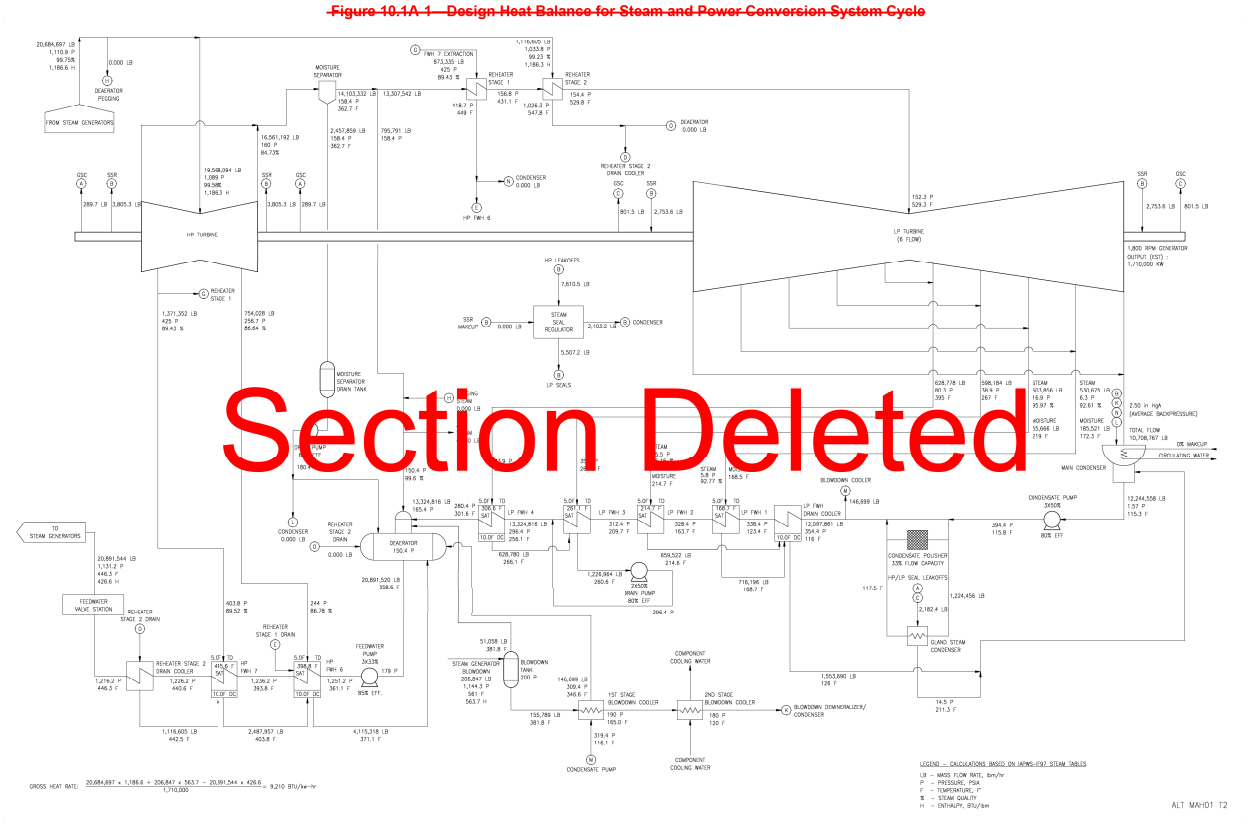
Next File

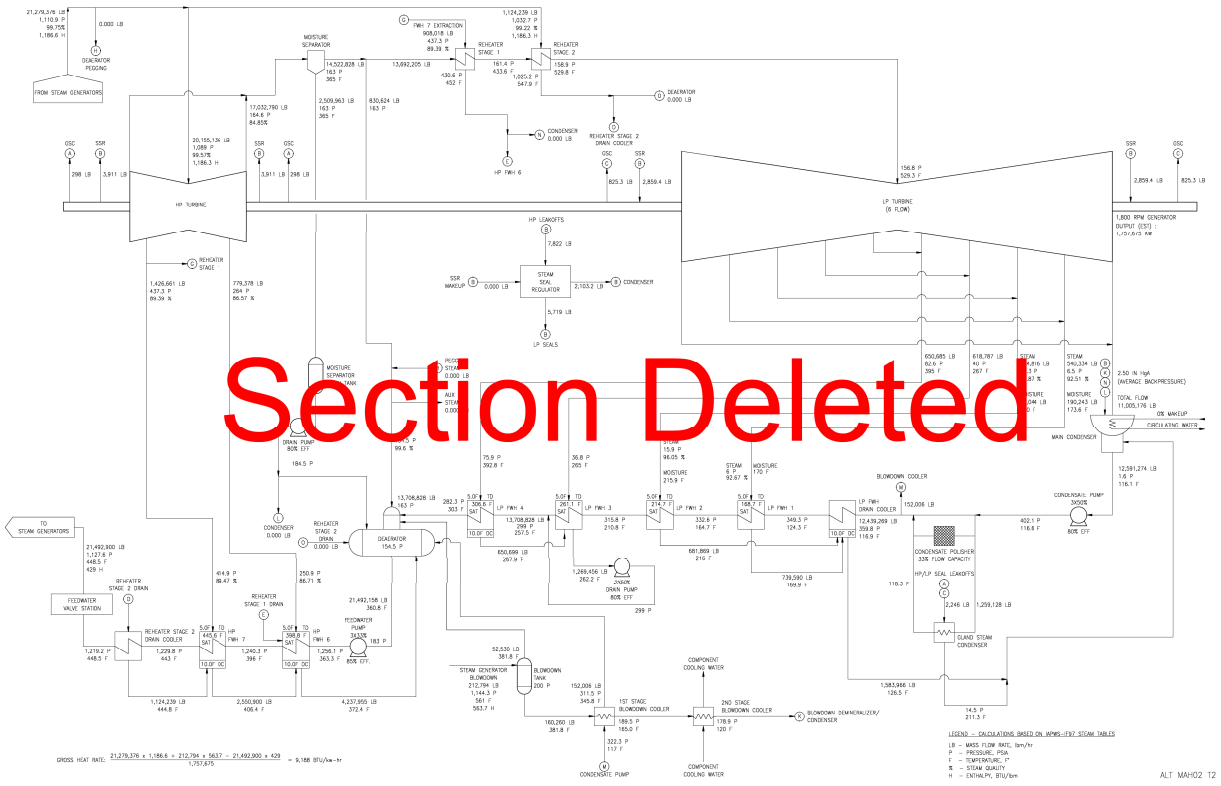
RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.1A-1—Design Heat Balance for Steam and Power Conversion System Cycle~~



RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.1A-2—Valves Wide Open Heat Balance for Steam and Power Conversion System Cycle~~



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Next File

10.2 Turbine-Generator

~~Depending on site specific data, equipment availability and utility requirements, alternative designs for the steam and power conversion system may be considered by the applicant for a combined license (COL). An optional design description for the turbine generator (TG) is provided in Section 10.2A. The alternative section outlines the changes to support the use of an optional TG design. Those areas of the U.S. EPR design not affected by selection of the optional TG design are so identified within the alternative section. Only one of the design descriptions is used by the applicant within the site-specific FSAR.~~[1]

RAI 91 S3,
RAI 100 S2,
RAI 106 S1

This section describes the turbine-generator (TG) for the U.S. EPR.

