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Inventor(s) Noel; Derek et al.

WELD DOWN PIPE AND TUBE SUPPORT BASE

Abstract

A mount support system comprising a base having a first end and a second end opposite the first end. The base including a first surface configured to engage a clamp, a second surface configured to engage with an installation surface, a first T-slot extending at from the first end toward a center of the base, and a second T-slot extending from the second end toward the center of the base. The clamp including a lower portion configured to engage with the base, and an upper portion configured to engage with the lower portion, at least one fastener extending through the clamp configured to engage with at least one of the first T-slot and the second T-slot, and configured to penetrate the lower portion of the clamp and the upper portion of the clamp, and at least one fastening device configured to couple with the at least one fastener.

Inventors: **Noel; Derek (Albany, OR), Schaller; Stephen (Denver, CO), Diefendorf; Daniel (Albany, OR), Why; John Van (Albany, OR)**

Applicant: **NuScale Power, LLC** (Corvallis, OR)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION(S) [0001] This application claims the benefit of U.S. Provisional Patent Application No. 63/555,442 filed Feb. 20, 2024 and titled “Weld Down Pipe and Tube Support Base,” which is incorporated herein by reference in its entirety.

BACKGROUND
[0003] Nuclear reactors utilize a network of pipes and tubes to transport various fluids at various temperatures and pressures. In some circumstances, pipes and/or tubes must be secured in place using pipe and/or tube supports. Attaching pipe and tube supports to a reactor pressure vessel (RPV) and/or a containment vessel (CNV) may require special considerations because of various regulatory requirements set forth by various governing bodies. Accordingly, various constraints under regulatory requirements are considered for pipe and tube support mounting systems and components.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0004] FIG. **1** schematically illustrates an integrated power plant system that includes a power plant system that uses a small modular nuclear reactor (SMR) system with nuclear power modules (NPMs) that include a weld down pipe and tube support base system, according to an embodiment of this disclosure.
[0005] FIG. **2** illustrates an isometric view, depicting front, top, and side of an installed weld down pipe and tube support base system, according to an embodiment of this disclosure.
[0006] FIG. **3**A illustrates an isometric view, depicting front, top, and side of a weld down pipe and tube support base system, according to an embodiment of this disclosure.
[0007] FIG. **3**B illustrates a close-up view of a portion of the front and side of the weld down pipe and tube support base system of FIG. **3**A, according to an embodiment of this disclosure.
[0008] FIG. **4** illustrates an isometric view, depicting front, bottom, and side of the weld down pipe and tube support base system of FIG. **3**A, according to an embodiment of this disclosure.
[0009] FIG. **5** illustrates an isometric view, depicting front, top, and side of the weld down pipe and tube support base (“base”) of FIG. **3**A, according to an embodiment of this disclosure.
[0010] FIG. **6** illustrates an isometric view, depicting bottom, top, and side of the weld down pipe and tube support base (“base”) of FIG. **3**A, according to an embodiment of this disclosure.
[0011] FIG. **7** is a partially schematic, partially cross-sectional view of a nuclear reactor system configured in accordance with embodiments of the present technology.
[0012] FIG. **8** is a partial schematic, partial cross-sectional view of a nuclear reactor system configured in accordance with additional embodiments of the present technology.
[0013] FIG. **9** is a schematic view of a nuclear power plant system including multiple nuclear reactors in accordance with embodiments of the present technology.
DETAILED DESCRIPTION
Overview
[0014] The Detailed Description is set forth with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items. Furthermore, the drawings may be considered as providing an approximate

depiction of the relative sizes of the individual components within individual figures. However, the drawings are not to scale, and the relative sizes of the individual components, both within individual figures and between the different figures, may vary from what is depicted. In particular, some of the figures may depict components as a certain size or shape, while other figures may depict the same components on a larger scale or differently shaped for the sake of clarity.

[0015] This disclosure is directed to pipe supports for use in nuclear reactors (e.g., small modular nuclear reactors (SMRs), pressurized water reactors, advanced reactors, etc.). While specifically, discussed as being useful for nuclear reactors, the pipe supports may be useful in other applications for other systems.

[0016] Specific details of several embodiments of the present technology are described herein. The present technology, however, may be practiced without some of these specific details. In some instances, well-known structures and techniques often associated with steam generation, nuclear power conversion systems, and the like have not been shown in detail so as not to obscure the present technology.

[0017] The terminology used in the description presented below is intended to be interpreted in its broadest reasonable manner, even though it is used in conjunction with a detailed description of certain specific embodiments according to this disclosure. Certain terms may be emphasized below; however, any terminology intended to be interpreted in any restricted manner may be overtly and specifically defined as such in this Detailed Description section.

[0018] The headings provided herein are for convenience only and should not be construed as limiting the subject matter disclosed.

Illustrative Embodiments

[0019] FIG. **1** schematically illustrates an integrated power plant system **100** that includes a power plant system **102** that uses a small modular nuclear reactor (SMR) system **104** with one or more nuclear power modules (NPMs) **106** that include a weld down pipe and tube support base system **108** (“support base system”), according to an embodiment of this disclosure.

