World Leader in Temperature Controlled Technology

Steps In The Right Direction
Your guide to the care and maintenance of calender rolls, with a special operating section on temperature controlled rolls.
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SHW ROLL SERVICES

Inspection, Maintenance, Repairs, Rebuilding and Consulting

At SHW, we take great pride in our products. That’s why we would like to provide you with regular inspection and maintenance of your calender rolls.

The best time to have your rolls inspected is when they are at our facility for regrinding, repair or service.

Here are some of the services available to you. However, if you would like further details or costs, we will be happy to provide them.

Profile and Surface Roughness Measurements

Both normal and abnormal wear are often typical in calender rolls. It is a good idea to get an exact surface profile measurement before re-grinding a roll so that you have a visual representation of its wear. This profile will help you detect the cause for any abnormal or uneven wear.

Measuring TIR and Out-of-Balance

Vibrations are a major problem for machine builders and operators. When they become your problem, we offer the advanced technology of measuring instruments and balancing machines that have been developed in the last few years. During the balancing operation, we can detect the reason(s) for your vibration problems.

Hardness and Chill Depth Measurements

In older rolls, hardness and chill depth measurements are especially important. As the paper sheet product passes through the nip, the chilled cast iron rolls begin to wear. Regrinding of the roll surface corrects this wear process. As the roll surface is reground, the chill depth diminishes. Eventually the chill is reduced and the hardness begins to decrease. Once the hardness values begin to steadily drop, the end of the chill zone is at hand, thus, the end of the roll life and the roll will need to be replaced. Therefore, it is advisable to know exactly what these levels are before you continue to regrind. Keep accurate records, or send the roll to SHW for chill and hardness check.
If you’re thinking of converting your standard rolls to temperature controlled rolls or hard surfacing your existing rolls, hardness and chill depth measurements should be determined first. Our roll specialists can give you the most precise measurements with our Vickers testing unit and tell you whether or not it is advisable to convert or hard surface your rolls.

**Measuring Temperature Profile**

If your paper profile is uneven, the cause could be an uneven temperature profile. This problem becomes even more critical as pressure and temperature increase. Contact an SHW Representative or ship the roll to our service facility for temperature profile testing in a controlled environment.

**Regrinding**

The precision regrinding techniques at SHW are well known and are used extensively by many paper mills. We can regrind entire roll stacks in a very short period of time because of our large grinding capacity.

**Roll Balancing**

When you need your rolls balanced, you should know that SHW is equipped with two of the most advanced balancing machines available. Balancing is extremely important for fast running temperature controlled rolls. We can also “Hot Balance” your rolls if you are having a problem with temperature profile. Also, as part of our service, SHW balances virtually every roll it rebuilds.

**Repairs**

There are times when your rolls cannot be repaired just by regrinding. These are the times when our calender roll specialists can be of help. Before you attempt to make any of the following repairs, please consult our specialists and have SHW make the repairs.

- Replacing a broken journal
- Rebuilding bearing surfaces
- Regrinding rolls which have heat cracks
- Plugging rolls, etc.
**Rebuilding Standard Calender Rolls**

If you’re thinking about rebuilding standard calender rolls so that you can put temperature controlled rolls into your machine calender or supercalender, it is to your advantage to consult our roll specialists. Sometimes, you are better off purchasing new rolls rather than having your old rolls rebuilt. If you are advised to rebuild your rolls, here are examples of the ways we can rebuild them:

- Rebuilding standard rolls into temperature controlled rolls of either AQUITHERM®-V, Displacer body or TRI-PASS, peripherally drilled design.
- Rebuilding old center bore steam heated rolls into an AQUITHERM-V or TRI-PASS roll using water, thermal oil, or steam as a heating medium.
- Enlarging of the center bore to increase the natural frequency (critical speed) of the roll to allow for increasing machine speeds.

**Hard Surfacing**

We now have in-house thermal spray, hard surfacing capabilities. With the most advanced technology available today, our HP-HVOF, JP-5000 system, is capable of spraying a variety of coatings on your calender roll(s). We can increase the surface hardness of your roll(s) to approximately 100 Shore “C” depending upon your particular application. Whether it’s to combat wear, corrosion or just to improve your roll regrind cycle, SHW has the coating for you.

**Rebuilding S-Rolls**

We offer full service on S-Roll rebuilds. Whether it is a new shell or seal rebuild, SHW can rebuild your S-Roll within 5-10 working days depending upon your needs and our backlog.