The TG converts the thermal energy supplied by the main steam supply system (MSSS) into electrical energy.

The TG package interfaces with the MSSS at the high pressure (HP) turbine stop valves. It interfaces with the condensate and feedwater system at the low pressure (LP) turbine exhausts to the condenser, at the turbine extraction connections to the feedwater heaters, and at the moisture separator reheater (MSR) condensate and drain tank outlet connections to feedwater heaters and drain coolers. The generator terminals and enclosure connect to the isolated phase buses and ducts. The TG control system interfaces with the plant process automation system (PAS).

10.2.1 Design Bases

The TG performs no safety-related functions and therefore has no nuclear safety-related design bases.

The TG principal design features include:

- The TG is designed for base load operation. The design of the TG has provisions for load follow operation for future consideration.
- The TG is capable of a load step (increase or decrease) of 10 percent of rated load below a 50 percent power level or a ramp rate (increase or decrease) of 5 percent per minute of actual load when the power level is in the range of 50 to 100 percent, without necessitating a turbine trip.
- The TG is designed to trip automatically under abnormal conditions.
- The TG load change characteristics are compatible with the instrumentation and control system which coordinates TG and reactor operation.

1. ~~This paragraph denotes instructions for reviewers and other readers. It is not an integral part of the text.~~

~~10.2A Turbine Generator~~

~~Depending on site specific data, equipment availability and utility requirements, alternative designs for the steam and power conversion system may be considered by the applicant for a combined license (COL). An optional design description for the turbine generator (TG) is provided in Section 10.2A. The alternative section outlines the changes to support the use of an optional TG design. Those areas of the U.S. EPR design not affected by selection of the optional TG design are so identified within the alternative section. Only one of the design descriptions is used by the applicant within the site-specific FSAR[1].~~

~~This section is the same as for the U.S. EPR (see Section 10.2).~~

~~10.2A.1 Design Bases~~

~~Same as for the U.S. EPR (see Section 10.2.1).~~

~~10.2A.2 General Description~~

~~The TG package is shown in Figure 10.2A-1—Turbine-Generator System. Performance characteristics are provided in Table 10.2A-1—Performance Characteristics.~~

Section Deleted

~~The design and valves wide open (VWO) heat balances are presented in Section 10.1A (refer to Figure 10.1A-1 and Figure 10.1A-2).~~

~~The turbine consists of an 1800 rpm, double-flow, high pressure (HP) element and three double-flow, low pressure (LP) elements in tandem. The generator has a hydrogen-cooled rotor and a water-cooled stator. The generator is directly coupled to the turbine shaft. It is equipped with a collector for the static excitation system directly coupled to the generator shaft. Moisture separation and reheating of the steam is provided between the HP turbine and LP turbines by two combined MSR assemblies. The MSRs have two stages of reheating.~~

~~10.2A.2.1 Component Description~~

~~Same as for the U.S. EPR (see Section 10.2.2.1).~~

~~10.2A.2.1.1 TG Package Equipment~~

~~The TG package equipment includes the HP turbine stop and control valves, reheat stop and intercept valves, MSRs, MSR drain tanks, steam lead piping, cold reheat piping, hot reheat piping, TG control system static excitation system and accessory~~

1. ~~This paragraph denotes instructions for reviewers and other readers. It is not an integral part of the text.~~

~~equipment listed in Section 10.2A.2.1.2. A COL applicant that references the U.S. EPR design certification, and selects the alternate turbine, will provide a list of material specifications for the alternate turbine-generator components.~~

~~HP Turbine~~

~~The HP turbine design features a double flow HP turbine. The HP steam admissions are located at the center of the turbine and the exhausts at its two extremities. The HP turbine receives steam through four steam leads, one from each main steam control valve outlet. The steam is expanded axially across the stationary and rotating blades. Extraction steam from the turbine at two locations supplies the sixth and seventh stages of feedwater heating and the heating steam to the first stage reheaters. HP turbine exhaust steam is collected in four cold reheat pipes (two per MSR). Most of the exhaust steam is routed to the MSR inlet, but part of it is diverted and supplies the fifth stage of feedwater heating. After removal of the water content and reheating in the MSRs, the steam is directed through six (three per MSR) hot reheat steam pipes to the three LP turbines.~~

~~LP Turbines~~

~~Each of the three LP turbines receives steam from the MSR outlets. The LP turbines are identical double-flow turbines. The LP turbines are constructed of an inner casing and outer casing. The inner casing structure supports the LP blade carriers and the LP bearings. The outer casing collects the steam exhausted from the last LP stages. The outer casing is installed independently of the inner casing and is welded to the condenser, which is directly anchored to the foundation slab. The outer casing moves freely with condenser thermal movements. All connections between the outer casing and inner casing have flexible expansion joints that maintain vacuum tightness. The casing is provided with a piping header that allows water to be injected into the exhaust structures and prevents an excessive temperature rise during no-load or low-load operation. Each LP turbine has four extraction stages that are routed to the LP feedwater heaters.~~

Section Deleted

~~HP Main Stop and Control Valves~~

~~Same as for the U.S. EPR (see Section 10.2.2.1.1).~~

~~Reheat Stop and Intercept Valves~~

~~The reheat stop and intercept valves are arranged between the MSRs and LP turbine inlets. The LP steam admission is controlled by six sets of two series-mounted individual valves. One valve fulfills a protection function (stop valve), and the other, a control and protection function (intercept valve). The valves are butterfly type valves. The disc of each valve can rotate 90 degrees, from closed to open position, by means of a servomotor. The stop and intercept valves close in approximately 0.30 seconds.~~