[0020] In an embodiment, the SMR system **104** may include a multi-module power plant design with similar NPMs. In an embodiment, the SMR system **104** may represent any type of power plant system (e.g., advanced nuclear reactor system, microreactor system, pressurized heavy water nuclear reactor system, etc.). For example, the power plant system **102** may include multiple SMRs with the same or different sizes and/or operating characteristics.

[0021] In an embodiment, the support base system **108** may be installed on a surface of one or more NPMs **106**. For example, the support base system **108** may be installed vertically, horizontally, or angularly, on an inside surface of the NPM **106**. When installed, the support base system **108** may be used as an anchor point (i.e., mounting point, stabilization point, etc.) for various support system components (e.g., fluid piping, fluid tubing, electrical conduit, control rod drive system, containment system, and reactor pressure vessel and containment vessel flange test port tubing, etc.). In an embodiment, the support base system **108** may be used on the containment system flooding and drain piping inside of the containment vessel of the one or more NPMs **106**.

[0022] FIG. **2** illustrates an isometric front, top, and side view of an installed weld down pipe and tube support base system **200** (“support base system”), according to an embodiment of this disclosure. In an embodiment, the support base system **200** may include a weld down pipe and tube support base **202** (e.g., base plate, base, support base, etc.), clamp **204** (e.g., tube support, pipe support, conduit support, etc.), first bolt **206** (e.g., first fastener, etc.), first fastening device **208**, second bolt **210** (e.g., second fastener, etc.), and second fastening device **212**.

[0023] In an embodiment, the clamp **204** may be configured to secure component P to base **202**. In an embodiment, the first fastening device **208** and the second fastening device **212** may include one or more nuts, one or more locknuts, one or more washers, one or more lock washers, or any other fastener configured to engage with the first bolt **206** and/or the second bolt **210**. In an embodiment the base **202** may be attached (e.g., welded, etc.) to a mounting plate **214** that may be attached to mounting surface S (e.g., reactor pressure vessel wall, containment vessel wall, installation surface, etc.). In an embodiment, the base **202** may be attached (e.g., welded, etc.) directly to the mounting surface S (e.g., reactor pressure vessel wall, containment vessel wall, installation surface, etc.).

[0024] In an embodiment, the mounting surface S may be curved (e.g., convex, concave, etc.) and the mounting plate **214** may include a first surface configured to planarly engage the curved mounting surface S, and a second surface that is configured to planarly engage with the base **202**.

[0025] FIG. **3**A illustrates an isometric front, top, and side view of a weld down pipe and tube support base system **300** ("support base system"), according to an embodiment of this disclosure. In an embodiment, the support base system **300** may include a weld down pipe and tube support base **302** (e.g., base plate, base, support base, etc.), clamp **304** (e.g., tube support, pipe support, conduit support, etc.), first bolt **306**, first fastening device **308**, second bolt **310**, and second fastening device **312**.

[0026] In an embodiment, the support base system **300** may have a front side **314** (e.g., front end, front face, etc.), a first side **315**, a rear side **316** (e.g., rear end, rear face, etc.), a second side **317**, a top end **318** (e.g., top side, top face, first end, etc.), and a bottom end **320** (e.g., bottom side, bottom face, second end, etc.).

[0027] In an embodiment, the clamp **304** may include an upper portion **322** (e.g., top portion, upper half, top half, etc.). In an embodiment, the upper portion **322** may include a channel **324** (e.g., first channel, top channel, cutout, curved portion, etc.) that extends from the front side **314** to the rear side **316**. In an embodiment, the clamp **304** may include a lower portion **326** (e.g., bottom portion, lower half, bottom half, etc.). In an embodiment, the lower portion **326** may include a channel **328** (e.g., second channel, bottom channel, cutout, curved portion, etc.) that extends from the front side **314** to the rear side **316**.

[0028] In an embodiment, the upper portion **322** and the lower portion **326** may be installed such that the first channel **324** and the second channel **328** may form aperture **330** extending from the front side **314** of the clamp **304** to the rear side **316** of the clamp **304**. At the time of manufacture, the aperture **330** may be sized and shaped to accommodate any size and/or shape as required (e.g., 1 inch steam pipe, ¾ inch steam pipe, etc.).

[0029] In an embodiment, the first bolt **306** and the second bolt **310** may be sized to extend from the base **302**, through (e.g., penetrate, etc.) the lower portion **326** of the clamp **304**, through (e.g., penetrate, etc.) the upper portion **322** of the clamp **304**, and extend past the top end **318** of the clamp **304** at a length L, as desired. In an embodiment, the first fastening device **308** and the second fastening device **312** may be configured to engage with the first bolt **306** and the second bolt **310**, respectively, along length L.

[0030] In an embodiment, the first fastening device **308** and the second fastening device **312** may include lock nut(s), lock washer(s), jam nut(s), flat washer(s), or any other suitable fastener configured to engage with the first bolt **306** and the second bolt **310**, respectively.