**Consulting**

Whenever you encounter a roll problem you cannot solve yourself, you can call on our roll specialists who have worldwide experience.
Choice of Material

SHW experts can assist you in determining which roll material is most applicable for your operation.

ROLL CALENDER CARE

At SHW, we manufacture our rolls to meet the highest standards of precision. But, their accuracy and benefits to your operation depend on you to take the right steps from the beginning.

Storage and Handling

We have taken great care in delivering perfection. Now, it’s your responsibility to make sure your rolls are stored properly.

- All our rolls are shipped in sturdy wooden crates and coated with an anti-corrosion film to protect them. (The anti-corrosion protection is easily removed.)
- As soon as you receive your rolls, unpack and inspect them.
- Make sure they are stored in a warm, dry place. Freezing conditions must be avoided. For water heated rolls, we recommend adding antifreeze to the roll prior to storage or shipping.
- When rolls are not in use, they should be coated with an anti-corrosion solution because chilled cast iron corrodes easily.

Storage

- Place rolls on supports that will not likely cause corrosion.
- We recommend our original wood shipping crates with their specially prepared supports.
- Inspect your rolls periodically.
- Horizontally stored rolls must be rotated 180° weekly to minimize normal sag.
- Never store rolls with the roll face in contact with another roll or any other surface. This can cause “contact corrosion.”

Be careful to store rolls away from traffic lanes. Remember, the roll surface is relatively brittle and banging the rolls with passing equipment could cause damage.
Handling

Once you have your roll, it’s your responsibility to take the utmost care in handling it.

- Do not drop or bump rolls.
- Do not lift it with a bare chain or cable. (SHW recommends nylon slings.)
- Do not roll or skid roll faces on floor, rollers, or any other surface.
- If possible, lift your roll using a crane with two hoists. If your crane has only one hoist, use a lifting beam with adjustable protected slings on each end.
- Wrap all finished roll surfaces as they can be easily marked.
- Small journal diameter (or large bore) rolls* should be lifted with a protected sling around their body.

- These rolls are shipped with supports on the roll face or on the shoulder. You should continue to store them this way in your mill.
- We recommend that you do not add sleeves to the journals for the purpose of lifting. By extending the lifting centers, you put tremendous stresses on the smallest journal step and the bolts.

Transport and Storage

- Store calender rolls in a dry, heated place.
- When this is not possible for a roll operated with water, or if the roll has to be transported under freezing conditions, the following applies:

  For **AQUITHERM-V**, displacer rolls, remove all water by opening the drain plug to the lowest position. Then, close the drain plug and pour four liters (one gallon) of a permanent type antifreeze into both ends of the roll bore, and close airtight. Turn the roll slowly, several times to allow even distribution of the antifreeze.

  For **AQUITHERM-P**, peripherally drilled rolls, turn repeatedly until no water appears at the center bore. Then, pour four liters (one gallon) of a permanent type antifreeze in the roll bore, and close airtight. Turn the roll slowly, several times to allow even distribution of the antifreeze.

- For long and slim rolls (diameter-to-face length >1:12), SHW recommends storage equipment that rotates the rolls slowly to avoid sag.
- General handling and storage instructions for chilled cast iron calender rolls must be followed.

  See “Care of Calender Rolls” Section for more information.
**General Care Considerations**

Keep a roll history record. This will help you maintain and insure the good condition of your rolls.

Your record sheet should include:
- Equipment data
- Casting body material
- Period of service in the calender
- Position in stack
- Wear
- Regrinding frequency
- Alterations in crowning and all crown data
- Test data

Avoid running loaded rolls metal-to-metal!!

Temperature controlled rolls must be warmed or cooled gradually to avoid the hazard of thermal cracking. We recommend a maximum cooling/heating ramping rate of 4°F per minute.

**Roll Marking**

Crease marks caused by folds in the paper sheet (paper wads) are readily transferred from one roll to the next roll. Once your roll surface is severely marked or scored, it should be changed immediately to avoid damage to adjacent rolls.

We recommend that all rolls be changed simultaneously. If not, new rolls will soon become marked by the remaining rolls. Because of this, many mills keep a complete set of spare rolls.

It is also important to check the roll diameter. There is the possibility that the roll diameter has been reduced through the usable chill depth. This means, proper hardness no longer exists.

NOTE: Proper roll material selection is critical. SHW offers materials with a range of hardnesses and other properties to meet your specific application.

