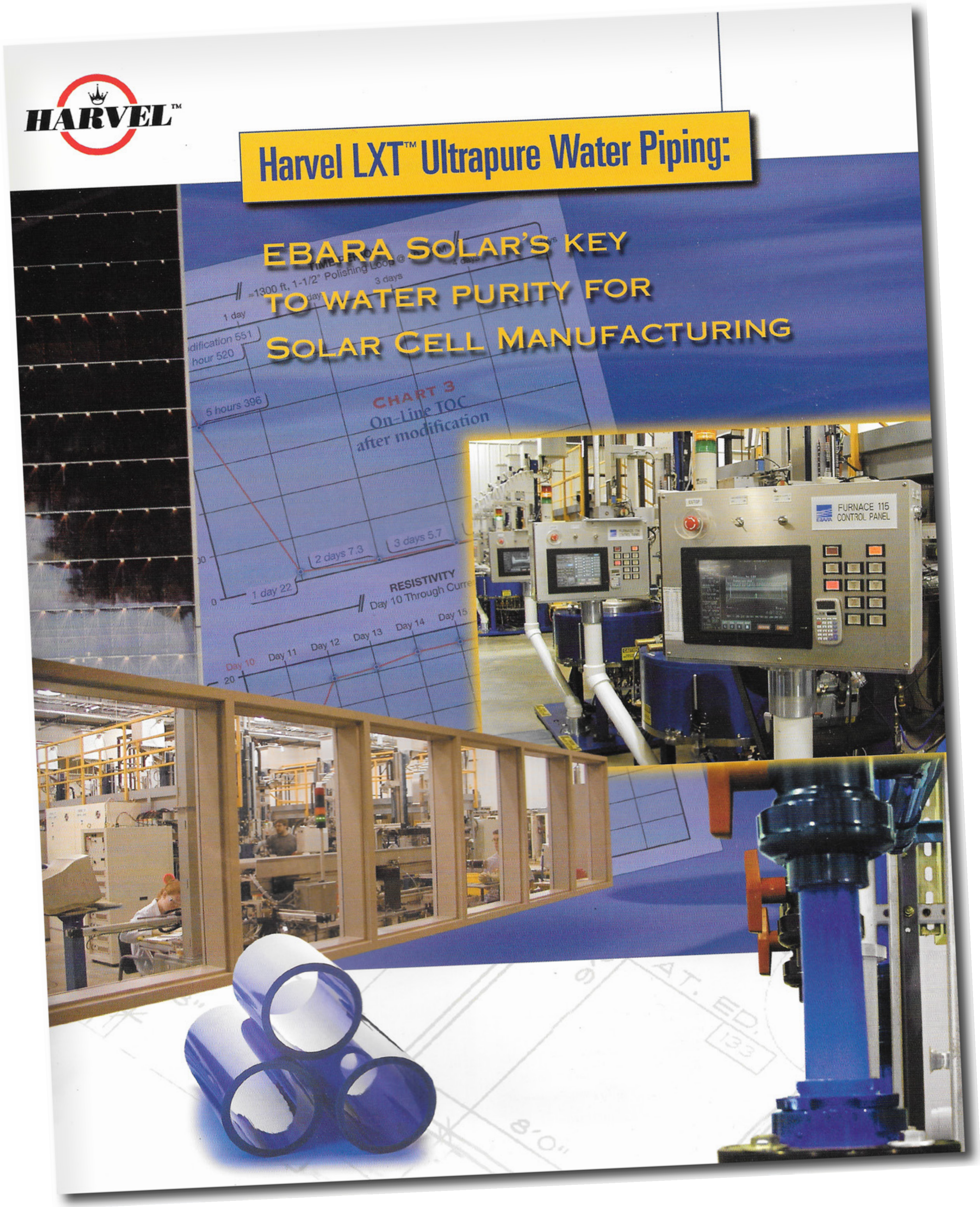

Front Cover

Company Brochure for
Harvel Plastics

Finished Size: 8.5 x 11"
8 Pages

Self-cover: 100# Glossy Text
CMYK, 4/4

Objective: Produce brochure containing case study and capabilites for plastic piping manufacturer.