[0031] In an embodiment, the clamp **304** may be coupled to the base **302** via first bolt **306**, first fastening device **308**, second bolt **310**, and second fastening device **312**. In an embodiment, the base **302** may be configured to secure a bottom end **320** of the first bolt **306** and a bottom end **320** of the second bolt **310** in place such that neither the first bolt **306** nor the second bolt **310** may rotate. When the clamp **304** is installed on the base **302** the first bolt **306** and the second bolt **310**, rotation of the first fastening device **308** and the second fastening device **312** may tighten the clamp **304** against the base **302**.

[0032] FIG. **3**B illustrates a close-up view **301** of a portion of the front and side of the weld down pipe and tube support base system **300** ("support base system") of FIG. **3**A, according to an embodiment of this disclosure.

[0033] In an embodiment, the base **302** may include a T-slot **332** (e.g., first T-slot, etc.) that extends from the second side **317** toward the first side **315** (not shown in FIG. **3**B, see FIG. A). In an embodiment, the T-slot **332** may include a first width **334** that is sized to accommodate a shank (e.g., shaft, etc.) portion of a bolt (e.g., first bolt **306**, second bolt **310**, etc.). In an embodiment, the T-slot **332** may include a second width **336** that is sized to slidably accommodate (e.g., receive, allow, accept, etc.) the head of a bolt (e.g., first bolt **306**, second bolt **310**, etc.). For example, the head of first bolt **306** may slide into the portion (e.g., first portion, second portion, etc.) of the T-slot **332** that has second width **336**. In an embodiment, the second width **336** may be such that the head of a bolt may fit within second width **336** but may not rotate freely within the second width **336**.

[0034] FIG. **4** illustrates an isometric front, bottom, and side view of the weld down pipe and tube support base system **300** of FIG. **3**A, according to an embodiment of this disclosure. In an embodiment, the base **302** may include the T-slot **332** and a T-slot **400** (e.g., second T-slot, etc.). In an embodiment, the first bolt **306** may include a bolt head **402**. The bolt head **402** may be sized to fit within the T-slot **332** at the second width **336** such that the first bolt **306** may not rotate.

[0035] In an embodiment, the T-slot **400** may include a first width (not shown) that is sized to accommodate a shank (e.g., shaft, etc.) portion of the second bolt **310**. The T-slot **400** may include a second width **404** sized to accommodate a bolt head **406** of the second bolt **310**. In an embodiment, the second bolt **310** may include a bolt head **406**. The bolt head **406** may be sized to fit within the T-slot **400** at second width **404** such that the second bolt **310** may not rotate.

[0036] In an embodiment, the T-slot **332** may extend in a first direction **408** toward the T-slot **400**. In an embodiment, the T-slot **332** may extend to length **410**. In an embodiment, the T-slot **400** may extend in a second direction **412** toward the T-slot **332**. In an embodiment, the T-slot **400** may extend to length **414**.

[0037] The orientation of T-slot **332** and T-slot **400** (i.e., on opposite ends of the base **302**) allows for the first bolt **306** and the second bolt **310** to be installed after the base plate is welded in place. T-slot **332** and T-slot **400** prevent the first bolt **306** and the second bolt **310** from rotating, when installed in the base **302**. Length **410** and length **414** of T-slot **332** and T-slot **400**, respectfully, are such that when the first bolt **306** and the second bolt **310** are installed, neither bolt may slide out of the open end of the T-slot before the opposite bolt hits the closed end of the slot.

[0038] In an embodiment, a strain relief feature may be cut into the center of the welded base to relieve the strain of being welded to a dissimilar material or expanding pressure vessel. For example, the portion of base **302** between the T-slot **332** and T-slot **400** (e.g., middle portion, middle section, center, etc.) may include a gap, groove, channel, or other modification to allow for expansion and/or contraction.

[0039] FIG. **5** illustrates an isometric front, top, and side view of the weld down pipe and tube support base **302** ("base") of FIG. **3**A, according to an embodiment of this disclosure.

[0040] In an embodiment, the base **302** may include a clamp surface **500** (e.g., first surface, second surface, etc.) at the top end **318** of the base **302**. In an embodiment, the rear side **316** of the base **302** may include a lip **502** (e.g., raised edge, shoulder, etc.) that extends (e.g., runs, follows, etc.) along the length **504** of the base **302**. In an embodiment, the front side **314** of the base **302** may include a lip **506** (e.g., raised edge, shoulder, etc.) that extends (e.g., runs, follows, etc.) along the length **504** of the base **302**.

[0041] In an embodiment, when the lower portion **326** (not shown in FIG. **5**, see FIG. **3**A and/or FIG. **3**B), is planarly engaged with the clamp surface **500**, the lip **502** and the lip **506** prevent the lower portion **326** from moving in a direction **512**. For example, in an embodiment, when the lower portion **326** is engaged with the clamp surface **500**, the lip **506** may be engaged with the front side **314** of the lower portion **326**, and the lip **502** may be engaged with the rear side **316** of the lower portion **326**.

[0042] In an embodiment, the lip **502** and the lip **506** may extend past the clamp surface **500** in a direction away from the clamp surface **500**. For example, in an embodiment, the distance between the bottom end **320** of the base **302** to the clamp surface **500** may extend to a height **508**, and the bottom end **320** of the base **302** may extend to the top end **318** of the lip **502**/**506** at height **510**, wherein height **510** is greater than height **508**. At the time of manufacture of the base **302**, the lip **502** and the lip **506** may be configured such that the height **510** may be greater than the height **508** as desired.

