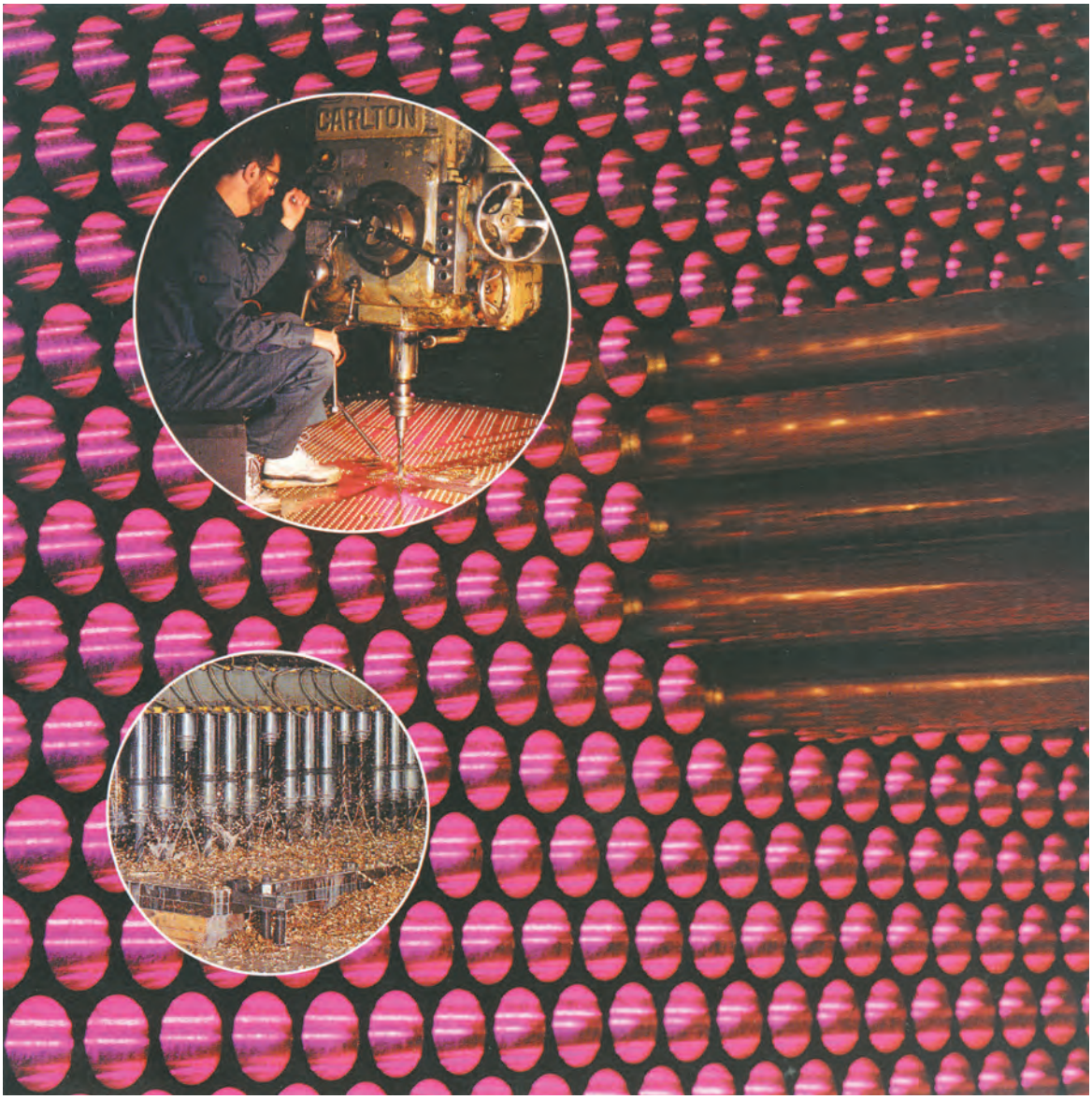
Global Supplier of Steam Condensers and Related Technology



Ecolaire®

Engineering Expertise

Quality and innovation go into the building of each Ecolaire steam surface condenser. . .on the drawing board, on the assembly floor, in the test lab, and at your jobsite. The result is a condenser specifically engineered to meet the needs of your application. . .and built to perform at full design efficiency.