Ebara Solar's Power Module Manufacturing: A Demanding Application for High-Quality Ultrapure Water

A leading maker of solar power modules, Ebara Solar, Inc. operates an ultrapure water (UPW) production and distribution system to keep manufacturing processes in its new Pennsylvania plant working at peak effectiveness.

Mike Rosinski
Manager of Facilities Operations

According to Mike Rosinski, manager of facilities operations, Ebara features dendritic web technology at its Pittsburgh-area manufacturing facility. "Dendritic web modules are lighter, more powerful, and more reliable than photovoltaic alternatives," Rosinski says. "They also score well on benefits like portability, simplicity, safety, stability and environmental impact. We can produce the modules as bifacial units, and their flexibility makes it possible to install them almost anywhere there's sunshine."

The process that produces Ebara Solar's power modules has important features in common with those in the semiconductor industry. Like a computer chip, the solar module is made from high-purity silicon. And the process likewise demands a plentiful supply of ultrapure water.

Without a reliable flow of UPW, it's impossible to produce the high-quality semiconductor-grade materials that go into Ebara's modules. Non-conductive, contaminant-free water is absolutely necessary to avoid finished-product defects. Ebara's water must be purified to Electronic Grade Quality E-2 specifications, as defined in ASTM D5127-99 (minimum resistivity of 17.5 megohms at 25°C and on-line TOC no greater than 50 parts per billion [ppb]).

"We need a sophisticated, high-volume system to prepare the water for the manufacturing cycle," says Rosinski. "But purifying the water is not the only requirement in keeping a constant supply for our manufacturing process. We also have to maintain the quality as the water passes through the system."

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The purified water is used in multiple manufacturing processes. A varied list of applications such as parts rinsing, oxide removal, wet bench rinsing, lithography, polishing, acid mixing and temperature cycling processes all depend on the ultrapure water supply. Plant-wide requirements bring the volume demand to a minimum of 2000 gallons of E-2 grade water per day.

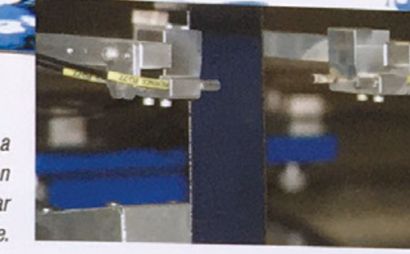
Piping Material Selection: Low-Extractable and Cost-Effective

Ebara's expansion into its new facility required a state-of-the-art water system. According to Rosinski, three alternative materials were initially considered for the UPW piping during the planning stages of construction. "We ruled out high-purity PVDF early on because of budget constraints," he said. "We had some experience with conventional PVC in some of our earlier systems, but we had performance concerns under the tougher water quality requirements for this system.

"And we also considered high-purity polypropylene. We actually solicited initial bids for the system with polypropylene, but we had concerns there as well, as past experience revealed that the fusion joining process could be cumbersome and time-consuming, and it required a high degree of installer skill."

With the bidding solicitation process already open, Rosinski learned of a low-extractable PVC (Harvel LXT™) through a reputable design authority. On reviewing the test data and specification information, he recognized the characteristics needed to meet Ebara's demanding performance requirements. Harvel Plastics, Inc. was

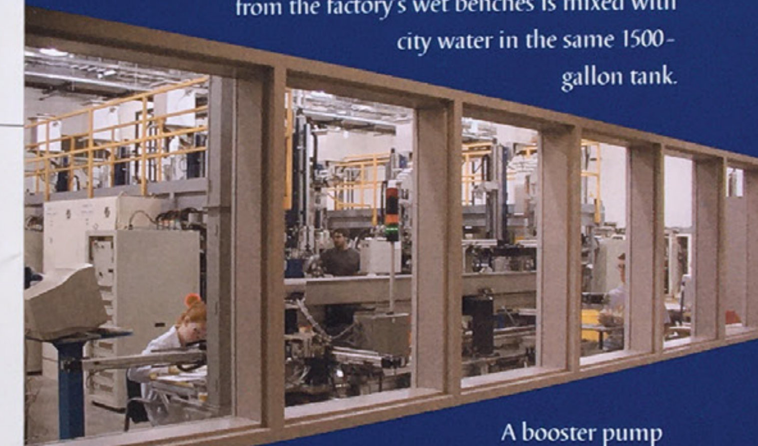
contacted to provide a technical presentation on the attributes of the system. Shortly thereafter, Harvel LXT™ was specified as the material of choice for Ebara's new UPW system. According to Rosinski, "The decision to proceed with Harvel LXT™ was influenced by the joining process of the system in addition to other product benefits. Harvel LXT™ is used for plumbing throughout the purification sequence as well as the polishing loop, and reclaim and return lines."



