



HWI

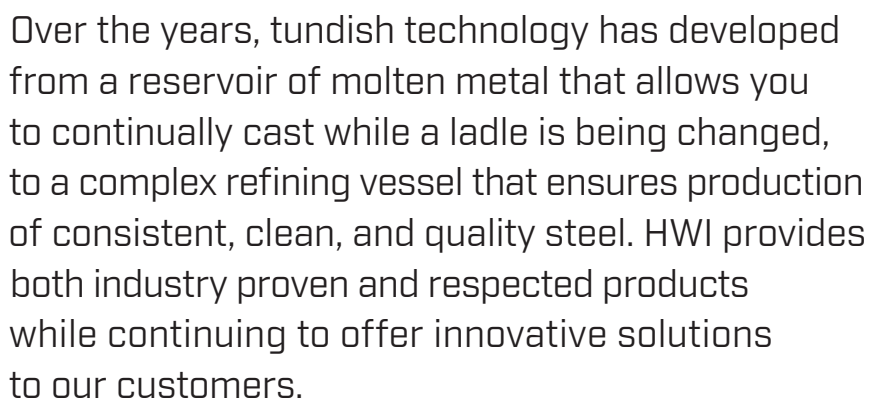
HarbisonWalker
International™

TUNDISH



**STEELY RESOLVE.
IRONCLAD TRUST.**

FOR MORE THAN 150
YEARS, WE'VE BEEN
A VITAL PARTNER
TO ALL THE MAJOR
STEEL PRODUCERS.
WE PROVIDE THE
WORLD-CLASS
PRODUCTS THAT
SET THE GOLD
STANDARD.



HWI TUNDISH REFRACTORY SOLUTIONS

The tundish is a refractory-lined intermediary vessel located between the ladle and the caster. It is an integral part of the continuous casting process that directs and controls the flow of steel to the caster mold. The tundish is designed to provide a constant depth of metal, which allows for a constant cast rate. Common tundish designs rely on a disposable magnesite-based monolithic working lining; in conjunction with flow-modifying tundish furniture, this lining has enabled significant improvements in steel quality.

HarbsionWalker International provides innovative, industry-proven products to our customers.

- **Disposable Working Linings:** HWI offers a wide variety of magnesia-based disposable tundish working lining materials. Our traditional families of materials include DOSSOLITE and NARSPRAY® mixes for spray linings, the NARCOTUN® product line for dry vibrate, and CLEANCOAT products for trowelable linings. All of these products provide a lightweight, joint-free, corrosion-resistant, disposable working lining that has been engineered for easy deskulling.
- **Cast/Safety Lining:** From brick to low-cement alumina-silica and ultra-high purity castables, HWI offers a full range of backup lining materials. This includes our NARCON® 70 CASTABLE product, which offers very high hot strengths and volume stability.
- **Tundish Furniture/Precast:** HWI offers custom-made tundish flow modifiers, patented impact and turbulence control pads, and specifically designed dams, baffles, and weirs.
- **Robotic Automated Installation Systems:** HWI offers fully automated tundish spray and dry vibrate installation systems. These include many different robotic systems and designs that are built to suit our partners' needs and designed with efficiency, reliability, and safety in mind.



WORKING LINING

**DOSSOLITE
NARCOTUN®**

- Excellent de-skulling
- Very clean, non-reactive surface
- Great insulating characteristics

