



U.S. NUCLEAR REGULATORY COMMISSION

# STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

## 6.2.2 CONTAINMENT HEAT REMOVAL SYSTEMS

### REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB) and Severe Accident Branch (SCSB)<sup>1</sup>

Secondary - None

### I. AREAS OF REVIEW

The CSB/SCSB<sup>2</sup> reviews the information in the applicant's safety analysis report (SAR) concerning containment heat removal under post-accident conditions to assure<sup>3</sup> conformance with the requirements of General Design Criteria 38, 39, and 40 (Ref. 1, 2 and 3).<sup>4</sup> The types of systems provided to remove heat from the containment include fan cooler systems, spray systems, and residual heat removal systems. These systems remove heat from the containment atmosphere and the containment sump water, or the water in the containment wetwell. The CSB/SCSB<sup>5</sup> review includes the following analyses and aspects of containment heat removal system designs:

1. Analyses of the consequences of single component malfunctions.
2. Analyses of the available net positive suction head (NPSH) to the containment heat removal system pumps.
3. Analyses of the heat removal capability of the spray water system.
4. Analyses of the heat removal capability of fan cooler heat exchangers.

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### USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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5. The potential for surface fouling of fan cooler, recirculation, and residual heat removal heat exchangers, and the effect on heat exchanger performance.
6. The design provisions and proposed program for periodic inservice inspection and operability testing of each system or component.
7. The design of sumps and water sources for emergency core cooling and containment spray systems, including an assessment for potential loss of long-term cooling capability due to loss-of-coolant accident (LOCA)<sup>6</sup> generated debris effects such as debris screen blockage and pump seal failure.
8. The effects of debris such as thermal insulation on recirculating fluid systems.

#### Review Interfaces<sup>7</sup>

The ~~CSB~~SCSB<sup>8</sup> will coordinate other branch evaluations that interface with the overall review of the containment heat removal systems as follows:

- A. ~~the Auxiliary Systems Branch (ASB)~~The Plant Systems Branch (SPLB)<sup>10</sup> will review the secondary cooling systems, which provide cooling water to the heat exchangers in the containment heat removal systems, as part of its primary review responsibility for Safety Review Plan (SRP)<sup>11</sup> Section 9.2.2.
- B. The Instrumentation and Control ~~Systems Branch (ICSB)~~Branch (HICB)<sup>12</sup> will review the sensing and actuation instrumentation provided for the containment heat removal systems as part of its primary review responsibility for SRP Section 7.3.
- C. ~~The Equipment Qualification Branch (EQB)~~SPLB<sup>13</sup> will review the qualification test program for the active components of the fan cooler system, and the sensing and actuation instrumentation for the containment heat removal system as part of its primary review responsibility for SRP Section 3.11.
- D. ~~The Chemical Engineering Branch (CMEB)~~Materials and Chemical Engineering Branch (EMCB)<sup>14</sup> will evaluate the quantity of unqualified paint that can potentially reach the emergency sump(s) under design basis pipe break accident review responsibility for SRP Section 6.1.2.
- E. ~~The Accident Evaluation Branch (AEB)~~EMCB<sup>15</sup> will review fission product control features of containment heat removal systems as part of its primary review responsibility for SRP Section 6.5.2.
- F. The Mechanical Engineering Branch (~~MEB~~EMEB<sup>16</sup>) will review the system seismic design and quality group classification as part of its primary review responsibility for SRP Section 3.2.1 and SRP Section 3.2.2, respectively.

- G. ~~The Licensing Guidance Branch (LGB)~~ Technical Specifications Branch (TSB)<sup>17</sup> will review the proposed technical specifications for each system at the operating license stage of review as part of the primary review responsibility for SRP Section 16.0.

For those areas of review identified above ~~being reviewed~~<sup>18</sup> as part of the primary review responsibility of other branches, the acceptance criteria ~~necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.~~<sup>19</sup>

## II. ACCEPTANCE CRITERIA

~~CSB~~SCSB<sup>20</sup> acceptance criteria for the design of the containment heat removal system is based on meeting the relevant requirements of General Design ~~Criterion~~ Criteria<sup>21</sup> 38, 39, and 40. The relevant requirements are as indicated below.