Ebara Solar grows a unique silicon ribbon crystal for the solar cell substrate.

The Water Purification Sequence

At Ebara's Pennsylvania plant, city water is initially passed through a mixed bed multimedia filter and stored in a 1500-gallon tank which feeds the reverse osmosis (RO) system. At this point in the system, used process water (reclaim) from the factory's wet benches is mixed with city water in the same 1500-gallon tank.



A booster pump sends the pretreated water to an RO system with a design flow rate of 20 GPM. The RO-treated water then passes through a 254 nm ultraviolet-light sterilizer, also maintaining a 20-GPM flow, and into two 2,200-gallon RO storage tanks. Process water is returned from the distribution loop to the RO tanks after passing through a 0.2-micron filter at this location. "Any deionized water that's not consumed in the process returns to the RO storage tanks, moving through another 0.2 micron filter first," says Rosinski.

From here a re-pressure pump sends the RO water at a flow rate of 40 GPM through deionization tanks. The deionized (DI) water system consists of four mixed bed service tanks and two polishers. The DI water is passed through a 0.2-micron final filter and then through an additional UV light sterilizer (185nm) as the last step before entering the distribution loop.

Pretreated water is sent through a reverse osmosis system with a design flow rate of 20 GPM prior to deionization.

Water is maintained in its purified state as it passes through the complete manufacturing process.

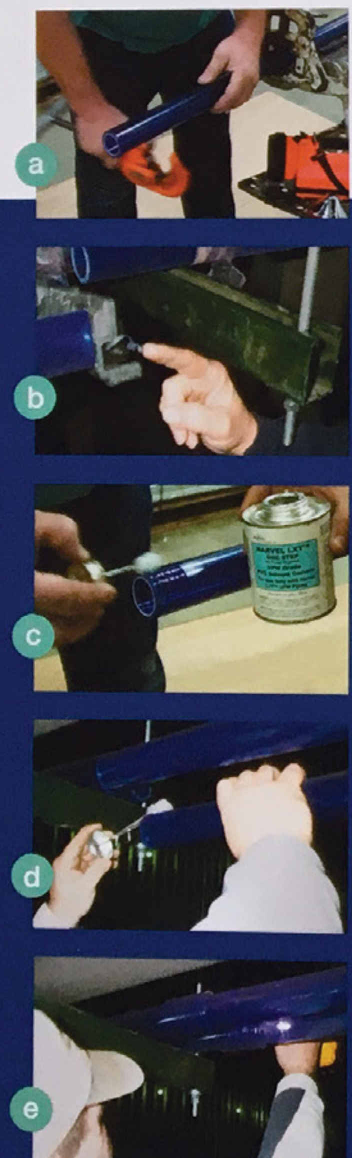
Maintaining Water Purity Throughout the Distribution Loop

Producing a steady supply of ultrapure water is only part of the need at Ebara. It's equally important to maintain the water in its purified state as it passes through the manufacturing process. To hold that purity, the company chose Harvel LXT™ for the construction of the distribution loop in order to maintain its Electronic Grade E-2 water quality requirement (minimum resistivity of 17.5 meg-ohms at 25°C and on-line TOC no greater than 50 ppb).

"Our distribution loop plumbing pipe at Ebara's Pennsylvania plant is sized at 1½-inch," Rosinski says. "Plumbing length is roughly 1,500 feet with a designed flow of 40 GPM. All through the system, the water passes through Harvel LXT™ piping and remains ultrapure."

Used process water from Ebara's wet benches is reclaimed, conserving water resources.

"All through the system, the water passes through Harvel LXT™ piping and remains ultrapure."