see page 4-5

SAFETY LINING / CAST LINING

**NARCON® 70
FASKAST® 80**

- Durable, volume stable
- High hot strength

see page 6

SHELL INSULATION

**INSBOARD
PNEULITE® SPRAY**

- High compressive strength
- Low thermal conductivity

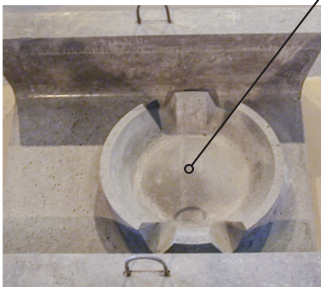
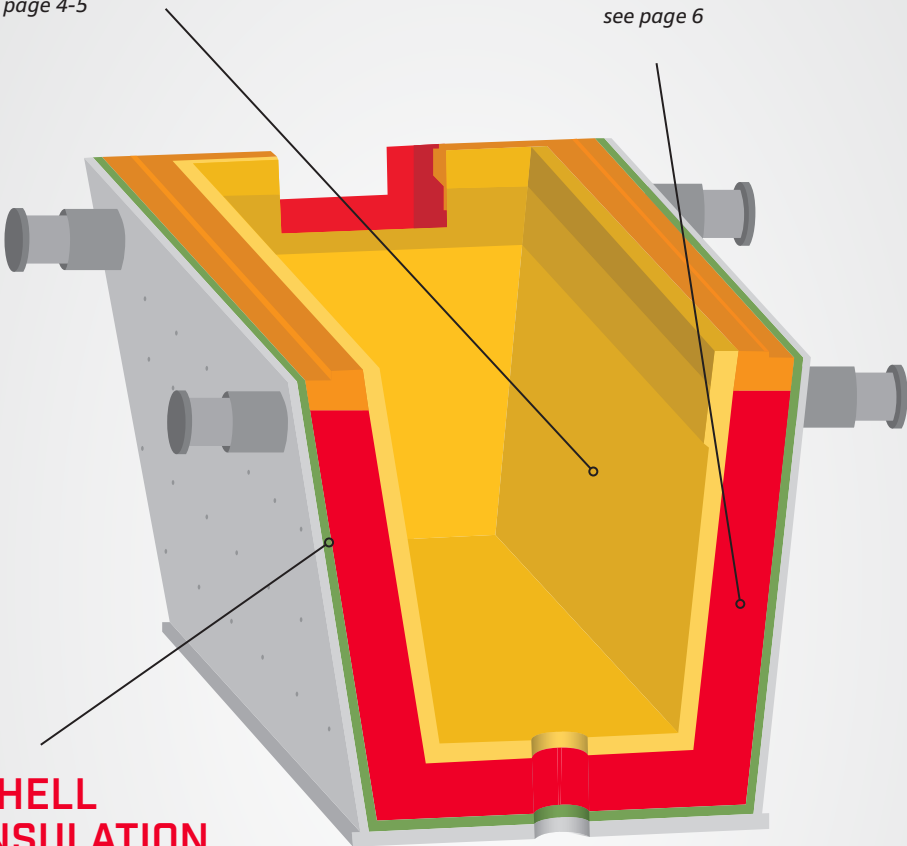
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PRECAST TUNDISH FURNITURE

**NC-CAST MAXIMA
D-CAST®**

- Custom designs
- Thermal shock resistant
- Capable of maintaining geometries through demanding sequences

see page 8



WORKING LINING PRODUCTS

SPRAY PRODUCTS

DOSSOLITE FAMILY

DOSSOLITE is one of the oldest and most respected products on the market and remains the benchmark that similar products are measured against. The DOSSOLITE Family includes high performance systems for long sequence life that improve slag resistance and ensure deskulling in the most demanding conditions.

NARSPRAY® FAMILY

NARSPRAY® is a silicate-free, low density product that is designed for longer working time. Engineered for rapid drying, these products result in fuel savings and more flexibility with the tundish fleet.

DRY VIBE PRODUCTS

NARCOTUN® FAMILY

A heat set family of dry-vibes ideally suited for customers that benefit from an alternate solution to spray products. These products offer easy installation and quick turnaround times for a tundish fleet. Water free lining results in less hydrogen concerns and significant energy efficiency. NARCOTUN® materials provide outstanding deskulling performance and superior wear resistance leading to more consistent steel volumes. All products can be used in hot or cold start tundish practices.

BASIC 187 DV FAMILY

BASIC 187 DV products are also heat setting dry vibe products. These mixes can utilize traditional dry vibe binders or a starch binder for initial curing.