1A.<sup>22</sup> General Design Criterion 38 (GDC 38)<sup>23</sup> as it relates to:

- a. Containment heat removal system being capable of reducing rapidly the containment pressure and temperature following a LOCA, and maintaining them at acceptably low levels.
- b. The containment heat removal system performance being consistent with the function of other systems.
- c. The containment heat removal system being safety-grade design; i.e., ~~have suitable redundancy of components and features, and interconnections, to assure that for either a loss of onsite as a loss of offsite power, the system function can be accomplished assuming a single failure.~~ suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to ensure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.
- d. ~~Leak detection, isolation and containment capabilities being incorporated in the design of the containment heat removal system.~~<sup>24</sup>

2B.<sup>25</sup> General Design Criterion 39 (GDC 39),<sup>26</sup> as it relates to the containment heat removal system being designed to permit periodic inspection of components.

3C.<sup>27</sup> General Design Criterion 40 (GDC 40),<sup>28</sup> as it relates to the containment heat removal system being designed to permit periodic testing to ~~assure~~ensure<sup>29</sup> system integrity, and the operability of the system, and active components.

Specific acceptance criteria necessary to meet the relevant requirement of ~~GDC~~ General Design Criteria<sup>30</sup> 38, 39, and 40 are as follows:

1. The containment heat removal systems should meet the redundancy and power source requirements for an engineered safety feature; i.e., the systems should be designed to accommodate a single active failure. The results of failure modes and effects analyses of each system should assure<sup>31</sup> that the system is capable of withstanding a single failure without loss of function. This is conformance with the requirements of ~~General Design Criterion GDC~~<sup>32</sup> 38.
2. With regard to ~~General Design Criterion GDC~~ 38 as it relates to the capability of the<sup>33</sup> containment system to accomplish its safety function, the spray system should be designed to accomplish this without pump cavitation occurring. Therefore, the net positive suction head available to the pumps in both the injection and recirculation phases of operation should be greater than the required NPSH. A supporting analysis should be presented in sufficient detail to permit the staff to determine the adequacy of the analysis and should show that the available NPSH is greater than the required NPSH. Regulatory Guide 1.82, Rev. 1 (Ref. 5)<sup>34</sup> describes methods acceptable to the staff for evaluating the NPSH margin.

In the recirculation phase; i.e., in the long term (after about 1 hour) following a LOCA, the containment spray system is required to circulate the water in the containment. The NPSH analysis will be acceptable if (1) it is done in accordance to the guidance in Regulatory Guide 1.82, Rev. 1 (Ref. 5)<sup>35</sup> and (2) it is done in accordance with the guidelines of Regulatory Guide 1.1 (Ref. 4),<sup>36</sup> i.e., is based on maximum expected temperature of the pumped fluid and with atmospheric pressure in the containment. For clarification, the analysis should be based on the assumption that the containment pressure equals the vapor pressure of the sump water. This ensures that credit is not taken for containment pressurization during the transient.

The recirculation spray system for a subatmospheric containment is designed to start about 5 minutes after a loss-of-coolant accident, i.e., during the injection phase of spray system operation. For subatmospheric containments, the guidelines of Regulatory Guide 1.1 as defined above will apply after the injection phase has terminated, which occurs about 1 hour after the accident. Prior to termination of the injection phase the NPSH analyses should include conservative predictions of the containment atmosphere pressure and sump water temperature transients.

3. In evaluating the performance capability of the containment spray system, to satisfy GDC 38, analyses of its heat removal capability should be based on the following considerations:
  - a. The locations of the spray headers relative to the internal structures.
  - b. The arrangement of the spray nozzles on the spray headers and the expected spray pattern.
  - c. The type of spray nozzles used and the nozzle atomizing capability, i.e., the spray drop size spectrum and mean drop size emitted from each type of nozzle as a function of differential pressure across the nozzle.

- d. The effect of drop residence time and drop size on the heat removal effectiveness of the spray droplets.

The spray systems should be designed to assure<sup>37</sup> that the spray header and nozzle arrangements produce spray patterns which maximize the containment volume covered and minimize the overlapping of the sprays.