[0043] FIG. **6** illustrates an isometric bottom, top, and side view of the weld down pipe and tube support base **302** ("base"), according to an embodiment of this disclosure. In an embodiment, the base **302** may include a mounting surface **610** (e.g., first surface, second surface, etc.). The mounting surface **610** may be configured to engage with the mounting plate **214** (not shown in FIG. **6**, see FIG. **2**). In an embodiment, the mounting surface **610** may be engaged with the mounting plate **214** when the base **302** is welded to the mounting plate **214**.

[0044] In an embodiment, the T-slot **332** may include a ledge **600**. In an embodiment, the T-slot **400** may include a ledge **602**. The ledge **600** and the ledge **602** may extend along the length **410** and the length **414**, respectively.

[0045] In an embodiment, the T-slot **332** may include an inner wall **604** that extends from the clamp surface **500** to the ledge **600** at a height **606**. In an embodiment, the T-slot **332** may include an inner wall **608** that extends from the ledge **600** to a mounting surface **610**.

[0046] In an embodiment, the inner wall **608** may be configured to engage with the outside surface of a bolt head (e.g., bolt head **402**, bolt head **406**, etc.) such that the bolt head may not rotate.

[0047] In an embodiment, the T-slot **400** may be mirror identical to the T-slot **332**. For example, the inner wall **612** of the T-slot **400** may be identical in form and function of the inner wall **608** of the T-slot **332** and the ledge **602** of T-slot **400** may be identical in form and function of the ledge **600** of the T-slot **332**.

[0048] FIGS. **7** and **8** illustrate representative nuclear reactors that may be included in embodiments of the present technology. FIG. **7** is a partially schematic, partially cross-sectional view of a nuclear reactor system **700** configured in accordance with embodiments of the present technology. The system **700** can include a power module **702** having a reactor core **704** in which a controlled nuclear reaction takes place. Accordingly, the reactor core **704** can include one or more fuel assemblies **701**. The fuel assemblies **701** can include fissile and/or other suitable materials. Heat from the reaction generates steam at a steam generator **730**, which directs the steam to a power conversion system **740**. The power conversion system **740** generates electrical power, and/or provides other useful outputs, such as super-heated steam. A sensor system **750** is used to monitor the operation of the power module **702** and/or other system components. The data obtained from the sensor system **750** can be used in real time to control the power module **702**, and/or can be used to update the design of the power module **702** and/or other system components.

[0049] The power module **702** includes a containment vessel **710** (e.g., a radiation shield vessel, or a radiation shield container) that houses/encloses a reactor vessel **720** (e.g., a reactor pressure vessel, or a reactor pressure container), which in tum houses the reactor core **704**. The containment vessel **710** can be housed in a power module bay **756**. The power module bay **756** can contain a cooling pool **703** filled with water and/or another suitable cooling liquid. The bulk of the power module **702** can be positioned below a surface **705** of the cooling pool **703**. Accordingly, the cooling pool **703** can operate as a thermal sink, for example, in the event of a system malfunction.

[0050] A volume between the reactor vessel **720** and the containment vessel **710** can be partially or completely evacuated to reduce heat transfer from the reactor vessel **720** to the surrounding environment (e.g., to the cooling pool **703**). However, in other embodiments the volume between the reactor vessel **720** and the containment vessel **710** can be at least partially filled with a gas and/or a liquid that increases heat transfer between the reactor vessel **720** and the containment vessel **710**. For example, the volume between the reactor vessel **720** and the containment vessel **710** can be at least partially filled (e.g., flooded with the primary coolant **707**) during an emergency operation.

[0051] Within the reactor vessel **720**, a primary coolant **707** conveys heat from the reactor core **704** to the steam generator **730**. For example, as illustrated by arrows located within the reactor vessel