This bulletin outlines many of the factors that go into the engineering, design, fabrication, installation and testing of Ecolaire's condensers. . .factors that contribute to their worldwide reputation for efficient performance and long life. It describes the many special features available to meet diverse needs and to enhance reliability.

We start by designing each condenser on an individual basis, to meet the specifications for your system. Our engineering staff considers every element that will affect condenser efficiency over your specified plant operating range to offer you the best possible heat rate over the widest range.

This basic system data includes:

- Monthly generating load changes.
- Average inlet cooling water temperatures, monthly.
- Worst-case cooling water temperature(s).
- Heat Balances for 25%, 50%, 75%, 100% and VWO.
- Turbine response curves (% changes in heat rate).
- Specific cycle requirements.

Based on the system data you provide, we engineer a condenser to meet your specific site requirements. We design and build it to Heat Exchange Institute Standards, and we pay attention to detail. Service connections are designed for both static and dynamic reactions and to cope with potential erosion. We give the same attention to these connections as to the unit itself because we believe a service connection malfunction should never be the cause of a condenser being taken off-line.

Basic Construction

- Modular construction with shop-installed tubes
- Anti-vortex baffles on condensate outlets
- Cascading air cooler
- Bolted-on tube sheets
- Rolled tube sheets
- Bolted-on waterboxes
- ASTM A516, Gr. 70 carbon steel shell
- Vaned steam dome
- Sliding support feet
- 20" diameter quick-opening manways
- All required service connections including internal baffles and spray pipes

System Oriented Features

- Heater and extraction piping supports
- Extraction steam piping
- Lagging
- Extraction piping manifold
- Fairing enclosures
- Isolation support plates
- Circulating water crossover piping
- Circulating water standpipes
- Retention hotwells
- Divided hotwells
- Double-effect hotwells
- Welded-on tube sheets
- Double tube sheets
- Integral groove tube sheets
- Serrated tube holes
- Flared tube ends
- Welded tube ends
- Welded-on waterboxes
- Lined waterboxes
- Lubricated support-feet pads
- Rubber "U" steam inlet expansion joints
- Rubber belt steam inlet expansion joints
- Stainless steel steam inlet expansion joints
- 24" diameter quick-opening manholes
- Condensate outlet screens
- Dirt collars
- Sole plates
- Field installation of tubes
- Steam dump systems
- Alternate materials of construction
- On-line condensate leak detection systems
- Turbine isolation dampers
- Spring supports

Manufacturing Capabilities

A key to the successful manufacturing of steam condensers is the ability to drill a large quantity of precision holes. Ecolaire has five (5) multi-spindle CNC drilling machines (up to 41 spindles) that drill tube sheets and support plates to ensure proper hole tolerances.

SPX Heat Transfer's 230,000 sq ft. manufacturing facility is located in Tulsa, Oklahoma, on a 38 acre improved site. Our welders are qualified under ASME Section IX. Presently we hold the ASME Section VIII Division 1 and 2 "U", "S" and "R" stamps. Our manufacturing facility also is Chinese SQL and ISO9001 certified.

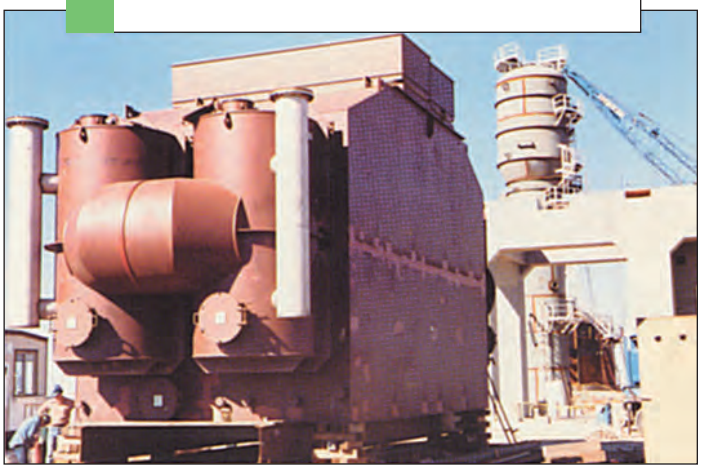
State of the art automatic oxy/fuel plasma cutting machine prepares all plates for assembly. This machine provides and simplifies cutting operations thus enhancing the productivity in the assembly operation.