4. In evaluating the performance capability of the fan cooler system, to satisfy GDC 38, the design heat removal capability (i.e., heat removal rate vs. containment temperature) of fan coolers should be established on the basis of qualification tests on production units or acceptable analyses that take into account the expected post-accident environmental conditions and variations in major operating parameters such as the containment atmosphere steam-air ratio, condensation on finned surfaces, and cooling water temperature and flow rate. The equipment housing and ducting associated with the fan cooler system should be analyzed to determine that the design is adequate to withstand the effects of containment pressure following a loss-of-coolant accident (see SRP Section 6.2.5). Fan cooler system designs that contain components which do not have a post-accident safety function should be designed such that a failure of nonsafety-related equipment will not prevent the fan cooler system from accomplishing its safety function.
5. In evaluating the heat removal capability of the containment heat removal system, to satisfy GDC 38, the potential for surface fouling of the secondary sides of fan cooler, recirculation, and residual heat removal heat exchangers by the cooling water over the life of the plant and the effect of surface fouling on the heat removal capacity of the heat exchangers should be analyzed and the results discussed in the SAR. The analysis will be acceptable if it is shown that provisions such as closed cooling water systems are provided to prevent surface fouling or surface fouling has been accounted for in establishing the heat removal capability of the heat exchangers.
6. To satisfy the requirement of GDC 38 regarding the long-term spray system(s) and emergency core cooling system(s), the containment emergency sump(s) should be designed to provide a reliable, long-term water source for ~~ECCS and CSS~~ the emergency core cooling system (ECCS) and core spray system (CSS)<sup>38</sup> recirculation pumps. Provision should be made in the containment design to allow drainage of spray and emergency core cooling water to the emergency sump(s), and for recirculation of this water through the containment sprays and emergency core cooling systems. The design of the sumps, and the protective screen assemblies is a critical element in ~~assuring~~ ensuring<sup>39</sup> long-term recirculation cooling capability. Therefore, adequate design consideration of (a) sump hydraulic performance, (b) evaluation of potential debris generation and associated effects including debris screen blockage, ~~c) and~~ (c) residual heat removal (RHR)<sup>40</sup> and CSS pump performance under postulated post-LOCA conditions, is necessary. These design considerations are addressed in Regulatory Guide 1.82, Rev. 1 (Ref. 5)<sup>41</sup> and NUREG-0897, Rev. 1 (Ref. 7).<sup>42</sup>
7. In meeting the requirements of ~~GDC~~ General Design Criteria 39 and 40 regarding inspection and testing, provisions should be made in the design of containment heat

removal systems for periodic inspection and operability testing of the systems and system components such as pumps, valves, duct pressure-relieving devices, and spray nozzles.

8. To satisfy the system design requirements of GDC 38, instrumentation should be provided to monitor containment heat removal system and system component performance under normal and accident conditions. The instrumentation should be capable of determining whether a system is performing its intended function, or a system train or component is malfunctioning and should be isolated.

#### Technical Rationale

The technical rationale for application of these acceptance criteria to reviewing the containment heat removal systems is discussed in the following paragraphs:<sup>43</sup>

- (a) Compliance with GDC 38 requires that systems be provided to remove heat from the reactor containment. The system safety function is to reduce containment pressure and temperature rapidly after any LOCA and to maintain them at acceptably low levels.

This SRP section describes staff positions related to the design of containment heat removal systems. Requirements related to spray systems, heat removal systems, cooling water sources, and cooling water recirculation are discussed. Regulatory Guide 1.82 provides guidance for "Water Sources For Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident."

Meeting the requirements of GDC 38 regarding the characteristics of containment heat removal systems and their design provides assurance that containment pressure and temperature will be reduced to and maintained at acceptably low levels after any LOCA, thereby protecting the safety function of the containment as an engineered safety feature.<sup>44</sup>

- (b) Compliance with GDC 39 requires that containment heat removal systems be designed to permit appropriate periodic inspection of important components such as the torus, sumps, spray nozzles, and piping to ensure the integrity and capability of these systems.

This SRP section describes staff positions related to the inspection of containment heat removal systems, indicating that provisions should be made for periodic inspection of system components.

Meeting the requirements of GDC 39 with regard to periodic inspection of containment heat removal systems provides assurance that containment pressure and temperature will be reduced to and maintained at acceptably low levels after any LOCA, thereby protecting the safety function of the containment as an engineered safety feature.<sup>45</sup>

- (c) Compliance with GDC 40 requires that containment heat removal systems be designed to permit periodic pressure and functional testing to ensure leaktight integrity, operability, and performance of active components, as well as overall system operability.

This SRP section describes staff positions related to the testing of containment heat removal systems, indicating that provisions should be made for startup and periodic operability testing of these systems and their components.

Meeting the requirements of GDC 40 with regard to testing of containment heat removal systems provides assurance that containment pressure and temperature are reduced to and maintained at acceptably low levels after any LOCA, thereby protecting the safety function of the containment as an engineered safety feature.<sup>46</sup>

### III. REVIEW PROCEDURES

The procedures described below provide guidance for the review of containment heat removal systems. The reviewer selects and emphasizes material from the review procedures as may be appropriate for a particular case. Portions of the review may be done on a generic basis for aspects of heat removal systems common to a class of containments, or by adopting the results of previous reviews of plants with essentially the same system.