Section Deleted

~~**Generator**~~

~~The generator is directly driven by the turbine and supplies the step-up transformer with high voltage. It is a four-pole machine and is cooled by internal hydrogen circulation and stator cooling water. The field winding is directly cooled by hydrogen gas. The stator winding is directly cooled by an internal circulation of deionized water (stator cooling water). The auxiliaries include cooling system, gas supply and shaft sealing circuits. The generator static excitation system is controlled by an automatic voltage regulator. The frame, which constitutes the outer envelope, is made of fabricated steel. The outer casing is gas-tight after field assembly. Hydrogen detectors are located around the generator hydrogen system to provide warning of a hydrogen leak. The generator hydrogen system is designed in accordance with NFPA 55 (Reference 2). The generator rotor is forged from solid alloy steel stock.~~

~~**Moisture Separator Reheaters**~~

~~Two cylindrical-shell, combined MSRs are installed in the steam path between the HP and LP turbines. The MSRs dry and reheat the HP turbine steam exhaust. Cold reheat steam is piped into the MSR. Moisture is removed in chevron type moisture separators, drained to the moisture separator drain tanks and then drained or pumped to the feedwater deaerator storage tank. The dry steam then passes across two stages of reheaters, which are supplied with turbine extraction steam (first reheating stage) and main steam (second reheating stage). The steam is then routed to the hot reheat stop valves/intercept valves, which are located just upstream of the LP turbine inlet nozzles. The reheaters drain via drain tanks to the HP heaters. Safety valves are provided on the MSR for overpressure protection.~~

~~**10.2A.2.1.2 TG Accessories**~~

~~Same as for the U.S. EPR (see Section 10.2.2.1.2).~~

~~**10.2A.2.2 TG Foundation**~~

~~The TG foundation structure consists of a top reinforced concrete mat resting on spring elements. The mat on springs provides vibration isolation from the other Turbine Building structures. The top mat consists of longitudinal beams and transverse beams and carries the weight of the HP turbine, LP turbines and generator. The total machine weights, operational static and dynamic forces, as well the emergency forces, are transmitted from the top mat through spring elements into the substructure. The foundation is designed to withstand normal loads and abnormal loads under all TG operational conditions. Anchoring systems are designed to withstand these maximum loads.~~

~~The TG foundation is referred to as a low tuned foundation. This means that the fundamental vertical frequency is much lower than the rotational speed of the shaft.~~

~~The turbines and generator are mounted on steel base plates, which are grouted and bolted to the top mat. Transverse and axial guides are provided to prevent misalignment of the shaft due to thermal expansion, external pipe forces or an earthquake.~~

~~Intermediate steel platforms, which are also vibration isolated, are located below the turbines and the generator to provide access for the operational inspection of valves and other auxiliary equipment.~~

~~Transverse walls are located below the condenser bottom plate to transmit the weight and forces to the base mat of the Turbine Building. Each condenser shell is rigidly attached to its LP turbine exhaust and is supported on the basemat of the Turbine Building.~~

~~10.2A.2.3 Cycle Description~~

~~The main steam flows from the MSSS through the four combined main steam stop and control valves into the HP turbine. After expanding across the HP blading, the steam passes through the steam exhaust branches into the cold reheat piping system. There is a preseparator in each cold reheat line. Steam passes to each of the two MSRs in two cold reheat lines.~~

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~~The first stage reheat steam is supplied from the HP turbine through an extraction line. The second stage reheat steam is supplied from the MSSS or from connections downstream of the stop valve. Condensed steam from the second stage reheater is drained to a drain tank and then flows to the shell side of a drain cooler, which is the last stage of feedwater heating. Condensed steam from the first stage reheater is drained to a drain tank and then flows to the shell side of the No. 6 feedwater heaters. The moisture removed from the MSRs is drained to a drain tank, and then drained or pumped to the deaerator.~~

~~Two extraction lines are connected to the HP turbine. The steam goes to the HP feedwater heaters No. 6 and No. 7. The steam passes from the two MSRs into the hot reheat piping system and then through six LP stop-intercept butterfly valve assemblies to the three LP turbines.~~

~~Each LP turbine has a total of four extraction stages. No check valves are necessary in the two latter extraction lines since the pressure level in the associated feedwater heaters is low. One free-swinging and one actuator-assisted swing check valve are provided in each of the other extraction lines.~~

~~The turbine casings, turbine valves and turbine piping are provided with drain valves or traps for removing condensate during startup and transient operation.~~

~~The turbine shaft seals are fitted with connections to the gland steam system. The leakage from the main steam valve glands flows to the gland steam system. The glands of the intercept valves are connected to the gland steam system.~~

~~10.2A.2.4 Excitation System~~

~~A static excitation system incorporates automatic voltage regulating, excitation cubicles and three single phase excitation potential transformers connected to a three phase transformer bank. Also included is an isolated phase bus duct connecting the excitation transformer and the excitation cubicles, which also connect the excitation cubicles with the slip rings. The excitation transformers are dry type and are enclosed in indoor enclosures. Cooling of excitation equipment is by forced air cooling or forced air-to-water cooling.~~

~~10.2A.2.5 TG Control System~~

~~Same as for the U.S. EPR (see Section 10.2.2.5).~~

~~10.2A.2.6 Speed Control~~

~~Same as for the U.S. EPR (see Section 10.2.2.6).~~

~~10.2A.2.7 Load Control~~

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~~Same as for the U.S. EPR (see Section 10.2.2.7).~~

~~10.2A.2.8 Valve Control~~

~~The flow of main steam entering the HP turbine is controlled by four stop valves and four governing control valves. Each stop valve is controlled by an electro-hydraulic actuator, so that the valve is either fully open or fully closed. The function of the stop valves is to shut off the steam flow to the turbine when required. Actuation of the emergency trip system devices closes the stop valves.~~

~~The turbine control valves are positioned by electro-hydraulic servo actuators in response to signals from their respective flow control unit. The flow control unit signal positions the control valves for wide-range speed control through the normal turbine operating range and for load control after the TG unit is synchronized.~~

~~The reheat stop and intercept valves, located in the hot reheat lines at the inlet of the LP turbines, control steam flow to the LP turbines. During normal operation of the turbine, the reheat stop and intercept valves are fully open. The intercept valve flow control unit positions the valve during startup and normal operation and closes the valve rapidly on loss of turbine load. The reheat stop valves close completely on turbine overspeed and turbine trip.~~

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~~10.2A.2.9 Overspeed Protection~~