TROWELABLE PRODUCTS

CLEANCOAT 6M

CLEANCOAT is a fine grain lightweight magnesia based powder that is designed to be mixed with water and troweled directly onto the safety lining. CLEANCOAT provides good material workability and easy installation in smaller tundishes where spraying is not practical or economical. The benefits from spray linings are still realized such as clean metals processing and deskulling.





TYPE	HWI PRODUCT	SPECIFICATION	BENEFIT
SPRAY	DOSSOLITE 1400-72	77% magnesia	<ul style="list-style-type: none">• High post drying strength• Great wear resistance
	NARSPRAY® M-77	77% magnesia	<ul style="list-style-type: none">• Long working time• Low density• Outstanding tundish life
DRY VIBRATABLE	NARCOTUN® 87	87% magnesia	<ul style="list-style-type: none">• Excellent deskulling• Special extra hard thermal setting• Resin free dry vibe product
	NARCOTUN® 87XH	85% magnesia	
	BASIC 187 DV 88D	90% magnesia	
TROWLEABLE	CLEANCOAT 6M	57% magnesia	<ul style="list-style-type: none">• Ideal for applications where spraying is not practical or economical

SAFETY LININGS

CASTABLE LININGS

From brick to low cement alumina-silica castables to ultra-high purity castables, HWI offers the full gambit of monolithic back up lining materials. This includes our work horse brand NARCON® 70 which offers very high hot strengths and volume stability. Complete, ready-to-use precast lining can also be supplied.

BRICK LININGS

HWI can supply a variety of options if a water-free brick lining is preferred. Depending on practice, brick linings can be more cost effective with a zonable lining when the slagline can be replaced or patched.



TYPE	HWI PRODUCT	SPECIFICATION	BENEFIT
CASTABLE	NARCON® 70 CASTABLE	70% alumina, ultra low cement	<ul style="list-style-type: none">• High hot strength• Outstanding volume stability• Outstanding thermal shock resistance• Also available in pre-cast
	FASKAST® 80	80% alumina, ultra low cement	<ul style="list-style-type: none">• High hot strength• Outstanding slagline resistance• Impact and abrasion resistant, high alumina castable• Also available in pre-cast
BRICK	UFALA®	60% alumina brick	<ul style="list-style-type: none">• Very low PLC• Recommended for bottoms and bellies of a steel tundish
	KORUNDAL XD®	90% alumina ultra high purity brick	<ul style="list-style-type: none">• Superior slagline resistance• Minimal PLC



SHELL INSULATION

BOARDS AND BLANKETS

The insulation lining must offer compressive refractory strength and thermal shock resistance to minimize heat loss and reduce shell temperatures. For these applications HWI offers a full range of INSBOARD and INSWOOL® products. Most common are our INSWOOL®-HP blanket for covers and seals, INSBOARD 2300 HD for shell contact, and INSBOARD 2600 HD for shell contact and cover applications.

SPRAY PRODUCT

PNEULITE® SPRAY 22 is a unique spray insulation that can be installed with our standard tundish spray equipment. This product offers excellent safety lining support and allows ease of installation over complex anchor systems.

TUNDISH FURNITURE

The design and use of tundish furniture has helped the tundish to become a sophisticated tool in the production of cleaner steel. The design and location of tundish furniture, including impact pads, baffles, weirs, and dams can be customized to modify the flow of steel through the tundish.

IMPACT ZONE

HWI offers proven brands such as D-CAST® 85TMCC and NC-CAST MAXIMA in the form of precast pads, splash resistant pads, and bowls. These brands offer outstanding erosion resistance and high hot strengths.

BAFFLES, DAMS, AND WEIRS

Precast flow modifiers are available in brands such as ULTRA-GREEN® 60 and VERSAFLOW® 70 C for cost-effective solutions that offer good wear and thermal shock resistance.



REFRACTORY MAINTENANCE

HWI offers all the mortars, rams, and plastics needed for the longevity of your tundish refractories. This includes our T-Well family of products for ramming around the nozzles. T-Well products have carefully controlled sintering characteristics for easy nozzle removal after service.