1. <sup>47</sup>Upon request from ~~ESB~~SCSB, <sup>48</sup> the ~~secondary review branches~~ review branches with review interface responsibilities, as noted in subsection I, <sup>49</sup> will provide input for the areas of review stated in subsection I of this SRP section. ~~ESB~~SCSB<sup>50</sup> obtains and uses such input as required to ~~assure~~ensure<sup>51</sup> that this review procedure is complete. ~~ESB~~SCSB<sup>52</sup> ~~assures~~ensures<sup>53</sup> that the design and functional capability of the containment heat removal system conform to the requirements of General Design Criteria 38, 39, and 40.
2. ~~ESB~~SCSB<sup>54</sup> determines the acceptability of a containment heat removal system design by reviewing failure modes and effects analyses of the system to ~~be sure that~~ensure that:<sup>55</sup>
  - a. All potential single failures have been identified and no single failure could incapacitate the entire system;
  - b. ~~verifying that~~Engineered safety feature design standards have been applied;
  - c. ~~reviewing~~The system design provisions for periodic inservice inspection and operability testing to ensure that the system and components are accessible for inspection and all active components can be tested; and
  - d. ~~reviewing~~The capability exists<sup>56</sup> to monitor system performance and control active components from the control room so that the operator can exercise control over system functions or isolate a malfunctioning system component.
3. ~~ESB~~The SCSB<sup>57</sup> reviews analyses of the net positive suction head available to the spray system pumps. ~~ESB~~The SCSB<sup>58</sup> ~~assures~~ensures<sup>59</sup> that the analyses for the recirculation phase are done in accordance with the guidelines of Regulatory Guide 1.1, i.e., are based on maximum expected temperature of the pumped fluid and with atmospheric pressure in the containment. For clarification, the analyses should be based on the assumption that

the containment pressure equals the vapor pressure of the sump water. This ensures that credit is not taken for containment pressurization during the transient.

- a. ~~ESB~~The SCSB<sup>60</sup> ~~assures~~~~ensures~~<sup>61</sup> that calculations of the available NPSH are based on transient values of the suction head and the friction head.
  - b. The ~~ESB~~SCSB<sup>62</sup> reviews information provided by the applicant to identify and justify the conservatism applied in determining the water level in the containment and the friction losses in the recirculation system suction piping. For example, the uncertainty in determining the free volume in the lower part of the containment that may be occupied by water, and the quantity of water that may be trapped by the reactor cavity and the refueling canal, should be factored into the calculation of the suction head.
4. The ~~ESB~~SCSB<sup>63</sup> reviews analyses of the available NPSH for subatmospheric containments for the period prior to termination of the injection phase of containment spray to determine that containment pressure and sump water temperature transients have been conservatively used in the NPSH calculations.
- a. The ~~ESB~~SCSB<sup>64</sup> reviews information provided by the applicant to identify and justify the conservatism in the analysis of the containment atmosphere pressure and sump water temperature transients.
  - b. The ~~ESB~~SCSB<sup>65</sup> also reviews the conservatism used in determining the water level in the containment and the friction losses in the recirculation system piping.
5. The ~~ESB~~SCSB<sup>66</sup> compares the NPSH requirements for the containment heat removal system pumps to the minimum calculated NPSH available to the pumps to ~~assure~~~~ensure~~<sup>67</sup> that a positive margin is maintained. The ~~ESB~~SCSB<sup>68</sup> also reviews the pre-operational test programs, and periodic inservice inspection and test programs, to verify that adequate NPSH is available to the pumps and the continuing operability of the pumps during the lifetime of the plant.
6. If in the judgment of the ~~ESB~~SCSB,<sup>69</sup> the NPSH analyses were not done in a sufficiently conservative manner, confirmatory analyses are performed using the CONTEMPT-LT<sup>70</sup> (Reference 8)<sup>71</sup> computer code.
7. The ~~ESB~~SCSB<sup>72</sup> also reviews the evaluation of the volume of the containment covered by the sprays and the extent of overlapping of the sprays with respect to heat removal capabilities. A judgment will be made regarding the acceptability of the spray coverage and extent of overlapping; the volume of the containment covered by the sprays should be maximized and the extent of overlapping kept to a minimum. Elevation and plan drawings of the containment showing the spray patterns are used to determine coverage and overlapping.
8. In general, the design requirements for the spray systems with respect to spray drop size spectrum and mean drop size, spray drop residence time in the containment atmosphere,

containment coverage by the sprays, and extent of overlapping of the sprays are more stringent when the acceptability of the system is being considered from an iodine removal capability standpoint rather than from a heat removal capability standpoint. Consequently, when the iodine removal capability of the system is satisfied, the heat removal capability will be found acceptable.