~~A protective trip system is provided to quickly close the main stop, control, reheat stop and intercept valves in the event of an unsafe condition or to provide overspeed protection. The system is designed to minimize false and spurious trips during normal operation and testing of the trip system. A power load imbalance function is provided, which compares turbine and generator load and initiates an appropriate momentary intercept valve closure when the turbine load exceeds the generator load by a specified amount.~~

~~Two independent overspeed trip devices are provided, one of which may be a conventional mechanical type device located on the turbine control shaft or an electrical overspeed protection system.~~

~~The first overspeed trip device fully closes the valves at about 110 percent of rated speed. An independent and redundant backup electrical overspeed trip circuit is provided to fully close these valves at about 111 percent of rated speed. The TG rotor is designed for a maximum speed of 120 percent of rated speed.~~

~~The actuation of the turbine protection system does not rely on components in the electro-hydraulic control system. Conversely, turbine trip initiation devices are not used for normal control of the unit.~~

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~~Provisions for on-line testing of the emergency trip system, including individual trip devices, are provided.~~

~~After receipt of a trip signal, the hydraulic controllers for the main stop, control, reheat stop and intercept valves sufficiently close off these valves quickly to preclude an unsafe turbine overspeed. The response of the controllers considers the residual steam in the piping between the valves and the turbine.~~

~~10.2A.2.10 Turbine Supervisory Instrumentation~~

~~Same as for the U.S. EPR (see Section 10.2.2.10).~~

~~10.2A.2.11 Other Protective Systems~~

~~Same as for the U.S. EPR (see Section 10.2.2.11).~~

~~10.2A.2.12 Turbine Inservice Inspection and Testing~~

~~Major TG system components are readily accessible for inspection and are available for testing during normal plant operation.~~

~~The turbine inservice inspection and test program is used for the governor and overspeed protection system to provide reasonable assurance that flaws or component~~

~~failures are detected in the overspeed sensing and tripping subsystems, main steam control and stop valves, reheat steam intercept and stop valves or extraction steam non-return valves; or any other condition that could lead to an overspeed condition above that specified by the design overspeed. The inservice inspection program for operability of the governor and overspeed protection system includes, at a minimum, the following provisions:~~

- ~~For turbine governor and overspeed protection systems, at intervals of approximately three and one-third years, during refueling or maintenance shutdowns coinciding with the inservice inspection schedule required by the ASME BPV Code, Section XI, (Reference 3) for reactor components, at least one main steam stop valve, one main steam control valve, one reheat stop valve, one reheat intercept valve and one of each type of steam extraction valve are dismantled for examination. Visual and surface examinations of valve seats, disks and stems are conducted. Valve bushings are inspected and cleaned and bore diameters are checked for proper clearance. If any valve is shown to have flaws or excessive corrosion or improper clearances, the valve are repaired or replaced. Other valves of that type are also dismantled and inspected.~~

- ~~The main steam stop and control valves, reheat stop and intercept valves, and steam extraction no return valves are exercised on a frequency consistent with turbine manufacturer recommendations.~~

- ~~The components of the overspeed trip are tested on a frequency consistent with turbine manufacturer recommendations.~~

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~~10.2A.3 Turbine Rotor Integrity~~

~~Same as for the U.S. EPR (see Section 10.2.3).~~

~~10.2A.3.1 Materials Selection~~

~~The turbine rotor is made from a material and by a process that tends to minimize flaw occurrence and maximize fracture toughness properties, such as a NiCrMoV alloy or equivalent alloy processed by vacuum melting or vacuum degassing. The material is examined and tested to meet the following criteria:~~

- ~~Chemical analysis is performed for each forging. Elements that have a deleterious effect on toughness, such as sulfur and phosphorus, are controlled to low levels.~~

- ~~The 50 percent fracture appearance transition temperature (FATT) as obtained from Charpy tests performed in accordance with specification ASTM A370 (Reference 9) or equivalent standard is no higher than 0°F for low-pressure turbine rotors. The nil-ductility transition (NDT) temperature obtained in accordance with specification ASTM E208-95a (Reference 10) or equivalent standard may be used in lieu of FATT. NDT temperatures are no higher than -30°F.~~

- ~~The Charpy V-notch (C_v) energy at the minimum operating temperature of each low-pressure rotor in the tangential direction is at least 60 ft-lb. A minimum of~~

~~three C_v specimens are tested in accordance with specification ASTM A370, Reference 9, or equivalent standard.~~

~~A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the turbine rotor after the site-specific turbine has been procured.~~

~~10.2A.3.2 Fracture Toughness~~

~~As noted in Section 10.2A.3.1, a suitable material toughness is obtained through the use of selected materials to produce a balance of adequate material strength and toughness and maintain a reasonable level of safety, while simultaneously providing high reliability, availability and efficiency during operation.~~

~~The low-pressure turbine disk rotor fracture toughness properties meet the following criteria.~~

~~The ratio of the fracture toughness (K_{Ic}) of the rotor material to the maximum tangential stress at speeds from normal to design overspeed are at least 2 in~~2 √in~~, at minimum operating temperature. Bore stress calculations include components due to centrifugal loads, interference fit and thermal gradients. Sufficient warm up time is specified in the turbine operating instructions to provide reasonable assurance that toughness is adequate to prevent brittle fracture during startup. Fracture toughness properties are obtained by any of the following methods:~~

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- ~~Testing of the actual material of the turbine rotor to establish the K_{Ic} value at normal operating temperature.~~
- ~~Testing of the actual material of the turbine rotor with an instrumented Charpy machine and a fatigue precracked specimen to establish the K_{Ic} (dynamic) value at normal operating temperature. If this method is used, K_{Ic} (dynamic) is used in lieu of K_{Ic} (static) in meeting the toughness criteria.~~
- ~~Estimating of K_{Ic} values at various temperatures from conventional Charpy and tensile data on the rotor material using methods are presented in J. A. Begley and W. A. Logsdon, Scientific Paper 71-1E7-MSLRF-P1 (Reference 5). This method of obtaining K_{Ic} is used only on materials which exhibit a well-defined Charpy energy and fracture appearance transition curve and are strain-rate insensitive.~~
- ~~Estimating "lower bound" values of K_{Ic} at various temperatures using the equivalent energy concept developed by F. J. Witt and T. R. Mager, ORNL-TM-3894 (Reference 6).~~

~~Low pressure shrunk-on disk rotors are designed to prevent stress corrosion cracking through design features, material, quality, stress limitation and control of steam purity.~~