TYPE	HWI PRODUCT	SPECIFICATION	BENEFIT
MOTAR	GREENPATCH-421	55% alumina, air-set wet mortar	<ul style="list-style-type: none">• Thick patching mortar ideal for the safety lining crack and surface repair• Fine grained
RAM	T-WELL 80	80% alumina, heat set	<ul style="list-style-type: none">• Ideal for installation of nozzles and submerged entry nozzles
	T-WELL 96	96% alumina, heat set	<ul style="list-style-type: none">• Fine grained with tabular• Ideal for the longest sequencing• Good strength
PLASTIC	PLASTECH® 70P	70% alumina, phos-bonded	<ul style="list-style-type: none">• Cost-effective mullite based—ideal for bellies and bottoms• High strength
	PLASTECH® 85P	85% alumina, phos-bonded	<ul style="list-style-type: none">• Ideal for slagline repairs and spouts

TUNDISH MODELING CAPABILITIES

Tundish design and operation are critical in the optimal performance of a continuous casting facility. HWI consistently provides solutions for tundish applications growing our strong position in the tundish market.

WATER MODELING

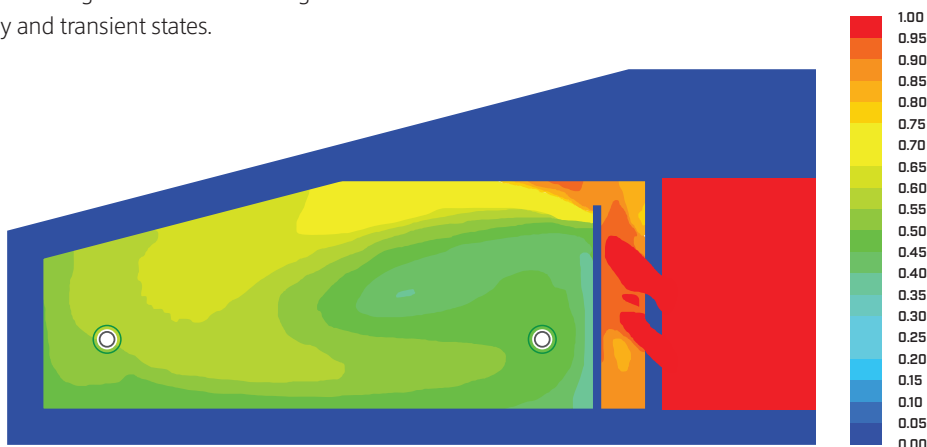
Water modeling has traditionally been used when looking at tundish design. It relies on hydrodynamic similarity between water and steel. HWI can perform and video different steel flow and slag simulations for our customers. The water modeling studies often times lead to custom precast furniture.