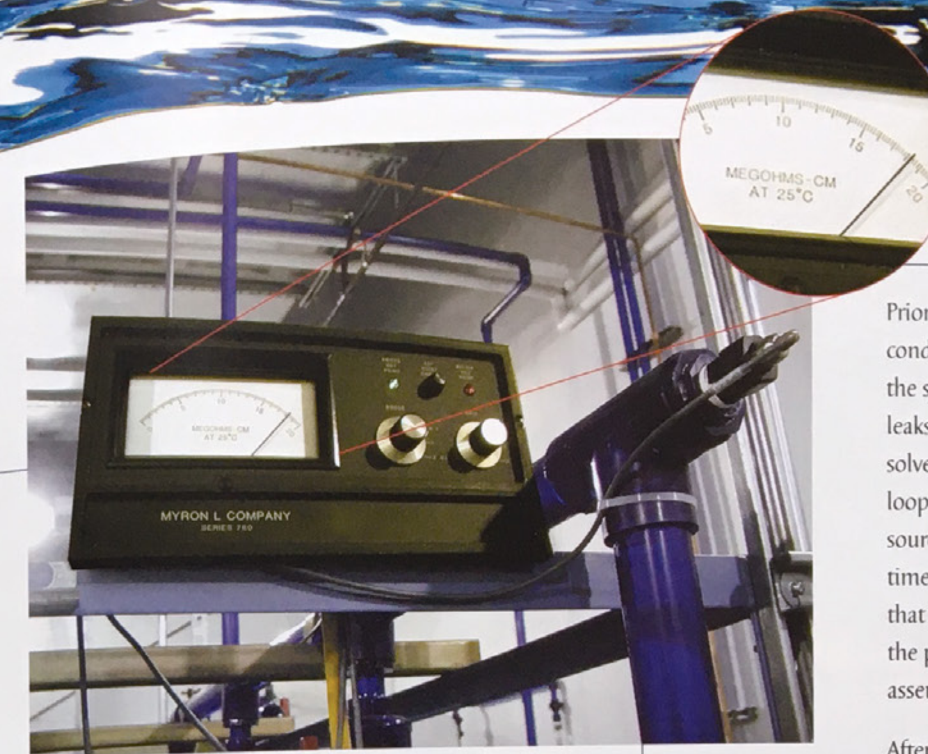


Simple Installation for System Integrity

Construction of the water system and distribution loop was conducted by two separate contractors at different time frames, the loop portion being installed shortly after the shell of the new building was erected. Prior to commencing the work, Harvel Plastics, Inc. was contacted to provide on-site training for the contractors involved. This also provided an opportunity for Ebara's personnel to become familiar with the joining technique and work hands-on with the product in anticipation of future system modifications or repair.

The use of Harvel LXT™ offered several installation advantages over alternate UPW piping materials based on the product's simple joining techniques and inherent rigidity. A fast-curing, one-step solvent cement specifically formulated for Harvel LXT™ is used to join the piping. This joining method eliminates the need for cumbersome thermal fusion joining equipment, and connections can be made quickly and efficiently with inexpensive joining tools. A wheel-type plastic tubing cutter (a), de-burring tool (b), one-step Harvel LXT™ cement (c), and applicator are all the tools required for joining. This joining method greatly reduces installation labor, particularly when working in ceilings (d) and other hard-to-reach areas. Installation is faster and more cost-effective with Harvel LXT™ than with other piping options. In addition, a simple flashlight test (e) makes it possible for installation crews to check joint integrity as they go, greatly expediting the installation process.

In all, more than 700 joining connections were necessary to install the piping system network. Most of this work was conducted on the distribution loop installed in a pipe rack suspended from the ceiling.