- a. The ~~Accident Evaluation Branch~~EMCB<sup>73</sup> is responsible for determining the acceptability of the iodine removal effectiveness of the sprays (See Standard Review Plan Section 6.5.2).
  - b. Since all plants do not use the containment sprays as a fission product removal system, the ~~ESB~~SCSB<sup>74</sup> reviews the system for cases where the system is used only as a heat removal system.
9. ~~ESB~~The SCSB<sup>75</sup> reviews analyses of the heat removal capability of the spray system. This capability is a function of the degree of thermal equilibrium attained by the spray water and the volume of the containment covered by the spray water. The spray drop size and residence time in the containment atmosphere determine the degree of thermal equilibrium attained by the spray water. The ~~ESB~~SCSB<sup>76</sup> confirms the validity of the degree of thermal equilibrium attained using the following information:
- a. An elevation drawing of the containment showing the locations of the spray headers relative to the internal structures, including fall heights,~~and;~~
  - b. The results of the spray nozzle test program to determine the spectrum of drop sizes and mean drop size emitted from the nozzles as a function of pressure drop across the nozzles~~;~~ and
  - c. Reference 6, "Design Considerations of Reactor Containment Spray Systems - Part VI, The Heating of Spray Drops In Air-Steam Atmospheres,"<sup>77</sup> contains information regarding the heating of spray drops in air-steam atmospheres which can be used to determine the validity of the degree of thermal equilibrium of the spray water used in the analyses.
10. ~~ESB~~The SCSB<sup>78</sup> reviews the adequacy of provisions made to prevent over-pressurization of fan cooler ducting following a loss-of-coolant accident (Standard Review Plan Section 6.2.5).
- a. ~~ESB~~The SCSB<sup>79</sup> reviews the heat removal capability of the fan coolers.
  - b. The test programs and calculation models used to determine the performance capability of fan coolers are reviewed for acceptability.
  - c. If the secondary side of a fan cooler heat exchanger is not a closed system, the ~~ESB~~SCSB<sup>80</sup> reviews the potential for surface fouling. The ~~ESB~~SCSB<sup>81</sup> determines whether or not surface fouling impairs the heat removal capability of a fan cooler.

11. ~~ESB~~The SCSB<sup>82</sup> reviews the system provided to allow drainage of containment spray water and emergency core cooling water to the recirculation suction points (sumps).
- a. ~~ESB~~The SCSB<sup>83</sup> reviews the design of the protective screen assemblies around the suction points.
- i. ~~ESB~~The SCSB<sup>84</sup> reviews plan and elevation drawings of the protective screen assemblies, showing the relative positions and orientations of the trash bars or grating and the stages of screening, to determine that the potential for debris clogging the screening is minimized.
- ii. ~~ESB~~The SCSB<sup>85</sup> also reviews the drawings to determine that suction points do not share the same screened enclosure. The effectiveness of the protective screen assembly will be determined by comparing the smallest mesh size of screening provided to the clogging potential of pumps, heat exchangers, valves, and spray nozzles.
- iii. The methods of attachment of the trash bars or grating and the screening to the protective screen assembly structure should be discussed in the SAR and shown on drawings.
- iv. A discussion of the adequacy of the surface area of screening with respect to ~~assuring~~ensuring<sup>86</sup> a low velocity of approach of the water to minimize the potential for debris in the water being sucked against the screening should be presented.
- v. For new applicants the size of the suction inlet screen area (PWR) and suction strainers (BWR) should have a factor of three sizing margin over that specified in Regulatory Guide 1.82.<sup>87</sup>
- b. <sup>88</sup>Regulatory Guide 1.82, ~~Rev. 1 (Ref. 5)~~<sup>89</sup> provides guidelines for the acceptability of the design of PWR sumps and BWR RHR suction inlets. NUREG-0897, Rev. 1, (~~Ref. 7~~Reference 7) "Containment Emergency Sump Performance,"<sup>90</sup> details technical considerations pertinent to these matters.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.<sup>91</sup>

#### IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that ~~his~~ the<sup>92</sup> evaluation supports conclusions of the following type, to be included in the staff's safety evaluation report (SER):<sup>93</sup>

##### 6.2.2 Containment Heat Removal Systems

The containment heat removal systems include (identify the systems; these may include systems such as the residual heat removal system in specified modes, emergency core cooling system, fan cooler systems, spray systems, containment sumps, wetwells, etc.<sup>94</sup>).

The scope of review of the containment heat removal systems for the (plant name) ~~has~~<sup>95</sup> included system drawings and descriptive information. The review ~~has~~<sup>96</sup> included the applicant's proposed design bases for the containment heat removal systems, and ~~the~~<sup>97</sup> analyses of the functional capability of the systems.