The combination of machined cast iron leveling tables and right angle strong backs provide a base for accurate construction of condenser assemblies. This combination enables ease of tubing and assures proper alignment during field erection.

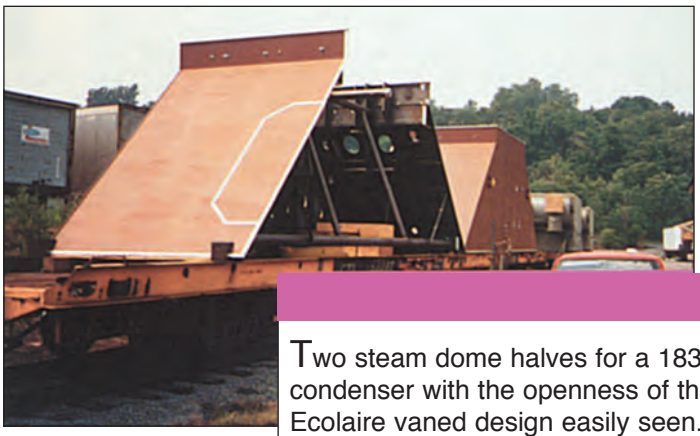
Utility and Independent Power Producers

The SPX Heat Transfer business has been producing Ecolaire condensers for power production since 1920 and to date has produced over 3,600 condensers. Those in operation have surfaces up to 1,400,000 square feet and serve plants up to 1300 MW. This extensive experience includes fossil-fueled installations with pressures up to 3,500 psig and nuclear installations on virtually every type of reactor system built.

Primary concern is always ease of installation; Ecolaire designs minimize field time. This 126,340 square-foot condenser was installed in 45 calendar days by a six-man crew working four, 10-hour days with no overtime. It was shipped in four major shell/hotwell and shell/steam dome sections, plus four waterboxes and two extension necks.



This two-shell, multi-pressure 600MW coal-fired condenser is ready for installation under a four-flow down exhaust steam turbine. The 458,704 square foot unit includes steam bypass provisions and low-pressure feedwater heaters in the steam dome.



Two steam dome halves for a 183 MW condenser with the openness of the Ecolaire vaned design easily seen. This feature minimizes cross-bracing and produces minimum pressure drop as steam distributes from the turbine to the tube bundles, thus increasing turbine efficiency.

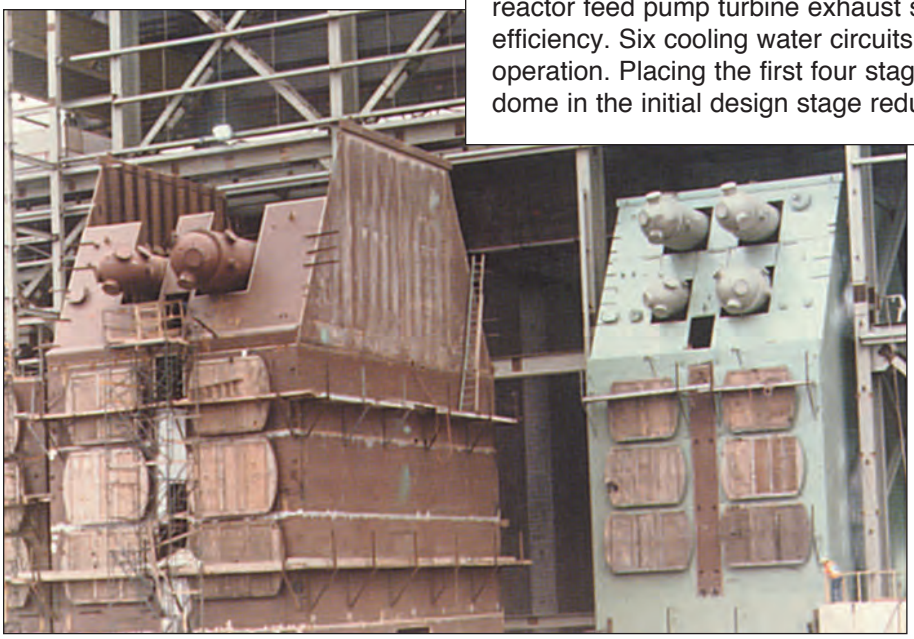
Final shop-tubed shell sections for two condensers are loaded in the hold of an exclusive-use ship for protection from the elements. Shipped complete on one vessel, they are destined for an 800 MW combined-cycle facility in the United Kingdom, transportation FOB jobsite arranged by Ecolaire.