System Performance: Resistivity > 18 Megohms, On-Line TOCs < 5 Parts per Billion

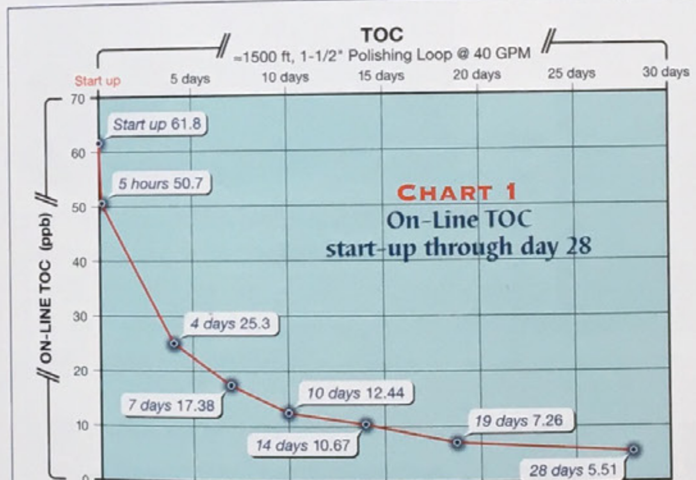
Prior to system start-up, a 50 psi pressure test was conducted for a period of two hours to validate the system's integrity. During this process, two leaks were identified at improperly assembled solvent-cemented connections in the distribution loop. Each leak was visually identified with a light source and repaired quickly with minimal down-time. A secondary analysis of the failures revealed that insufficient cement had been applied, and the pipe was not inserted completely during assembly, which created a dry joint.

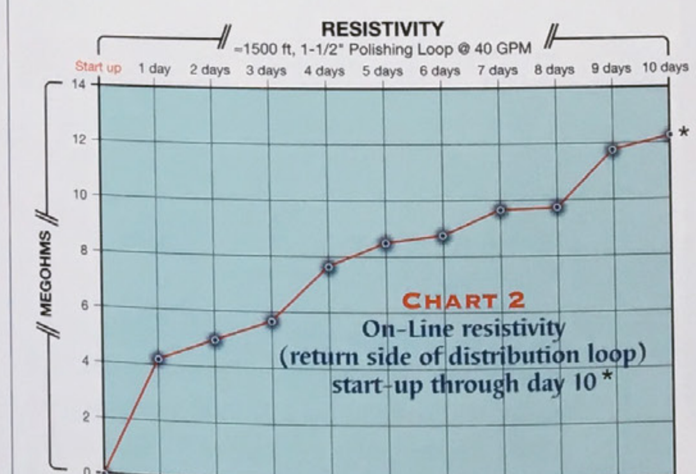
After a secondary pressure test to validate repairs, the system was filled with a 1 percent solution of Minncare® cold sterilant in DI water, allowed to soak for approximately 45 minutes, and then rinsed to drain prior to bringing the system on-line. From a cold start, both resistivity and TOC levels were continually monitored at system start-up to evaluate water quality over time. Resistivity is measured at the DI system prior to introduction of the water into the distribution loop, as well as on the return side of the distribution loop where process water is returned to the RO tanks. On-line TOC is measured continuously on the return side of the loop utilizing an Anatel Corporation A-1000 S20P Organics Analyzer.

So effective was the combination of purifying systems and Harvel LXT™ UPW piping that on-line TOC levels in Ebara's process water fell nearly to the E-2 spec of 50 ppb within five hours of system activation. After just 28 days, on-line TOC had dropped to 5.51 ppb – a little more than one-tenth of the allowable maximum (refer to chart 1).

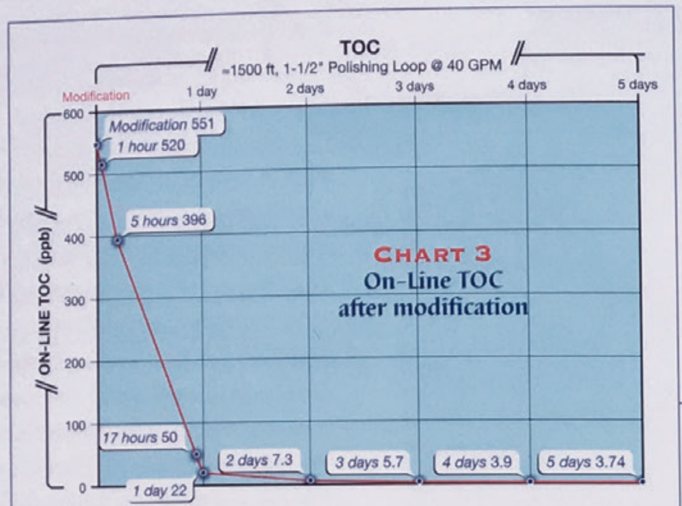
Resistivity measured on the return side of the distribution loop continued to increase over time as the water was continually polished (refer to chart 2).