720, the primary coolant **707** is heated at the reactor core **704** toward the bottom of the reactor vessel **720**. The heated primary coolant **707** (e.g., water with or without additives) rises from the reactor core **704** through a core shroud **706** and to a riser tube **708**. The hot, buoyant primary coolant **707** continues to rise through the riser tube **708**, then exits the riser tube **708** and passes downwardly through the steam generator **730**. The steam generator **730** includes a multitude of conduits **732** that are arranged circumferentially around the riser tube **708**, for example, in a helical pattern, as is shown schematically in FIG. **7**. The descending primary coolant **707** transfers heat to a secondary coolant (e.g., water) within the conduits **732**, and descends to the bottom of the reactor vessel **720** where the cycle begins again. The cycle can be driven by the changes in the buoyancy of the primary coolant **707**, thus reducing or eliminating the need for pumps to move the primary coolant **707**.
[0052] The steam generator **730** can include a feedwater header **731** at which the incoming secondary coolant enters the steam generator conduits **732**. The secondary coolant rises through the conduits **732**, converts to vapor (e.g., steam), and is collected at a steam header **733**. The steam exits the steam header **733** and is directed to the power conversion system **740**.
[0053] The power conversion system **740** can include one or more steam valves **742** that regulate the passage of high pressure, high temperature steam from the steam generator **730** to a steam turbine **743**. The steam turbine **743** converts the thermal energy of the steam to electricity via a generator **744**. The low-pressure steam exiting the turbine **743** is condensed at a condenser **745**, and then directed (e.g., via a pump **746**) to one or more feedwater valves **741**. The feedwater valves **741** control the rate at which the feedwater re-enters the steam generator **730** via the feedwater header **731**. In other embodiments, the steam from the steam generator **730** can be routed for direct use in an industrial process, such as a Hydrogen (H.sub.2) and Oxygen (O.sub.2) production plant, a chemical production plant, and/or the like, as described in detail below. Accordingly, steam exiting the steam generator **730** can bypass the power conversion system **740**.
[0054] The power module **702** includes multiple control systems and associated sensors. For example, the power module **702** can include a hollow cylindrical reflector **709** that directs neutrons back into the reactor core **704** to further the nuclear reaction taking place therein. Control rods **713** are used to modulate the nuclear reaction and are driven via fuel rod drivers **715**. The pressure within the reactor vessel **720** can be controlled via a pressurizer plate **717** (which can also serve to direct the primary coolant **707** downwardly through the steam generator **730**) by controlling the pressure in a pressurizing volume **719** positioned above the pressurizer plate **717**.
[0055] The sensor system **750** can include one or more sensors **751** positioned at a variety of locations within the power module **702** and/or elsewhere, for example, to identify operating parameter values and/or changes in parameter values. The data collected by the sensor system **750** can then be used to control the operation of the system **700**, and/or to generate design changes for the system **700**. For sensors positioned within the containment vessel **710**, a sensor link **752** directs data from the sensors to a flange **753** (at which the sensor link **752** exits the containment vessel **710**) and directs data to a sensor junction box **754**. From there, the sensor data can be routed to one or more controllers and/or other data systems via a data bus **755**.
[0056] FIG. **8** is a partially schematic, partially cross-sectional view of a nuclear reactor system **800** configured in accordance with additional embodiments of the present technology. In some embodiments, the nuclear reactor system **800** ("system **800**") can include some features that are at least generally similar in structure and function, or identical in structure and function, to the corresponding features of the system **700** described in detail above with reference to FIG. **7**, and can operate in a generally similar or identical manner to the system **700**.
[0057] In the illustrated embodiment, the system **800** includes a reactor vessel **820** and a containment vessel **810** surrounding/enclosing the reactor vessel **820**. In some embodiments, the reactor vessel **820** and the containment vessel **810** can be roughly cylinder-shaped or capsule-shaped. The system **800** further includes a plurality of heat pipe layers **811** within the reactor vessel

820. In the illustrated embodiment, the heat pipe layers **811** are spaced apart from and stacked over one another. In some embodiments, the heat pipe layers **811** can be mounted/secured to a common frame **812**, a portion of the reactor vessel **820** (e.g., a wall thereof), and/or other suitable structures within the reactor vessel **820**. In other embodiments, the heat pipe layers **811** can be directly stacked on top of one another such that each of the heat pipe layers **811** supports and/or is supported by one or more of the other ones of the heat pipe layers **811**.

[0058] In the illustrated embodiment, the system **800** further includes a shield or reflector region **814** at least partially surrounding a core region **816**. The heat pipe layers **811** can be circular, rectilinear, polygonal, and/or can have other shapes, such that the core region **816** has a corresponding three-dimensional shape (e.g., cylindrical, spherical). In some embodiments, the core region **816** is separated from the reflector region **814** by a core barrier **815**, such as a metal wall. The core region **816** can include one or more fuel sources, such as fissile material, for heating the heat pipe layers **811**. The reflector region **814** can include one or more materials configured to contain/reflect products generated by burning the fuel in the core region **816** during operation of the system **800**. For example, the reflector region **814** can include a liquid or solid material configured to reflect neutrons and/or other fission products radially inward toward the core region **816**. In some embodiments, the reflector region **814** can entirely surround the core region **816**. In other embodiments, the reflector region **814** may partially surround the core region **816**. In some embodiments, the core region **816** can include a control material **817**, such as a moderator and/or coolant. The control material **817** can at least partially surround the heat pipe layers **811** in the core region **816** and can transfer heat therebetween.

[0059] In the illustrated embodiment, the system **800** further includes at least one heat exchanger **830** (e.g., a steam generator) positioned around the heat pipe layers **811**. The heat pipe layers **811** can extend from the core region **816** and at least partially into the reflector region **814** and are thermally coupled to the heat exchanger **830**. In some embodiments, the heat exchanger **830** can be positioned outside of or partially within the reflector region **814**. The heat pipe layers **811** provide a heat transfer path from the core region **816** to the heat exchanger **830**. For example, the heat pipe layers **811** can each include an array of heat pipes that provide a heat transfer path from the core region **816** to the heat exchanger **830**. When the system **800** operates, the fuel in the core region **816** can heat and vaporize a fluid within the heat pipes in the heat pipe layers **811**, and the fluid can carry the heat to the heat exchanger **830**. The heat pipes in the heat pipe layers **811** can then return the fluid toward the core region **816** via wicking, gravity, and/or other means to be heated and vaporized once again.