SPX Heat Transfer's commitment to excellence has resulted in pioneering the path of advancement in condenser technology. There are over 80 multi-pressure Ecolaire units in operation with up to six pressure levels. Double-effect hotwells are in operation recovering the auxiliary turbine steam heat content that would otherwise be lost to the cooling system. Close-spaced double tube sheets are protecting condensate systems from cooling water inleakage at various installations. Steam dump systems with capacities to full steam generator flow are operating reliably.

SPX Heat Transfer has continued to advance condenser technology by designing and producing the first major condensers using Austenitic Stainless Steel AL-6XN® tubes and AL-6-XN® tube sheets, plus units using Ferritic Stainless Steel AL 29-4C® tubes and Type 904L tube sheets. These materials require the development of heat transfer parameters as well as tooling and other manufacturing technologies to ensure a quality product with high reliailty.

Whatever your cycle or material requirements, you can rely on SPX Heat Transfer to provide you with quality condensers that have a tradition of high availability and maintainability.

This three-shell, 900,000 square-foot 900 MW PWR condenser epitomizes the experience of design available from SPX Heat Transfer. Cycle efficiency is maximized by utilizing a three-shell three-pressure multi-pressure design with each shell having optimum surface with different tube lengths. Double-effect hotwells reheat condensate with reactor feed pump turbine exhaust steam to further improve cycle efficiency. Six cooling water circuits provide maximum flexibility of operation. Placing the first four stages of feedwater heaters in the steam dome in the initial design stage reduced overall plant space requirements.



Revamping

SPX Heat Transfer provided the first major revamping of two 815 MW, 650,870 square-foot PWR nuclear condensers with titanium tubes and tube sheets in 1981. Plant construction dictated that an in-place step-by-step procedure be used rather than modules. The methodology and special handling systems engineered by SPX Heat Transfer allowed completion of this revamping well within the schedule.

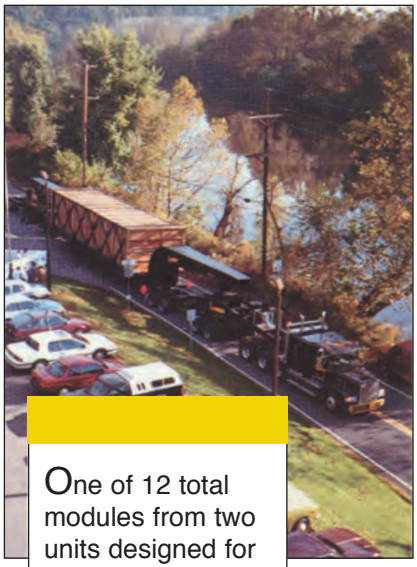
Since then revampings have been provided for condensers ranging from 3,600 square feet to 718,590 square feet and from one to six tube bundles per project. Extensive engineering support is available for:

- tube vibration studies
- support loadings
- structural analysis
- service connection analysis
- performance analysis

regardless of the original equipment manufacturer.

Experienced service personnel are available to guide any revamping work to ensure timely and accurate completion of the installation.