The staff concludes that the design of the containment heat removal systems is acceptable and meets the requirements of General Design Criteria 38, 39 and 40.

The conclusion is based on the following: ~~{The reviewer should discuss each item of the regulations or related set of regulations as indicated.}~~

1. ~~The applicant has met the requirements of (cite regulation) with respect to (state limits of review in relation to regulation) by (for each item that is applicable to the review state how it was met and why acceptable with respect to the regulation being discussed):~~

~~\_\_\_\_\_ a. meeting the regulatory positions in Regulatory Guide \_\_\_\_\_ or Guides;~~

~~\_\_\_\_\_ b. providing and meeting an alternative method to regulatory positions in Regulatory Guide \_\_\_\_\_, that the staff has reviewed and found to be acceptable;~~

~~\_\_\_\_\_ c. meeting the regulatory position in BTP \_\_\_\_\_;~~

~~\_\_\_\_\_ d. using calculational methods for (state what was evaluated) that has been previously reviewed by the staff and found acceptable; the staff has reviewed the impact parameters in this case and found them to be suitably conservative or performed independent calculations to verify acceptability of their analysis; and/or~~

~~\_\_\_\_\_ e. meeting the provisions of (industry standard number and title) that has been reviewed by the staff and determined to be appropriate for this application.~~

2. ~~Repeat discussion for each regulation cited above.~~

1. The staff's review indicates that the applicant complied with General Design Criterion 38 by providing containment heat removal systems consisting of (list systems). The applicant designed the containment heat removal systems according to the guidance provided in Regulatory Guides 1.1 and 1.82. The staff's review indicates that the systems will be capable of performing their intended safety function, which is to reduce containment pressure and temperature rapidly and to maintain them at acceptably low levels after any loss-of-coolant accident (LOCA). Suitable redundancy in components and features, and suitable interconnections, leak detection, isolation, and containment capabilities shall be provided to ensure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.
2. The staff's review indicates that the applicant complied with General Design Criterion 39 by designing the containment heat removal systems to permit appropriate periodic inspection of important components of the systems such as the torus, sumps, spray nozzles, and piping. (Other or additional examples may be appropriate.)
3. The staff's review indicates that the applicant complied with General Design Criterion 40 by designing the containment heat removal systems to permit appropriate periodic pressure and functional testing to ensure the structural and leaktight integrity of their components; the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves; and the operability of the systems as a whole. Testing will be conducted to ensure the performance of the full operational sequence that brings the systems into operation under conditions as close to design as practical, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems.<sup>98</sup>

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.<sup>99</sup>

## V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plan for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.<sup>100</sup> Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.<sup>101</sup>

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

~~The PWR sump and BWR RHR suction inlet design and evaluation guidance provided in Subsection H.6 of this SRP section, RG 1.82, Rev. 1, and as further detailed in NUREG-0897, Rev. 1B, is applicable to:~~

- ~~1) construction permit applications and preliminary design approvals (PDAs) that are docketed after<sup>2</sup>;~~
- ~~2) applications for Final Design Approval (FDA), for standardized designs which are intended for referencing in future construction permit applications that have not received approval at<sup>2</sup>;~~
- ~~3) applications for licenses to manufacture that are docketed after<sup>2</sup>;~~

~~The other portions of SRP Section 6.2.2 remain unchanged and are applicable to all CP and OL plants.<sup>102</sup>~~

## VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 38, "Containment Heat Removal."
2. 10 CFR Part 50, Appendix A, General Design Criterion 39, "Inspection of Containment Heat Removal System."
3. 10 CFR Part 50, Appendix A, General Design Criterion 40, "Testing of Containment Heat Removal System."

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<sup>2</sup>~~Six (6) months after issuance of this SRP Section (Ref. 4, October 1985) and Regulatory Guide 1.82, Rev. 1.<sup>103</sup>~~

4. Regulatory Guide 1.1, "Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps."
5. Regulatory Guide 1.82, Rev. 1, "Water Sources for Long Term Recirculation Cooling Following a Loss of Coolant Accident," October 15, 1985.
6. L. F. Parsly, "Design Considerations of Reactor Containment Spray Systems - Part VI, The Heating of Spray Drops In Air-Steam Atmospheres," ORNL-TM-2412, Oak Ridge National Laboratory, January 1970.