[0060] In some embodiments, the heat exchanger **830** can be similar to the steam generator **730** of FIG. **7** and, for example, can include one or more helically-coiled tubes that wrap around the heat pipe layers **811**. The tubes of the heat exchanger **830** can include or carry a working fluid (e.g., a coolant such as water or another fluid) that carries the heat from the heat pipe layers **811** out of the reactor vessel **820** and the containment vessel **810** for use in generating electricity, steam, and/or the like. For example, in the illustrated embodiment the heat exchanger **830** is operably coupled to a turbine **843**, a generator **844**, a condenser **845**, and a pump **846**. As the working fluid within the heat exchanger **830** increases in temperature, the working fluid may begin to boil and vaporize. The vaporized working fluid (e.g., steam) may be used to drive the turbine **843** to convert the thermal potential energy of the working fluid into electrical energy via the generator **844**. The condenser **845** can condense the working fluid after it passes through the turbine **843**, and the pump **846** can direct the working fluid back to the heat exchanger **830** where it can begin another thermal cycle. In other embodiments, steam from the heat exchanger **830** can be routed for direct use in an industrial process, such as an enhanced oil recovery operation described in detail below. Accordingly, steam exiting the heat exchanger **830** can bypass the turbine **843**, the generator **844**, the condenser **845**, the pump **846**, etc.

[0061] FIG. **9** is a schematic view of a nuclear power plant system **950** including multiple nuclear reactors **900** in accordance with embodiments of the present technology. Each of the nuclear reactors **900** (individually identified as first through twelfth nuclear reactors **900***a-l*, respectively) can be similar to or identical to the nuclear reactor **900** and/or the nuclear reactor **900** described in detail above with reference to FIGS. **7** and **8**. The power plant system **950** ("power plant system **950**") can be "modular" in that each of the nuclear reactors **900** can be operated separately to provide an output, such as electricity or steam. The power plant system **950** can include fewer than twelve of the nuclear reactors **900** (e.g., two, three, four, five, six, seven, eight, nine, ten, or eleven of the nuclear reactors **900**), or more than twelve of the nuclear reactors **900**. The power plant system **950** can be a permanent installation or can be mobile (e.g., mounted on a truck, tractor, mobile platform, and/or the like). In the illustrated embodiment, each of the nuclear reactors **900** can be positioned within a common housing **951**, such as a reactor plant building, and controlled and/or monitored via a control room **952**.

[0062] Each of the nuclear reactors **900** can be coupled to a corresponding electrical power conversion system **940** (individually identified as first through twelfth electrical power conversion systems **940***a-l*, respectively). The electrical power conversion systems **940** can include one or more devices that generate electrical power or some other form of usable power from steam generated by the nuclear reactors **900**. In some embodiments, multiple ones of the nuclear reactors **900** can be coupled to the same one of the electrical power conversion systems **940** and/or one or more of the nuclear reactors **900** can be coupled to multiple ones of the electrical power conversion systems **940** such that there is not a one-to-one correspondence between the nuclear reactors **900** and the electrical power conversion systems **940**.

[0063] The electrical power conversion systems **940** can be further coupled to an electrical power transmission system **954** via, for example, an electrical power bus **953**. The electrical power transmission system **954** and/or the electrical power bus **953** can include one or more transmission lines, transformers, and/or the like for regulating the current, voltage, and/or other characteristic(s) of the electricity generated by the electrical power conversion systems **940**. The electrical power transmission system **454** can route electricity via a plurality of electrical output paths **955** (individually identified as electrical output paths **955***a-n*) to one or more end users and/or end uses, such as different electrical loads of an integrated energy system.

[0064] Each of the nuclear reactors **900** can further be coupled to a steam transmission system **956** via, for example, a steam bus **957**. The steam bus **957** can route steam generated from the nuclear reactors **900** to the steam transmission system **956** which in tum can route the steam via a plurality of steam output paths **958** (individually identified as steam output paths **958***a-n*) to one or more end users and/or end uses, such as different steam inputs of an integrated energy system.

[0065] In some embodiments, the nuclear reactors **900** can be individually controlled (e.g., via the control room **952**) to provide steam to the steam transmission system **956** and/or steam to the corresponding one of the electrical power conversion systems **940** to provide electricity to the electrical power transmission system **954**. In some embodiments, the nuclear reactors **900** are configured to provide steam either to the steam bus **957** or to the corresponding one of the electrical power conversion systems **940** and can be rapidly and efficiently switched between providing steam to either. Accordingly, in some aspects of the present technology the nuclear reactors **900** can be modularly and flexibly controlled such that the power plant system **950** can provide differing levels/amounts of electricity via the electrical power transmission system **954** and/or steam via the steam transmission system **956**. For example, where the power plant system **950** is used to provide electricity and steam to one or more industrial process-such as various components of the integrated energy systems, the nuclear reactors **900** can be controlled to meet the differing electricity and steam requirements of the industrial processes.