Two of four modules for a 350 MW fossil power plant in final preparation for shipment. Each module contains 69,732 square feet, is tubed with Type 439 stainless steel tubes and has Locktite® applied to tube ends for enhanced seal integrity.



One of 12 total modules from two units designed for a twin, 1,100 MW BWR nuclear power plant. Each 151,000-pound module is 10’4” wide x 13’10” high x 50’1” long and contains 459,000 linear feet of titanium tubing with 18,360 tube ends, rolled and seal-welded into solid titianium tube sheets.

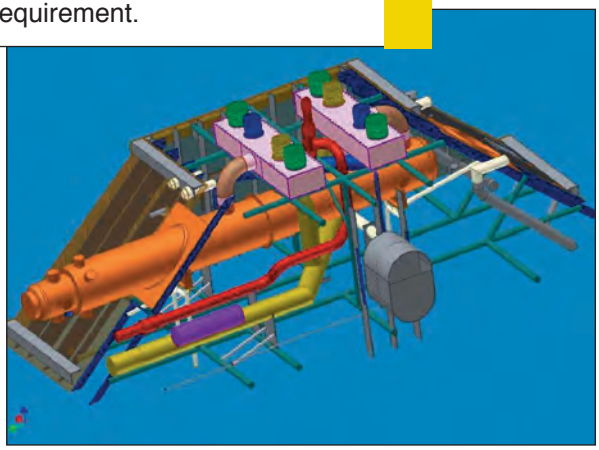
Vacuum-bubble testing of a complete module to prove the integrity of the welded tube ends, as well as the entire tube length. Vacuum-bubble testing ensures that the module is 100% leak-free, thus promoting reliability.

Refurbishing and Life Extensions

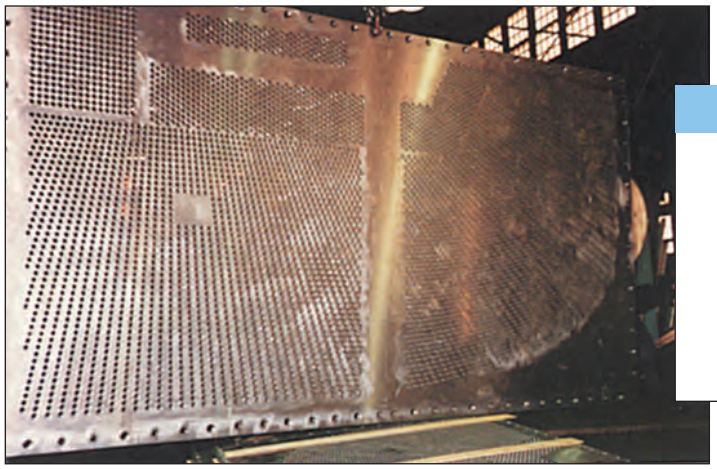
There are many condensers on salt water cooling systems with original cast iron waterboxes that are fast approaching their service life. These replacement waterboxes will be lined and will exactly match the tube sheet-to-waterbox bolting pattern because of our unique template matching to the original unit.

Refurbishments, upgrades and life extensions are designed by SPX Heat Transfer to provide the highest reliability for the specified service life. Refurbishing and upgradings range from new service connection review and redesign to new waterboxes and replacement tube sheets. Experienced personnel will follow your job through every step to the project's completion.

Examples of the engineering services SPX Heat Transfer can perform, regardless of condenser type or manufacturer include: addition of new or upgrading of old service connections due to cycle changes; spring support analysis and vibration studies when retubing with a different weight and wall gauge material; addition of exhaust hood cooling sprays when changing to prolonged steam dump cycles. Experienced engineering support is available for any condenser-related requirement.



SPX Heat Transfer is not just a new condenser manufacturer. Its engineers are prepared to service and upgrade the myriad operational units fabricated by other manufacturers, some no longer in business. If you have condenser units that require parts, service and connection upgrading as time passes and cycles are modernized, call SPX Heat Transfer. Our engineering capabilities can easily handle your needs.