**The Orange Peel Effect**

This surface defect is caused by tiny impressions made when an excessive amount of hard particles, like silicon sand or other impurities in the clay, pass through the calender nip.

NOTE: Proper roll material selection is critical. SHW offers material with a range of harnesses to meet your specific application.
Surface Etching – Ice Flower Effect

Etching of the roll surface is often referred to as “ice flowers.” This surface appearance is a result of chemical corrosion and fine abrasion. Increased surface temperatures reinforce the intensity of the chemical corrosion. This leads to increased regrinding intervals.

If this situation cannot be improved by modification of the stock, SHW can supply a HP-HVOF, hard surface coating of chromium carbide or tungsten carbide. This coating will help improve the current regrind cycle. Also, SHW can provide a corrosion resistant casting material to slow the chemical attack on the roll body.

Roll Scoring

For Calender Stacks Having Doctor Blades

You can reduce the wear and scoring of your rolls with an appropriate selection of the doctor material and with regular and experienced maintenance of the doctor blades.

Consult your doctor blade supplier for more details.

Possible Causes of Roll Scoring:

- Poorly ground doctor blades
- Excessive and uneven doctor pressure
- Dirty blades (when foreign particles are caught between the doctor blade and the roll)
- Improper setting of the doctor blades

You can use oscillating doctors to help prevent scoring. The blade should fit the roll shape correctly and should be ground frequently enough to maintain it. Otherwise, the doctor will not make complete contact with the roll.

To minimize deflection, make sure the doctor holder is rigid. The angle and pressure should be set as recommended by the doctor blade supplier.
**Damage Due to Overheating and Thermal Shock Damage**

“Fire cracks” and “spallings” in the roll surface frequently appear on calender rolls.

This damage is caused by friction heat (up to 600-750°C / 1,100-1,380°F) when a rotating calender roll touches a stationary roll. This heat shock, followed by a rapid cooling, causes cracks to develop due to thermal strains in the material. They occur most often in-line with the axial direction at the roll’s end. But, they can occur elsewhere on the roll’s face.

Thermal shock can also be attributed to cool water contacting a hot roll surface. A sudden temperature gradient can cause cracks from thermal shock. For example, water at 212°F is very cool compared to a 400°F roll surface temperature. This will cause thermal shock.

**Do not exceed the maximum heating/cooling rate of 4°F/min.**

**The two most frequent incidents that cause heat cracks AND how to correct them:**

- When a foreign body, like a paper wad, is squeezed into the nip, one of the rolls comes to a halt. If the opposite roll continues to rotate, local friction heat occurs. In this case, the cracks are usually found in the edge area of the rolls.

- When a rotating roll touches the surface of a stationary roll, heat cracks from localized friction occurs. Since some rolls have a very high starting torque, corrugated slip-jerk marks are found on the standing roll where it was first touched by the rotating roll.

This damage can be avoided with an interlock that prevents rolls that are not rotating from touching each other.

**Repairing Overheating and Thermal Shock Damage**

Only by grinding off the total damaged zone can these defects be repaired. Send your roll to SHW or contact SHW’s service and repairs department for proper instructions.

**Damage Due to Mechanical Abrasion between Rolls**

Mechanical abrasion of a calender roll is typically seen when a foreign body in the nip causes metal-to-metal contact.
**Roll Barring**

Barring marks result in an uneven hardening of the roll surface.

When you are regrinding rolls with barring marks, first obtain the geometrical tolerances and then grind off an additional 0.2-0.4 mm (0.008-0.015”) in diameter. This will give you an even surface hardness. If you do not remove enough surface material, barring marks can re-occur due to vibrations that are caused by the uneven hardness.

**Possible Causes of Barring Marks:**

- Poorly ground rolls.
- Improper bearing assembly.
- Excessive speed (operating rolls close to their \( \frac{1}{2} \) natural frequency \( \frac{1}{2} \) critical speed).
- Rolls not properly aligned
- Regenerative feedback from periodic thickness variations of the paper web.
- Impurities in the stock.

To avoid and repair “Roll Barring”, contact SHW Roll Specialists

**Excessive Roll Wear**

During operation, every calender roll will experience wear. However, if the wear becomes excessive or uneven, the quality of your paper, especially its profile, will suffer.

**Possible Causes of Excessive Roll Wear:**

- Excessive pressure from doctor blades.
- Running the rolls metal-to-metal.
- Improper roll crown.
- Insufficient roll hardness.
  
  (Either the hardness is too low or the chilled cast iron shell has been ground off.)