[0066] As one example, during a first operational state of an integrated energy system employing the power plant system **950**, a first subset of the nuclear reactors **900** (e.g., the first through sixth nuclear reactors **900***a-f*) can be configured to provide steam to the steam transmission system **956** for use in the first operational state of the integrated energy system, while a second subset of the nuclear reactors **900** (e.g., the seventh through twelfth nuclear reactors **900***g-l*) can be configured to provide steam to the corresponding ones of the electrical power conversion systems **940** (e.g., the seventh through twelfth electrical power conversion systems **940***g-l*) to generate electricity for the first operational state of the integrated energy system. Then, during a second operational state of the integrated energy system when a different (e.g., greater or lesser) amount of steam and/or electricity is required, some or all the first subset of the nuclear reactors **900** can be switched to provide steam to the corresponding ones of the electrical power conversion systems **940** (e.g., the seventh through twelfth electrical power conversion systems **940***g-l*) and/or some or all of the second subset of the nuclear reactors **900** can be switched to provide steam to the steam transmission system **956** to vary the amount of steam and electricity produced to match the requirements/demands of the second operational state. Other variations of steam and electricity generation are possible based on the needs of the integrated energy system. That is, the nuclear reactors **900** can be dynamically/flexibly controlled during other operational states of an integrated energy system to meet the steam and electricity requirements of the operational state.

[0067] In contrast, some conventional nuclear power plant systems can typically generate either steam or electricity for output and cannot be modularly controlled to provide varying levels of steam and electricity for output. Moreover, it is typically difficult (e.g., expensive, time consuming, etc.) to switch between steam generation and electricity generation in conventional nuclear power plant systems. Specifically, for example, it is typically extremely time consuming to switch between steam generation and electricity generation in prototypical large nuclear power plant systems.

[0068] The nuclear reactors **900** can be individually controlled via one or more operators and/or via a computer system. Accordingly, many embodiments of the technology described herein may take the form of computer-or machine-or controller-executable instructions, including routines executed by a programmable computer or controller. Those skilled in the relevant art will appreciate that the technology can be practiced on computer/controller systems other than those shown and described herein. The technology can be embodied in a special-purpose computer, controller or data processor that is specifically programmed, configured, or constructed to perform one or more of the computer-executable instructions described below. Accordingly, the terms “computer” and “controller” as generally used herein refer to any data processor and can include Internet appliances and hand-held devices (including palm-top computers, wearable computers, cellular or mobile phones, multi-processor systems, processor-based or programmable consumer electronics, network computers, mini computers and the like). Information handled by these computers can be presented at any suitable display medium, including a liquid crystal display (LCD).

[0069] The technology can also be practiced in distributed environments, where tasks or modules are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules or subroutines may be located in local and remote memory storage devices. Aspects of the technology described herein may be stored or distributed on computer-readable media, including magnetic or optically readable or removable computer disks, as well as distributed electronically over networks. Data structures and transmissions of data particular to aspects of the technology are also encompassed within the scope of the embodiments of the technology.

Conclusion

[0070] Although several embodiments have been described in language specific to structural features and/or methodological acts, it is to be understood that the claims are not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as illustrative forms of implementing the claimed subject matter.

[0071] The above detailed description of embodiments of the present technology are not intended to be exhaustive or to limit the technology to the precise forms disclosed above. Although specific embodiments of, and examples for, the technology are described above for illustrative purposes, various equivalent modifications are possible within the scope of the technology, as those skilled in the relevant art will recognize. For example, although steps may be presented in a given order, in an embodiment, the steps may be performed in a different order. The various embodiments described herein may also be combined to provide further embodiments.

[0072] From the foregoing, it will be appreciated that specific embodiments of the technology have been described herein for purposes of illustration, but well-known structures and functions have not been shown or described in detail to avoid unnecessarily obscuring the description of the embodiments of the technology. Where the context permits, singular or plural terms may also include the plural or singular term, respectively.

[0073] As used herein, the phrase “and/or” as in “A and/or B” refers to A alone, B alone, and A and B. Additionally, the term “comprising” is used throughout to mean including at least the recited feature(s) such that any greater number of the same feature and/or additional types of other features are not precluded. It will also be appreciated that specific embodiments have been described herein for purposes of illustration, but that various modifications may be made without deviating from the technology. Further, while advantages associated with some embodiments of the technology have been described in the context of those embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the technology. Accordingly, the disclosure and associated technology can encompass other embodiments not expressly shown or described herein.

Claims

1. A mount support system comprising: a base having a first end and a second end opposite the first end, the base including: a first surface extending from the first end to the second end, the first surface configured to engage a clamp, a second surface opposite the first surface, the second surface configured to engage with an installation surface, a first T-slot extending at least partially from the first end toward a center of the base, and a second T-slot extending at least partially from the second end toward the center of the base, the clamp including: a lower portion configured to engage with the first surface of the base, and an upper portion configured to engage with the lower portion, at least one fastener extending through the clamp, the at least one fastener including: a head configured to engage with at least one of the first T-slot or the second T-slot, and a shaft configured to penetrate the lower portion of the clamp and the upper portion of the clamp, and at least one fastening device configured to couple with the shaft of the at least one fastener.

2. The mount support system of claim 1, wherein the at least one fastener includes: a first fastener, and a second fastener, and wherein the at least one fastening device includes: a first fastening device, and a second fastening device.