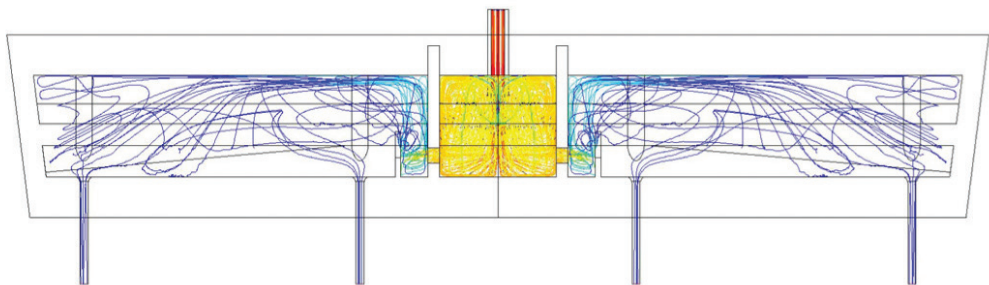
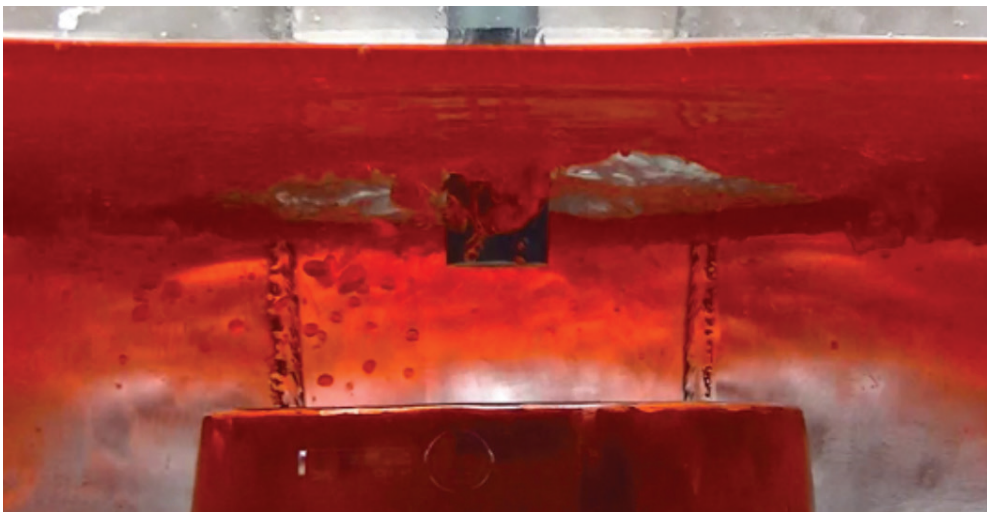
The general purpose of water modeling is to mimic the flow of steel inside a tundish and then design the ideal flow modifiers for clean, quality, and consistent steel and to optimize lining performance. This is done by improving and or controlling temperature distribution, defining and improving the residence time, and improving strand to strand distribution of the 'new steel' entering the tundish. We also can simulate the turbulence at the slag-steel interface using colored media during both steady and transient states.

COMPUTATIONAL FLUID DYNAMICS (CFD)

Computational fluid dynamics (CFD) uses mathematical analysis and algorithms to study fluid flows. HWI utilizes this technique to help our customers enhance steel flow inside their tundishes. Over the years demand for CFD has been growing due to improvements in the accuracy of the software programs used in the studies.

This method allows us to look more closely at inclusions and capture temperature effects which are significant when opening a new ladle into the tundish. It also can be more efficient when looking at various design changes because you are not making the physical pieces. CFD has been verified against field operating conditions.







AUTOMATED & STANDARD INSTALLATION EQUIPMENT

We have been supplying safe, modern, and reliable installation equipment for use in our customer facilities for over 20 years. These include our standard easy to use and maintain spray machines for manual sprays and robotic systems available in designs that best suit our customer's foot print. These include gantry, track, pedestal, and caged systems. For dry vibe installations, HWI can supply simple hopper/screw feeder systems or complex articulating arm delivery systems.

HWI also supplies efficient, state of the art combustion systems with covers and mandrels capable of drying any refractory installed in a tundish.

Equipment inclusions:

- 24/7 support
- All manuals and technical specs
- Comprehensive spare part management system



INSTALLATION SERVICES AND SUPPORT

Our Value Added Services (VAS) team will provide everything required for equipment support and operations as well as installation services. HWI is committed to supplying our partners with experienced, knowledgeable personnel to assist with installations and site managers that can work together to handle the day to day operations of the tundish area.

Services include:

- Continuous Improvement Program design to review practices and materials on a semi annual basis.
- Field support designed to fit the customer's needs—from all installation to supervision only.
- Development of standard operating and safe work procedures



ADVANCED TECHNOLOGY AND RESEARCH CENTER (ATRC)

HWI has two ATRC centers for learning, testing, exploration, and innovation. Here in the United States, ATRC houses some of the brightest minds in the refractory industry. Our team of research and development experts works directly with our customers to design, test, and trial new products and applications. ATRC China serves as an important raw materials and qualifications lab.

Services include:

- Research and development of new applications and products
- Customer-focused product development
- Comprehensive technical analysis
- Slag analysis
- Postmortem analysis





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