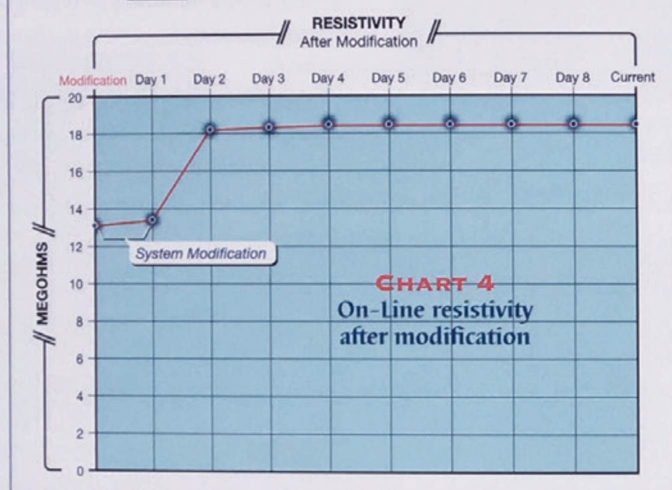
After approximately one month of being on-line, a portion of the DI system was modified and reconfigured to relocate a UV light sterilization unit. This modification provided a second opportunity to evaluate the rinse-down time of a newly installed piping network. This change required the installation of approximately 30 feet of 1½-inch Harvel LXT™ piping, and involved approximately 116 new solvent-welded connections.





*Prior to system modification (see Chart 4 on page 6)





On-line TOC is measured continuously on the return side of the loop.

Silicon growth furnace controls at Ebara Solar are highly automated.

Due to the fast joining techniques of the Harvel LXT™ system, the modifications were made in one day, and the system was brought back on-line the following day, minimizing critical downtime. Water quality was closely monitored during modification, confirming the fast clean-up of the piping system. Chart 3 reveals TOC, generated as a result of the newly assembled connections, quickly dropped to acceptable limits. And, as chart 4 indicates, resistivity climbed above 18 megohms shortly after the modifications were made.

Ebara's water system continues to produce and maintain UPW having a resistivity greater than 18 megohms, and on-line TOC averaging less than 5 ppb, exceeding their initial E-2 water quality specification per ASTM D5127.

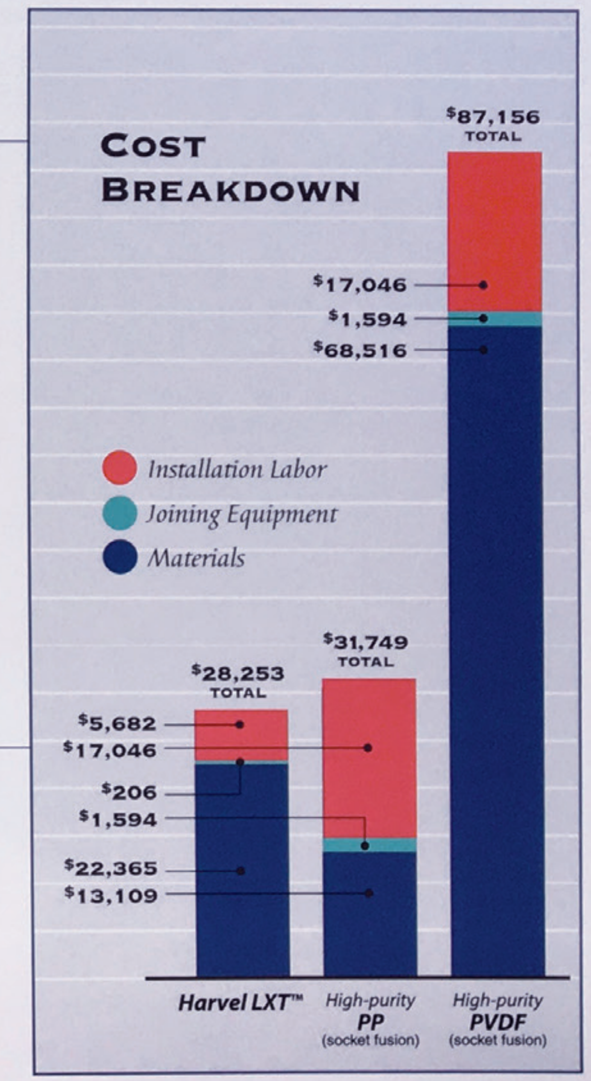
Installed Cost Comparison: The Total Advantage of Harvel LXT™ Piping