3. The mount support system of claim 1, wherein the first surface of the base includes: a first lip running along a first edge of the first surface of the base, the first lip extending in a direction away from the first surface, and a second lip running along a second edge of the first surface of the base opposite the first edge, the second lip extending in the direction.

4. The mount support system of claim 1, wherein: the lower portion of the clamp includes: a first surface configured to engage with the first surface of the base, and a second surface opposite the first surface of the lower portion of the clamp, the second surface of the lower portion of the clamp including a curved portion that curves toward the first surface of the lower portion of the clamp.

5. The mount support system of claim 1, wherein: the upper portion of the clamp includes: a first surface configured to engage with the at least one fastening device, and a second surface opposite the first surface of the upper portion of the clamp, the second surface of the upper portion of the clamp including a curved portion that curves toward the first surface of the upper portion of the clamp.

6. The mount support system of claim 1, wherein: the base includes a middle portion between the first T-slot and the second T-slot, the middle portion including at least one of a gap, a groove, and a channel, wherein the middle portion is configured to expand or contract.
7. A support mount apparatus comprising: a first side including: a surface configured to engage with a clamp, a first lip at a first edge, and a second lip at a second edge, a second side opposite the first side, the second side including a surface configured to engage with an installation surface, a first T-slot extending at least partially from a first end of the support mount apparatus toward a center of the support mount apparatus, and a second T-slot extending at least partially from a second end of the support mount apparatus toward the center of the support mount apparatus.
8. The support mount apparatus of claim 7, wherein: the first T-slot includes: a first portion having a first width, the first portion configured to receive a shaft of a fastener, and a second portion having a second width that is greater than the first width, the second portion configured to receive a head the fastener, and the second T-slot includes: a first portion having a first width, the first portion configured to receive a shaft the fastener, and a second portion having a second width that is greater than the first width, the second portion configured to receive the head of the fastener.
9. The support mount apparatus of claim 8, wherein: the first T-slot further includes a ledge defined by the first portion and the second portion, the ledge configured to prevent the head of the fastener from entering the first portion from the second portion, and the second T-slot further includes a ledge defined by the first portion and the second portion, the ledge configured to prevent the head of the fastener from entering the first portion from the second portion.
10. The support mount apparatus of claim 7, wherein: the surface of the first side is configured to planarly engage with a bottom side of the clamp, the first lip is configured to planarly engage with a first side of the clamp adjacent to the bottom side of the clamp, and the second lip is configured to planarly engage with a second side of the clamp opposite the first side of the clamp.
11. The support mount apparatus of claim 7, wherein: the first lip extends in a first direction away from the surface of the first side at a first height, and the second lip extends in a second direction away from the surface of the first side at a second height.
12. The support mount apparatus of claim 7, wherein: the first T-slot extends toward the center of the support mount apparatus in a first direction for a first length, and the second T-slot extends toward the center of the support mount apparatus in a second direction that is opposite the first direction for a second length.
13. The support mount apparatus of claim 7, further comprising a middle portion between the first T-slot and the second T-slot, the middle portion including at least one of a gap, a groove, and a channel, wherein the middle portion is configured to expand or contract.
14. A clamping assembly, comprising: a nuclear reactor vessel, and a clamp assembly including: a base configured to be welded to the nuclear reactor vessel, a lower clamp portion configured to couple to the base, an upper clamp portion configured to couple to the lower clamp portion, at least one fastener extending through the base, the lower clamp portion, and the upper clamp portion, and at least one fastening device configured to engage with the at least one fastener.
15. The clamping assembly of claim 14, wherein: the base includes: a first side including: a surface configured to engage with the lower clamp portion, a first lip at a first edge, and a second lip at a second edge, a second side opposite the first side, the second side including a surface configured to engage with the nuclear reactor vessel, a first T-slot extending at least partially from a first end of base toward a center of the base, and a second T-slot extending at least partially from a second end of the center toward the center of the center.
16. The clamping assembly of claim 15, wherein: the at least one fastener includes: a head configured to slidably engage with at least one of the first T-slot or the second T-slot, and a shaft configured to penetrate the lower clamp portion and the upper clamp portion.
17. The clamping assembly of claim 15, wherein: the first T-slot includes: a first portion having a first width, the first portion configured to receive a shaft of the at least one fastener, and a second

portion having a second width that is greater than the first width, the second portion configured to receive a head of the at least one fastener, and the second T-slot includes: a first portion having a first width, the first portion configured to receive a shaft of the at least one fastener, and a second portion having a second width that is greater than the first width, the second portion configured to receive a head of the at least one fastener.

18. The clamping assembly of claim 15, wherein: the first T-slot extends toward the center of the base in a first direction for a first length, and the second T-slot extends toward the center of the base in a second direction that is opposite the first direction for a second length.

19. The clamping assembly of claim 14, wherein: the lower clamp portion includes: a first surface configured to engage with the base, and a second surface opposite the first surface, the second surface including a curved portion that curves toward the first surface.

20. The clamping assembly of claim 14, wherein: the upper clamp portion includes: a first surface configured to engage with the at least one fastening device, and a second surface opposite the first surface, the second surface including a curved portion that curves toward the first surface.