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~~A COL applicant that references the U.S. EPR design certification will provide applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and the fracture toughness properties after the site-specific turbine has been procured.~~

~~10.2A.3.3 High Temperature Properties~~

~~Same as for the U.S. EPR (see Section 10.2.3.3).~~

~~10.2A.3.4 Turbine Rotor Design~~

~~The rotor of the HP turbine consists of a forged, monobloc shaft with forged-on coupling flanges with the moving blades held in slots.~~

~~The rotors of the LP turbines are of the built-up type with the moving blades held in slots. The individual rotor segments and coupling flanges are shrink-fitted to the shaft core.~~

~~LP shrunk-on-disk rotors have a high resistance to stress corrosion cracking due to design features, material, quality stress limitation and control of steam purity. The first lateral critical speed of the LP turbine rotors is below the operating speed.~~

~~The turbine assembly is designed to withstand normal conditions, anticipated transients, and accidents resulting in a turbine trip without loss of structural integrity. The design of the turbine assembly meets the following criteria:~~

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- ~~The design overspeed of the turbine is 120 percent of rated speed, which is higher than the highest anticipated speed resulting from a loss of load. The mechanical overspeed trip device fully closes the valves at about 110 percent of rated speed. An independent and redundant backup electrical overspeed trip circuit is provided to fully close these valves at about 111 percent of rated speed.~~
- ~~The combined stresses of low-pressure turbine rotor at design overspeed due to centrifugal forces, interference fit and thermal gradients do not exceed 75 percent of the minimum specified yield strength of the material, or 75 percent of the measured yield strength in the weak direction of the materials if tensile tests are performed on the actual rotor material.~~
- ~~The turbine shaft bearings are able to withstand any combination of the normal operating loads, anticipated transients and accidents resulting in a turbine trip.~~
- ~~The natural critical frequencies of the turbine shaft assemblies between zero speed and 20 percent overspeed are controlled by design and during operation to minimize adverse effects to the unit.~~
- ~~The turbine rotor design facilitates inservice inspection of high stress regions, including bores and keyways, without the need for removing the disks from the shaft.~~

RAIs 91-S3, 100-S2, & 106-S1

~~10.2A.3.5~~ ~~Turbine Rotor Preservice Inspections and Testing~~

~~Except for the addition of the following bullet, this section is the same as for the U.S. EPR (see Section 10.2.3.5).~~

- ~~Finish machined bores, keyways and drilled holes are subjected to magnetic particle or liquid penetrant examination. No flaw indications in keyway or hole regions are allowed.~~

~~10.2A.3.6~~ ~~Turbine Rotor Inservice Inspection Program Plan~~

~~A turbine rotor inservice inspection program detects rotor or disk flaws that can lead to brittle failure at or below design speed in the steam turbine rotor assembly. In accordance with the turbine manufacturer's procedures, the turbine rotor inservice inspection program uses visual, surface and volumetric examinations to inspect turbine components such as couplings, coupling bolts, LP turbine shafts, blades and disks, and HP rotors. The inspections are performed during plant shutdown on an interval consistent with the inservice inspection schedules in Reference 3 and be consistent with inspection intervals from the turbine manufacturer's turbine missile analysis.~~

~~A COL applicant that references the U.S. EPR design certification will provide the site specific turbine rotor inservice inspection program consistent with the recommendations of the manufacturer.~~

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~~10.2A.4~~ ~~Safety Evaluation~~

~~Same as for the U.S. EPR (see Section 10.2.4).~~

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~~Table 10.2A-1—Performance Characteristics~~

~~Turbine Generator~~	~~Details~~
~~Nominal Rating~~	~~1710 gross MW_e~~
~~Turbine type~~	~~Tandem compound, six flow~~
~~Operating speed~~	~~1800 rpm~~
~~Turbine throttle steam pressure~~	~~1089 psia~~
~~Throttle steam nominal moisture~~	~~0.42%~~
~~Moisture Separator/Reheaters (MSR)~~	
~~Number of MSRs per unit~~	~~2~~
~~Stages of moisture separation~~	~~1 with preseparator~~
~~Stages of reheat~~	~~2~~

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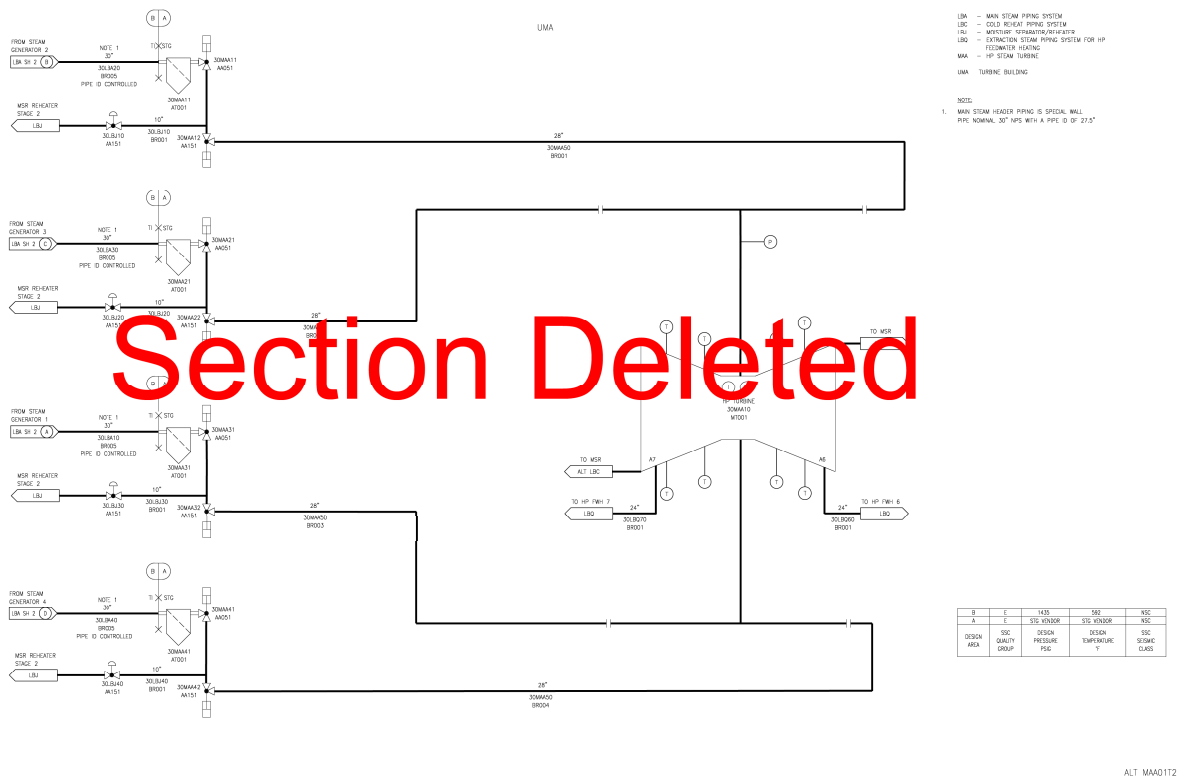
RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.2A-1—Turbine Generator System~~
~~Sheet 1 of 2~~