These titanium tube sheets replace original muntz metal tubesheets on a condenser whose manufacturer is no longer in business. Note that the tube pattern is not on a grid precluding the use of a multi-spindle drill. SPX Heat Transfer has tape-controlled drilling machines designed to drill any pattern.

Cogeneration
Refuse Recovery
Industrial

"The same but different" is probably the most apt euphemism for applications in these areas. The "same" is the primary function to condense steam from the turbine to increase its efficiency while maintaining a high availability. The "but different" are the unique requirements of the various cycles involved; some of which are:

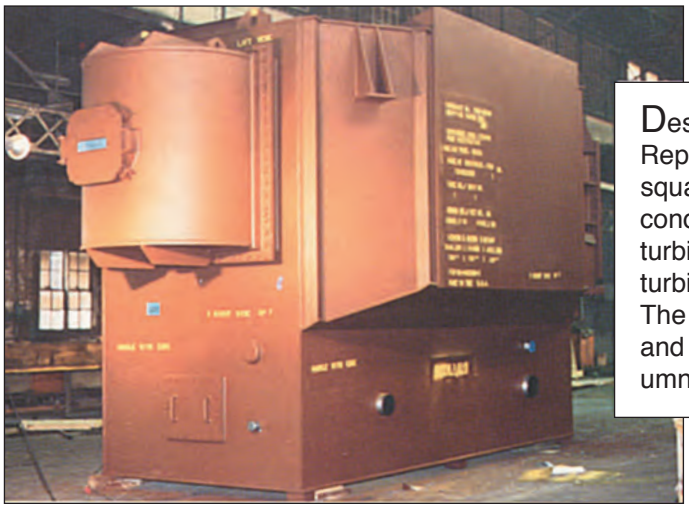
- support the turbine
- condense steam from more than one turbine at a time
- accept high steam dump volumes indefinitely
- use more than one cooling water source concurrently
- handle extremely high volumes of makeup

With our 85+ years of continuous condenser design and fabrication, SPX Heat Transfer is in a unique position to provide solutions for any individual cycle requirement. If it can be done in or handled by the condenser, we will engineer the solution to operate reliably over the life of the installation.

This 33,840 square-foot 50 MW axial exhaust condenser bolts directly to the steam turbine with metal to metal machined flange. The condenser supports and is the anchor point for the LP turbine. Expansion is controlled by a series of keys and guides.

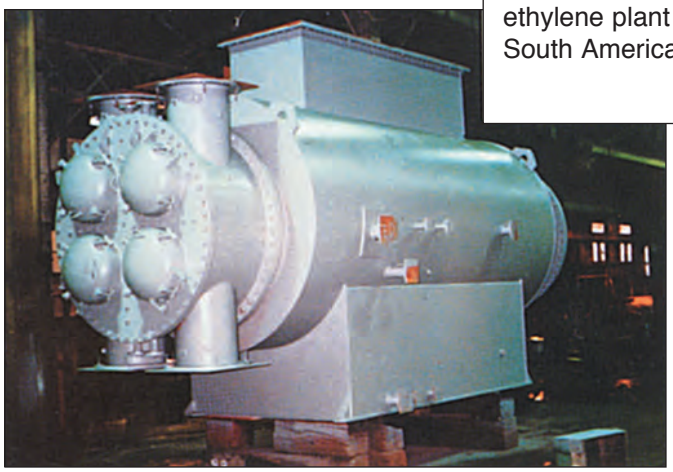
Serving a 25 MW vertical exhaust steam turbine as part of a combined cycle installation, this 20,000 square-foot unit includes a pressure balanced expansion joint and crossover duct designed by SPX Heat Transfer.