7. NUREG-0897, Rev. 1, "Containment Emergency Sump Performance - Technical Findings Related to USI A-43," October 1985.
8. NUREG/CR-0255, TREE-1279, "CONTEMPT-LT/028A Computer Program for Predicting Containment Pressure-Temperature Response to a Loss-of-Coolant Accident," Don W. Hargroves, Lawrence J. Metcalfe, Idaho National Engineering Laboratory, March 1979.<sup>104</sup>

**SRP Draft Section 6.2.2**  
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current primary review branch designation and abbreviation	Changed primary review branch designation and abbreviation in REVIEW RESPONSIBILITIES.
2.	Current primary review branch abbreviation	Revised primary review branch abbreviation.
3.	Editorial	Changed "assure" to "ensure."
4.	SRP-UDP format item	Deleted unnecessary reference citation: (Ref. 1, 2 and 3).
5.	Current primary review branch abbreviation	Revised primary review branch abbreviation.
6.	Editorial	Defined "LOCA" as "loss-of-coolant accident."
7.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW.
8.	Current primary review branch abbreviation	Revised primary review branch abbreviation.
9.	SRP-UDP format item	Divided existing paragraph into subsections I.A through I.G under "Review Interfaces." The existing text and order was preserved.
10.	Current review interface branch designation	Deleted Auxiliary Systems Branch and substituted the Plant Systems Branch which now has cognizance for primary review of SRP Section 9.2.2.
11.	Editorial	Defined "SRP" as "Standard Review Plan."
12.	Current review interface branch designation	Substituted current title and abbreviation of Instrument and Control Branch (HICB).
13.	Current review interface branch designation	Substituted "SPLB" for "Equipment Qualification Branch (EQB)." Plant systems branch now has cognizance for primary review of SRP Section 3.11.
14.	Current review interface branch designation	Changed "Chemical Engineering Branch (CMEB)" to "Materials and Chemical Engineering Branch (EMCB)."
15.	Current review interface branch designation	Changed "Accident Evaluation Branch (AEB)" to "EMCB" to reflect current primary review branch responsibility for SRP Section 6.5.2.
16.	Current review interface branch designation	Changed "MEB" to "EMEB."
17.	Current review interface branch designation	Changed "Licensing Guidance Branch (LGB)" to "Technical Specifications Branch (TSB)" to reflect current primary review branch responsibility for SRP Section 16.0.

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Item	Source	Description
18.	Editorial	Deleted superfluous words "being reviewed" from sentence to improve clarity.
19.	Editorial	Simplified for clarity and readability.
20.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
21.	Editorial	Corrected "Criterion" to "Criteria" to accommodate plural usage.
22.	Editorial	Changed paragraph designation from "1" to "A" so that there would be a unique designation for this paragraph.
23.	Editorial	Provided "GDC 38" as initialism for "General Design Criterion 38."
24.	Editorial	The structure of the existing sentence in subsection II.A.c is not intelligible. The text that was substituted was taken, essentially verbatim, from the second paragraph of GDC 38 and is considered to include the information that was originally intended. Subsection II.A.d is contained in the substituted text and is therefore redundant.
25.	Editorial	Changed paragraph designation from "2" to "B" so that there would be a unique designation for this paragraph.
26.	Editorial	Provided "GDC 39" as initialism for "General Design Criterion 39."
27.	Editorial	Changed paragraph designation from "3" to "C" so that there would be a unique designation for this paragraph.
28.	Editorial	Provided "GDC 40" as initialism for "General Design Criterion 40."
29.	Editorial	Changed "assure" to "ensure" to correct usage.
30.	Editorial	Changed "GDC" to "General Design Criteria" to accommodate plural usage (global change for this SRP section).
31.	Editorial	Changed "assure" to "ensure."
32.	Editorial	Used "GDC 38" as defined in item 23 above (global change for this SRP section).
33.	Editorial	Added the word "the" for precision.
34.	SRP-UDP format item	Deleted unnecessary reference citation: "Rev. 1 (Ref. 5)."