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RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.2A-1—Turbine Generator System~~
~~Sheet 2 of 2~~

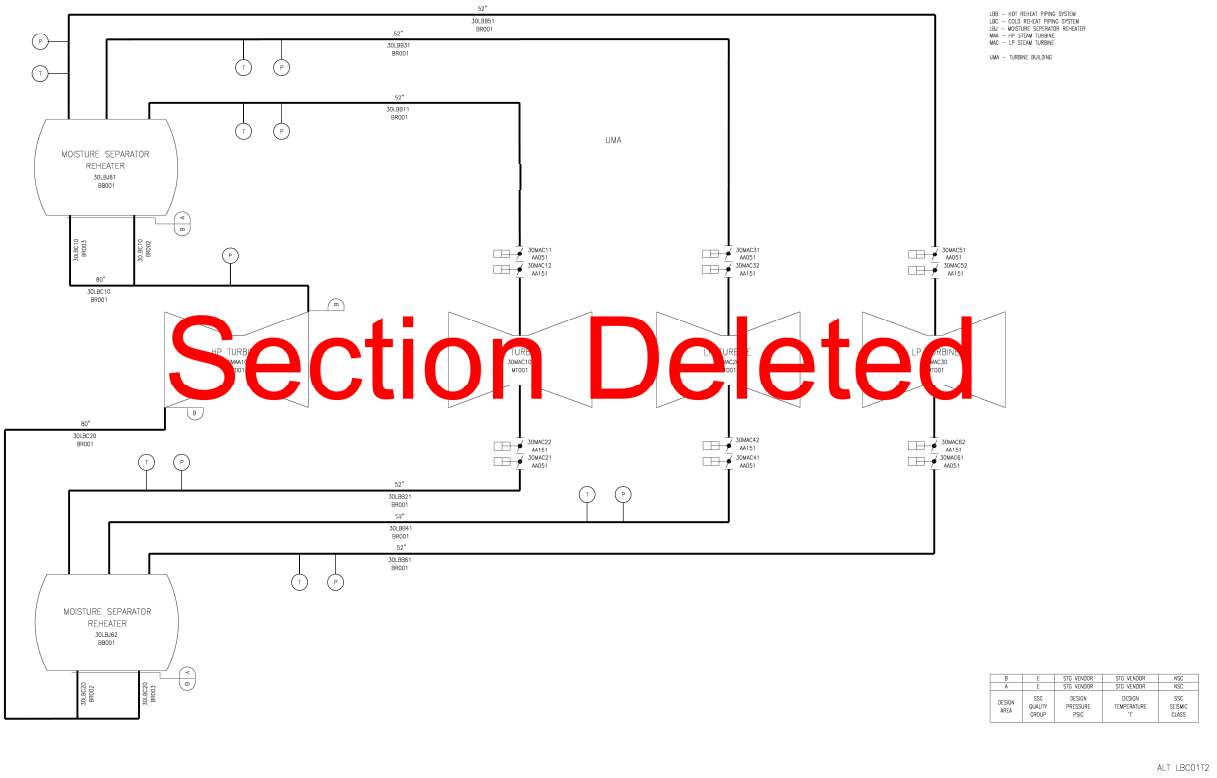

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Table 10.3-3—Main Steam Branch Piping (2.5 Inches and Larger), Downstream of MSIV

Description	Maximum Steam Flow	Shutoff Valve	Valve Closure Time	Actuator	Comments
Turbine bypass lines to condenser; six lines total	2.2 x 10^6 lb/hr each valve	18 in globe (turbine bypass valve)	5 seconds or less when tripped closed	Automatic operator, fail close	Valves are normally closed during power operation.
Reheating steam 2nd stage to MSRs, One or more lines.	1.2 x 10^6 lb/hr total	See Comment.	See Comment. RAI 91 S3, RAI 100 S2, RAI 106 S1	See Comment.	~~1.~~ Flow ceases following HP turbine stop valve closure on a turbine trip due to lack of heat transfer in the MSRs. The 2nd stage reheaters, their drain tanks and piping are designed to main steam design pressure and temperature. ~~2. For the optional TG design, each reheating steam 2nd stage supply line is downstream of its HP turbine stop valve, which isolates steam flow following turbine trip.~~
Backup main steam supply to auxiliary steam system - one line.	See Comment	4-in (isolation valve)	20 seconds or less	Automatic operator	This line is not normally open during power operation. It is open during startup. The capacity of the 4-inch line is small relative to the MSS capacity.
High pressure turbine steam supply lines; 4 lines total	5 x 10^6 lb/hr each line	27.5 in. ID inlet to stop valve in each line	0.3 seconds or less	Hydraulically operated from electro-hydraulic turbine control system	Main steam flow to high pressure turbine ceases following stop valve closure on a turbine trip. Each HP stop valve has a downstream control valve that also automatically closes.
Deaerator Pegging Steam -Two lines	See comment.	12-in. (isolation valve)	60 seconds or less	Automatic operator	This line is not normally open during power operation. It is open during startup.