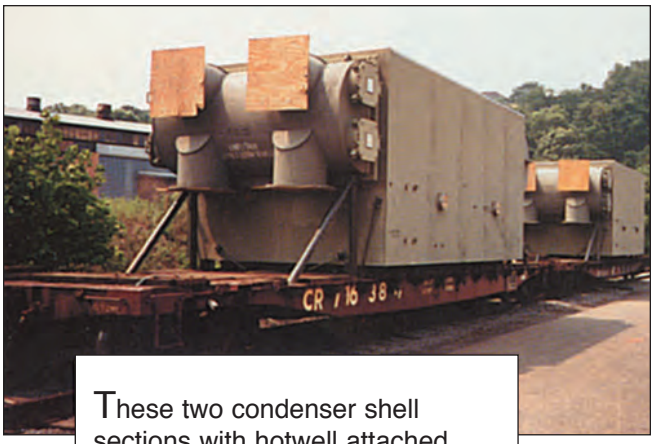
The burning of culm is an excellent example of cogeneration helping the environment. This power plant with its 34 MW down exhaust turbine and 40,570 square-foot condenser will aid in reducing the hills of coal tailings in Pennsylvania.



Destined for the Peoples Republic of China, this 11,065 square-foot axial exhaust condenser, serving a 17 MW turbine, is designed to be turbine centerline mounted. The unit supports the turbine and is mounted on rocker columns for expansion.

This 3,420 square-foot condenser will serve a heat pump compressor drive turbine in an ethylene plant in South America.





These two condenser shell sections with hotwell attached will serve a twin 55 MW coal fired cogeneration power station. The 35,945 square-foot condenser includes extraction piping for the steam host, provisions for high makeup and steam dump.

In the final stages of completion, this 79,280 square-foot twin shell side exhaust condenser will serve a 125 MW steam turbine at a 340 MW combined cycle installation. The top of the left hand shell supports a feedwater heater conserving plant space.

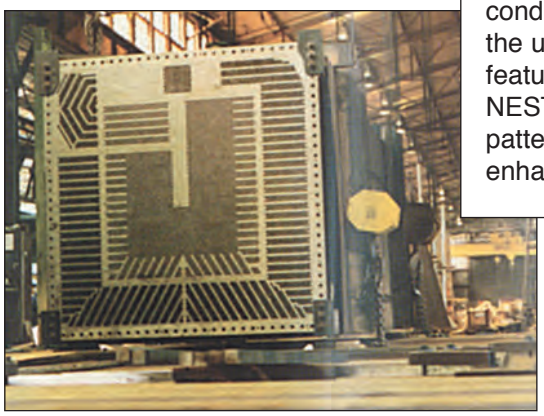
Geothermal

Geothermal condensers are unique in the power generating field. From the pioneering days of Geysers in the late 1950s and early 1960s, SPX Heat Transfer has applied both its field and in-house test results to produce reliable designs in both surface and direct contact condensers.

Unique to geothermal units is the extremely large amount of noncondensibles, as much as 10% or more of the steam flow. By comparison a typical power plant has less than 1/10% noncondensible flow. Ecolaire product designs include allowances for the heat transfer degradation by the noncondensibles and minimizing vapor carryover to reduce gas removal equipment power consumption.

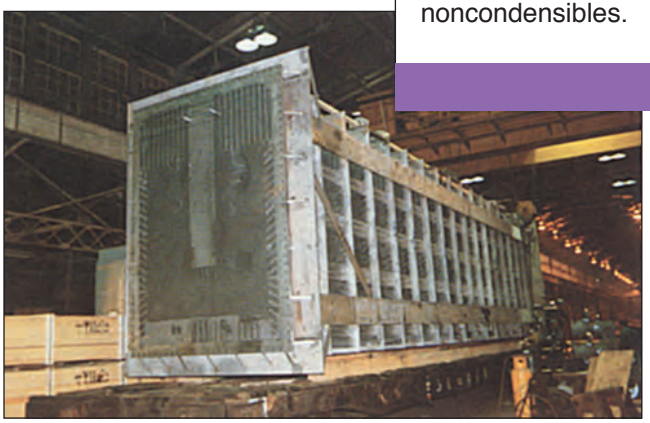
To negate the effects of corrosive steam, geothermal condensers are typically constructed entirely of stainless steel. Our 230,000 square-foot manufacturing facility is qualified to handle virtually any high-alloy material required.