After acceptance of the system and the quality of water it maintained, a thorough review was conducted to determine the overall installed cost of the Harvel LXT™ water system. This included a take-off of system components (pipe, fittings and valves) necessary for construction, joining equipment, and man-hours necessary for installation. As the following chart indicates, even though the material costs for the Harvel LXT™ were higher than polypropylene, the installed costs of the Harvel LXT™ piping system resulted in considerable cost savings based on reduced labor related to system joining techniques (60-70 percent less than the fusion joining process of the polypropylene and PVDF systems).

Installation costs were based on 5-minute assembly time per Harvel LXT™ joint, compared to 15-minute assembly time per socket fusion joint. The Ebara project involved the use of a pipe rack system to provide piping support. Compared to alternate materials, additional cost savings can be realized when working with Harvel LXT™ due to the fewer hangers needed to provide adequate support. As an example, a 100-foot straight run of 1½-inch diameter Harvel LXT™ piping would require 30 percent fewer hangers than alternate (PP or PVDF) piping, a considerable installed cost savings.

"The piping we chose offered us excellent performance in transporting UPW," Rosinski says, "and it was by far the fastest, easiest and most economical to install. In the end, the choice was obvious."

Cost Breakdown	Harvel LXT™	High-purity PP (socket fusion)	High-purity PVDF (socket fusion)
Installation Labor	$5,682	$17,046	$17,046
Joining Equipment	$206	$1,594	$1,594
Materials	$22,365	$13,109	$68,516
Total Installed Cost	*$28,253*	*$31,749*	*$87,156*



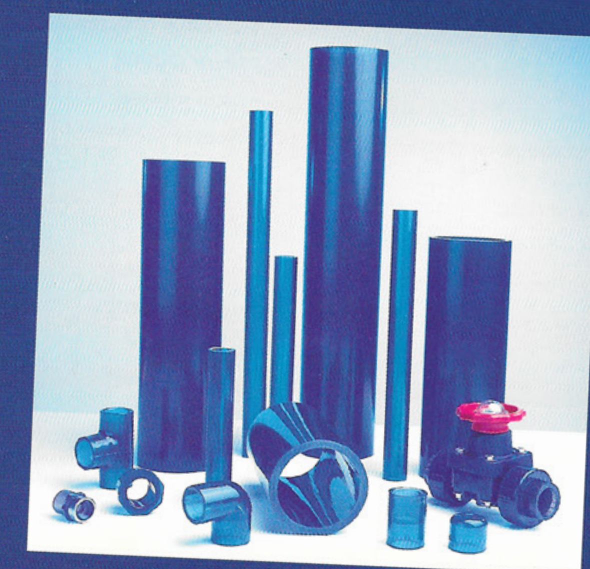
Back Cover

Harvel LXT™ – Manufactured for Demanding UPW Piping Applications

Harvel LXT™ pipe is specifically formulated and manufactured to meet the unique requirements of transporting ultrapure water. It is made of unique material with extremely low-extractable contaminants, especially TOC and trace metals. The product is double bagged, sealed and boxed on-line to maintain cleanliness for use in high-purity environments.

It can be used with confidence for semiconductor process water and other demanding applications where extremely stringent water purity standards apply.

In addition to its crucial water-quality characteristics and installation advantages, Harvel LXT™ piping also exhibits many physical characteristics that make it an effective choice for a variety of demanding UPW applications. Extremely smooth interior walls help minimize particle generation and reduce the potential for bacterial growth. Rigid Schedule 80 dimensions are ideal for pressure service while reducing the amount of supports required, and the piping system exhibits a unique translucency for direct visual inspection of joint integrity. System modification and repairs can be accomplished expeditiously, often by the end-user's own maintenance personnel, minimizing costs and reducing critical system downtime.



LXT™

Harvel Plastics, Inc.

P.O. Box 757, Easton, PA 18044-0757

Tel: 610-252-7355

Fax: 610-253-4436

e-mail: quality@harvel.com

www.harvel.com

HARVEL™