Table 1.8-2—U.S. EPR Combined License Information Items
Sheet 31 of 44

Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
9.5-18	A COL applicant that references the U.S. EPR design certification will perform a supplemental Fire Protection Analysis for site-specific areas of the plant not analyzed by the the FSAR.	9.5.1.3	Y	
9.5-19	A COL applicant that references the U.S. EPR design certification will provide a description and simplified Fire Protection System piping and instrumentation diagrams for site-specific systems.	9.5.1.2.1	Y	
9.5-20	A COL applicant that references the U.S. EPR design certification will describe the program used to monitor and maintain an acceptable level of quality in the fire protection system freshwater storage tanks.	9.5.1.2.1	Y	
9.5-21	A COL applicant that references the U.S. EPR design certification will provide a description of the offsite communication system that interfaces with the onsite communication system.	9.5.2.1.1	Y	
9.5-22	A COL applicant that references the U.S. EPR design certification will describe the site-specific sources of acceptable fuel oil available for refilling the EDG fuel oil storage tanks within seven days, including the means of transporting and refilling the fuel storage tanks, following a design basis event to enable each diesel generator system to supply uninterrupted emergency power.	9.5.4.4	Y	
~~10.0-1~~	Deleted. ~~A COL applicant that references the U.S. EPR design certification will select Sections 10.1, 10.2 and 10.4.7 or 10.1A, 10.2A and 10.4.7A for inclusion in the COL FSAR as applicable to the chosen turbine-generator design option.~~	~~10.0~~	~~Y~~	
~~10.2-1~~	Deleted. ~~A COL applicant that references the U.S. EPR design certification will provide the site-specific turbine rotor inservice inspection program consistent with the recommendations of the manufacturer.~~	~~10.2A.3.6~~	~~Y~~	

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Table 1.8-2—U.S. EPR Combined License Information Items
Sheet 32 of 44

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Item No.	Description	Section	Action Required by COL Applicant	Action Required by COL Holder
10.2-2	A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the turbine rotor after the site-specific turbine has been procured.	10.2.3.1-~~10.2A.3.1~~		Y
10.2-3	A COL applicant that references the U.S. EPR design certification will provide applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and the fracture toughness properties after the site-specific turbine has been procured.	10.2.3.2-~~10.2A.3.2~~		Y
~~10.2-4~~	Deleted. ~~A COL applicant that references the U.S. EPR design certification, and selects the alternate turbine, will provide a list of material specifications for the alternate turbine-generator components.~~	~~10.2A.2.1.1~~	~~Y~~	
10.2-5	A COL applicant that references the U.S. EPR design certification will provide the site-specific turbine rotor inservice inspection interval consistent with the manufacturer's turbine missile analysis.	10.2.3.6	Y	
10.3-1	A COL applicant that references the U.S. EPR design certification will identify the authority responsible for implementation and management of the secondary side water chemistry program.	10.3.5	Y	
10.3-2	A COL applicant that references the U.S. EPR design certification will develop and implement a FAC condition monitoring program that is consistent with Generic Letter 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam prior to initial fuel loading.	10.3.6.3	Y	
10.4-1	A COL applicant that references the U.S. EPR design certification will describe the site-specific main condenser materials.	10.4.1.2	Y	
10.4-2	A COL applicant that references the U.S. EPR design certification will describe the site-specific design pressure and test pressure for the main condenser.	10.4.1.2	Y	

10.4.7 Condensate and Feedwater System

~~Depending on site-specific data, equipment availability and utility requirements, alternative designs for the steam and power conversion system may be considered by the applicant for a combined license (COL). An optional design description for the condensate and feedwater system (CFS) is provided in Section 10.4.7A. The alternative section outlines the changes to support the use of an optional CFS design. Those areas of the U.S. EPR design not affected by selection of the optional CFS design are so identified within the alternative section. Only one of the design descriptions is used by the applicant within the site-specific FSAR.[1]~~

RAI 91 S3, RAI 100 S2, RAI 106 S1

This section describes the condensate and feedwater system (CFS) for the U.S. EPR.

The CFS provides feedwater to the steam generators (SG) at the required temperature, pressure and flow rate. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through the low pressure (LP) feedwater heaters and the deaerator-feedwater storage tank to the main feedwater (MFW) pumps, and is then pumped through the high pressure (HP) feedwater heaters to the SGs. The CFS includes a number of stages of regenerative feedwater heating and provisions for maintaining feedwater quality. It also includes extraction piping from the steam turbines and feedwater heater vents and drains, and drains from the moisture separator reheaters (MSR).

10.4.7.1 Design Bases

The CFS provides the following safety-related isolation functions:

- Provide containment isolation in the supply and return lines for the first stage SG blowdown cooler.
- Isolate main feedwater isolation valve (MFIV) and the full-load and low-load isolation valve in order to:
  - Shut off the feedwater supply in case of a feedwater control malfunction to prevent an overcooling event due to SG over feed.
  - Reduce overcooling in case of a main steam line break (MSLB).
  - Isolate the SG in the event of a feedwater line break (FWLB)
  - Prevent depressurization of the unaffected SGs in case of a non-isolatable FWLB inside containment.

1. ~~This information is made available to the reviewers and other readers to clarify this section. It is not to be considered part of the text.~~

~~10.4.7A Condensate and Feedwater System~~

~~Depending on site specific data, equipment availability and utility requirements, alternative designs for the steam and power conversion system may be considered by the applicant for a COL. An optional design description for the CFS is provided in Section 10.4.7A. The alternative section outlines the changes to support the use of an optional condensate and feedwater system (CFS) design. Those areas of the U.S. EPR design not affected by selection of the optional CFS design are so identified within the alternative section. Only one of the design descriptions is used by the applicant within the site-specific FSAR.[1]~~

~~This section is the same as for the U.S. EPR (see Section 10.4.7).~~

~~10.4.7A.1 Design Bases~~

~~Same as the U.S. EPR (see Section 10.4.7.1).~~

~~10.4.7A.2 System Description~~

~~10.4.7A.2.1 General Description~~

~~Except for the following paragraphs, this section is the same as for the U.S. EPR (see Section 10.4.7.2.1).~~

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~~A flow diagram of the CFS is provided in Figure 10.4.7A-1—Condensate and Feedwater System.~~

~~An external LP drain cooler is provided upstream of the No. 1 and No. 2 LP feedwater heaters and downstream of the deaerator makeup valve.~~

~~10.4.7A.2.2 Component Description~~

~~Except for the following paragraph, this section is the same as for the U.S. EPR (see Section 10.4.7.2.2).~~

~~**Low Pressure Drain Coolers**~~

~~The LP drain coolers are horizontal shell and tube design constructed of carbon steel with stainless steel tubes.~~

~~10.4.7A.2.3 System Operation~~

~~Same as for the U.S. EPR (see Section 10.4.7.2.3).~~

~~1. This information is made available to the reviewers and other readers to clarify this section. It is not to be considered part of the text.~~