Material selection and other sizing criteria may require change as a geothermal field ages. To ease replacement, if the situation arose, SPX Heat Transfer constructed this shop-tubed tube bundle for a two pass 104,800 square-foot condenser to slide in or out of the unit. This condenser also features a built-in precooler, NESTS® supports and a tube pattern specifically designed to enhance H_2S partitioning.

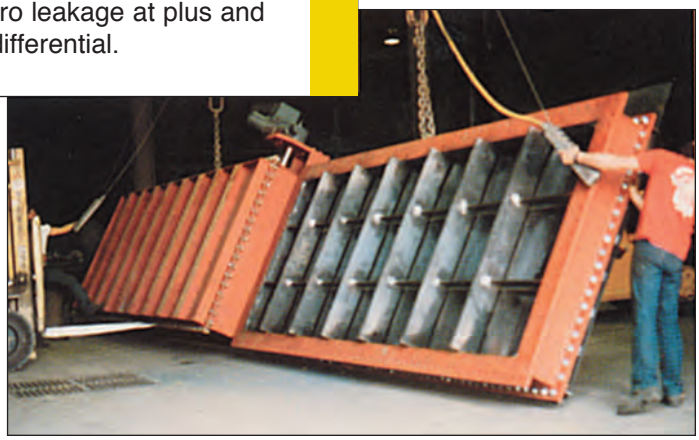


This noncondensible gas removal system including precooler has multiple ejectors to match capacity to actual noncondensible flow.

Until the well field is complete, operating actual noncondensible flow is unknown. To protect against any major variances, this shop-tubed shell section from a single pass 169,200 square-foot unit has a gas cooler section specifically designed to handle up to twice the amount of design noncondensibles.



This 7'-1" x 10'-11" damper will isolate a 60 MW turbine from a 45,300 square-foot condenser in a refuse recovery facility. The damper is fabricated as a separate unit for installation on top of the condenser. Test plates are being installed to test the seal for zero leakage at plus and minus 15 psi differential.



SPX Heat Transfer continues to pioneer in the condenser market by offering reliable solutions as cycle requirements evolve. In many combined cycle and refuse-recovery plants there is a requirement to operate the boiler while simultaneously performing maintenance on the steam turbine.

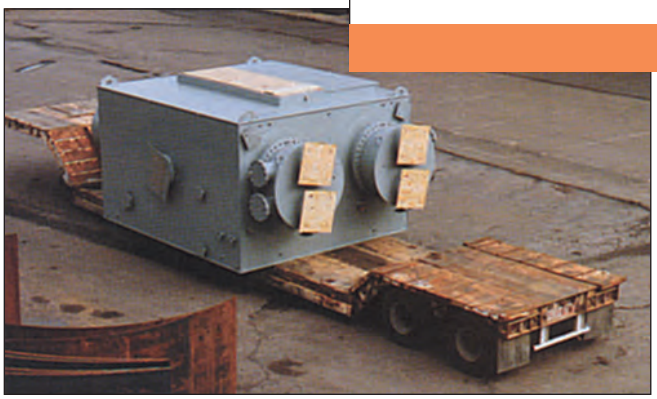
Traditionally this has been accomplished with a separate dump condenser. The method is costly in both equipment and space and can be fraught with control and operational problems.

SPX Heat Transfer has developed a zero-leakage turbine isolation damper that will allow the main condenser to accept the steam from the operating boiler, thus eliminating the dump condenser and attendant systems. Automatic operation allows complete isolation typically in less than 10 minutes.

Illustrated here are two of many installations that have proven their reliability and availability. In one instance, the turbine was damaged on initial start-up. The condenser then successfully operated in the isolated dump mode for over six months while turbine repairs were made.

The largest isolation damper to date is a 24'-10" x 24'-8" double-draw unit to isolate a 180 MW steam turbine. Essential to the reliable operation of large isolation dampers is integral design with the condenser to ensure vacuum and pressure loadings are properly balanced for all modes of operation.

This 6,575 square-foot condenser serves a 15 MW turbine in a combined cycle facility. The shell is oversize to dissipate the thermal and kinetic energy of the steam dump. The 9'-2" x 2'-5" isolation damper is integral within the top of the shell.



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