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Item	Source	Description
35.	SRP-UDP format item	Deleted unnecessary reference citation: "Rev. 1 (Ref. 5)."
36.	SRP-UDP format item	Deleted unnecessary reference citation: "(Ref. 4)."
37.	Editorial	Changed "assure" to "ensure."
38.	Editorial	Added explanation of acronyms "ECCS" and "CSS" in text.
39.	Editorial	Changed "assuring" to "ensuring."
40.	Editorial	Added the word "and" to correct usage. Added explanation of acronym "RHR" in text.
41.	SRP-UDP format item	Deleted unnecessary reference citation: "Rev. 1 (Ref. 5)."
42.	SRP-UDP format item	Deleted unnecessary reference citation: "Rev. 1 (Ref. 7)."
43.	SRP-UDP format item	Added "Technical Rationale" and lead-in paragraph to ACCEPTANCE CRITERIA.
44.	SRP-UDP format item	Added technical rationale for GDC 38.
45.	SRP-UDP format item	Added technical rationale for GDC 39.
46.	SRP-UDP format item	Added technical rationale for GDC 40.
47.	SRP-UDP format item	Numbered subsections in REVIEW PROCEDURES for clarity.
48.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
49.	Editorial	Deleted the phrase "secondary review branches" and substituted "review branches with review interface responsibilities, as noted in Subsection I." This SRP section has no secondary review branches. Primary review branch interfaces and responsibilities are described in subsection I.
50.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
51.	Editorial	Changed "assure" to "ensure."
52.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
53.	Editorial	Changed "assures" to "ensures."
54.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
55.	SRP-UDP format item	Broke existing text into subsections for clarity.

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Item	Source	Description
56.	SRP-UDP format item	Made editorial changes to subsections a, b, c, and d for clarity and to accommodate rearrangement of the text.
57.	Current primary review branch abbreviation	Changed "CSB" to "The SCSB."
58.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
59.	Editorial	Changed "assures" to "ensures."
60.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
61.	Editorial	Changed "assures" to "ensures."
62.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
63.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
64.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
65.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
66.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
67.	Editorial	Changed "assure" to "ensure."
68.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
69.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
70.	Editorial note without change to text	The CONTEMPT-LT computer code is cited in the text without a supporting reference. Reference 8 was added to SRP Section 6.2.2 to correct this omission. Several computer codes have been developed since the publication of Reference 8. These computer codes, such as CONTEMPT4/MOD4 (NUREG/CR-3716) and CONTAIN 1.1 (NUREG/CR-5026), provide more extensive analyses than the CONTEMPT-LT code. The CONTEMPT-LT computer code may be obsolete and its citation in the SRP section should be confirmed by the staff.
71.	SRP-UDP Format Item	Added reference number.
72.	Current primary review branch abbreviation.	Changed "CSB" to "SCSB."

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Item	Source	Description
73.	Current review interface branch designation	Deleted "Accident Evaluation Branch" and substituted "EMCB," which has current primary review responsibility for SRP Section 6.5.2.
74.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
75.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
76.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
77.	Editorial	Added the title of Reference 6 in the text for clarity.
78.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
79.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
80.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
81.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
82.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
83.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
84.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
85.	Current primary review branch abbreviation	Changed "CSB" to "SCSB."
86.	Editorial	Changed "assuring" to "ensuring."
87.	Integrated Impact # 374	Added Review Procedure 11.a.v to address the need for a factor of 3 sizing margin for inlet strainers for future applicants. This position was specified in the evolutionary plant FSER for the ABWR and the CE 80+.
88.	SRP-UDP format item	Numbered subsections in REVIEW PROCEDURES for clarity. This item is identical to item 47 in this table.
89.	SRP-UDP format item	Deleted unnecessary reference citation: "Rev. 1 (Ref. 5)."
90.	SRP-UDP format item	Deleted unnecessary reference citation: "(Ref. 7)." Added title for clarity.

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Item	Source	Description
91.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
92.	Editorial	Modified to eliminate gender-specific reference.
93.	Editorial	Provided "SER" as initialism for "safety evaluation report."
94.	Editorial	Added the parenthetical phrase, "including the residual heat removal system, emergency core cooling system, fan cooler systems, spray systems, containment sumps, wetwells, etc.," for clarity.
95.	Editorial	Deleted the word "has" to correct tense.
96.	Editorial	Deleted the word "has" to correct tense.
97.	Editorial	Deleted the word "the" as unnecessary.
98.	Editorial	Deleted "boiler plate" text of EVALUATION FINDINGS and substituted appropriate evaluation conclusions as taken from the GDC. The existing text is not meaningful and some parts are not appropriate to this SRP section.
99.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
100.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
101.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
102.	Editorial	Deleted paragraph pertaining to implementation schedule for subsection II.6 because it is no longer pertinent. The deleted paragraph and its associated footnote referring to applications after March 1986. All applications that will refer to this forthcoming revision of the SRP are in this category.
103.	Editorial	Deleted footnote that refers to deleted text because it is no longer pertinent. See item 93.
104.	SRP-UDP format item	Added Reference 8 for CONTEMPT-LT computer code that is cited in the existing text of SRP Section 6.2.2.

**SRP Draft Section 6.2.2**  
Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
374	Consideration should be given to revising REVIEW PROCEDURES to ensure adequate sizing of ECCS strainers in LWRs.	Review Procedures 11.a.v. and 11.b.