RAIs 91-S3, 100-S2, & 106-S1

~~**10.4.7A.3 Safety Evaluation**~~

~~Same as for the U.S. EPR (see Section 10.4.7.3).~~

~~**10.4.7A.4 Inspection and Testing Requirements**~~

~~Same as for the U.S. EPR (see Section 10.4.7.4).~~

~~**10.4.7A.5 Instrumentation Requirements**~~

~~Same as for the U.S. EPR (see Section 10.4.7.5).~~

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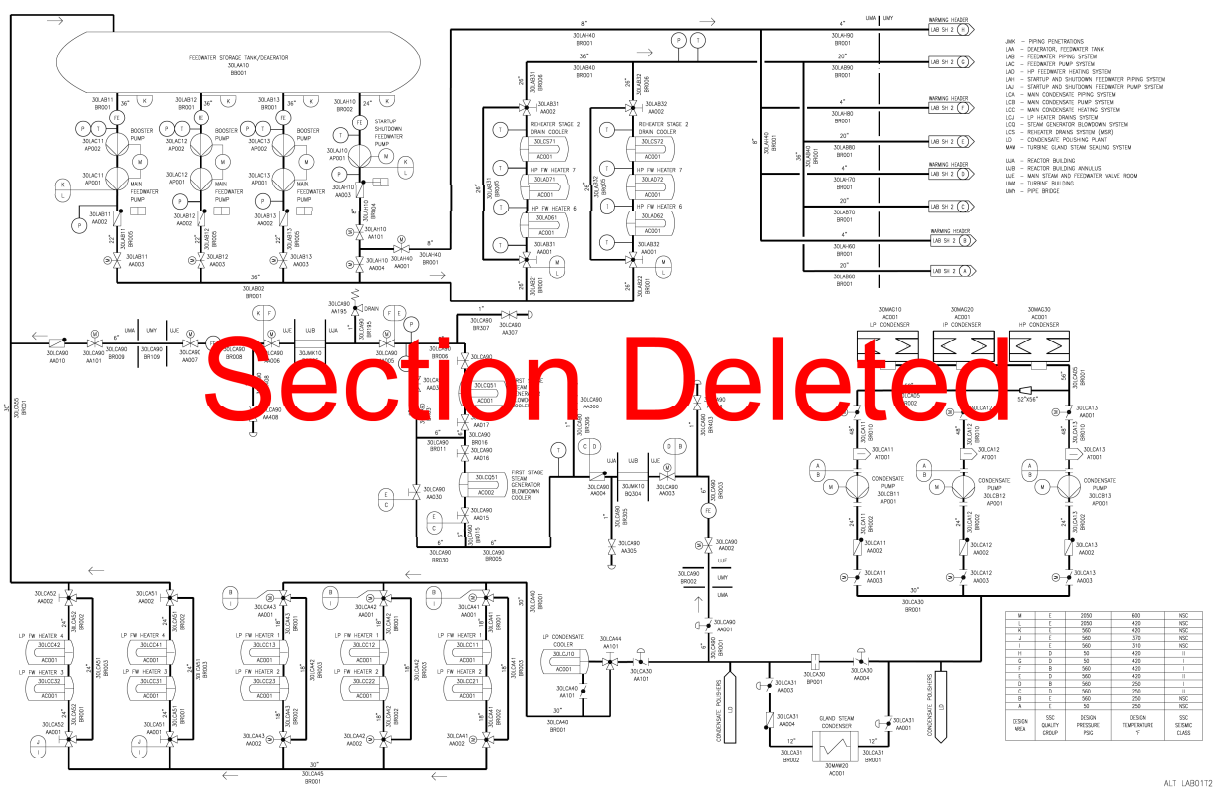
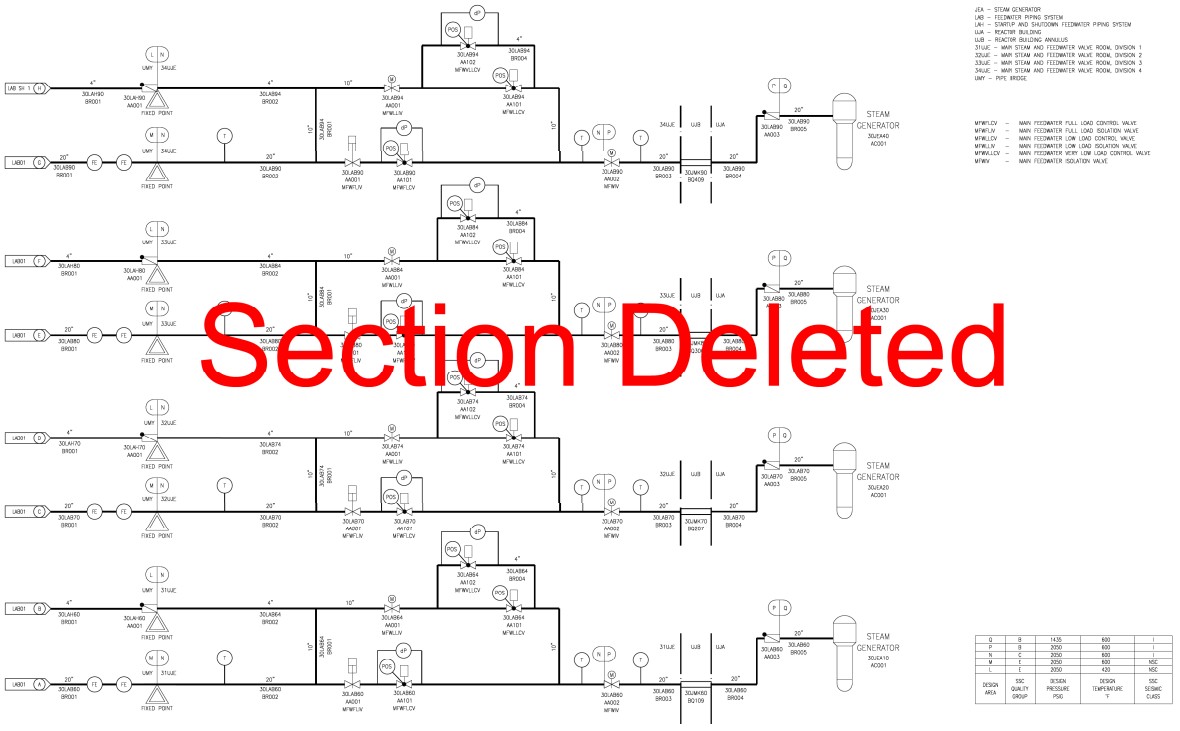
RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.4.7A-1—Condensate and Feedwater System (Sheet 1 of 2)~~



RAIs 91-S3, 100-S2, & 106-S1

~~Figure 10.4.7A-1—Condensate and Feedwater System (Sheet 2 of 2)~~



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