SHW Hard Surfacing may be an option to consider.

**Ripples**

Ripples are a result of wear on the roll surface. This wear pattern is generated by the relative movement of the paper sheet, which is an elastic and abrasive medium, to the roll surface. When coating and filler materials are used, the sheet becomes more abrasive. This condition is mostly found on drive rolls in supercalenders. The main cause for ripples is torsional vibration superimposed on the rotational movement of the roll.
The energy of acceleration and deceleration is transferred by friction forces from roll to roll. A micro slip caused by the torsional vibration occurs between the rolls' surface and the sheet causing wear. The formation of these ripples is not even on the roll surface, and is more prominent at the roll ends versus the center.

Eliminating vibrations in a complex system like a supercalender may be very difficult. However, a hard surface coating of Tungsten-Carbide has proven to be very effective in eliminating or reducing the development of ripples.

**Spallings at the Edges of the Roll Body**

**Broken-Out Edges**

Now and then, heavy bumping during operation will cause broken-out edges of your calender rolls. (Avoid metal-to-metal contact.) Because of the extreme hardness of chilled cast iron, you must maintain an edge radius of 6mm (0.25”) to avoid spalling. It is also important that the radii are reworked periodically when you are regrinding the roll.

NOTE: All SHW chilled cast iron rolls are manufactured with radii at both ends of the roll face.

**Pitting**

Under operating conditions, if you see an alteration in your roll surface, it is mainly due to coarse-grained, hard impurities in your paper stock. These particles must be removed by a careful pulp cleaning.

Local excessive pressing in the roll nip can cause pitting in the roll surface. This is usually due to rough and hard mineral impurities in the filler material.

When your roll has had a long service life and/or a high content of impurities, its roll surface shows more and more of the so called “orange peel effect”.

See “SHW Roll Services” Section.
OPERATING INSTRUCTIONS

(FOR TEMPERATURE CONTROLLED ROLLS)

1. Design types
2. Thermal Fluid Heating Mediums
3. Heating and/or Cooling Systems
4. Operating Recommendations
5. Maintenance
6. Transport and Storage

Before operating a temperature controlled roll, you should have a clear understanding of the type of temperature controlled roll you’re working with.

Basic Design Types

SHW manufactures two basic design types of temperature controlled rolls:

[1] **SHW-AQUITHERM-V-ROLL**

![Diagram of SHW-AQUITHERM-V-ROLL](image)

*This Aquitherm -V design has a shrink-fitted Volume displacer body.*

[2] **SHW-AQUITHERM-P-ROLL (MONO, DUO or TRI-PASS)**

![Diagram of SHW-AQUITHERM-P-ROLL](image)

The AQUITHERM-P design has a multitude of peripherally drilled longitudinal holes close to the roll surface. The **MONO, DUO** and **TRI-PASS** designs are differentiated by the number of times the fluid passes through adjacent holes.

One of the first things to be considered in operating your temperature controlled rolls is the thermal fluid.
Correct Use of Thermal Fluids:

Water

There are several things you should be aware of when using water as your thermal fluid.

- Water can be used as the heating medium to a temperature of 150 degrees C (300 degrees F).
- Corrosion can be avoided by maintaining your water quality and monitoring it with sampling. The following standard water quality values should be considered.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual water hardness</td>
<td>&lt;0.03 mval/kg</td>
</tr>
<tr>
<td>p-value</td>
<td>0.5-1.5 mval/kg</td>
</tr>
<tr>
<td>pH-value</td>
<td>8.5-10.0</td>
</tr>
</tbody>
</table>

- Condensate from the dryer section may be used as thermal fluid.
- Prior to start-up, you should flush the complete system.
- The system should be refilled before placing it in operation.
- The water should be changed 1-2 weeks after the first filling to remove dissolved impurities and potential foreign bodies.

Thermal Oil

Use only those oils that are approved by the manufacturer of the oil system, and insure they are for the selected temperature range. It is important to note that higher temperatures may occur in the heat exchanger than in the flow line.

Saturated Steam

Steam can be used as a heating medium in our Aquitherm-PS or PSW designs. Saturated steam is channeled through peripheral bores. Depending on available mill, steam pressures, surface temperatures of approximately 350°F can be attained.

Steam is a readily abundant source of power in most paper mills. Steam is efficient, clean and environmentally friendly. The Aquitherm-PS (PSW) roll that channels saturated steam as the heating medium can save power and money. When high surface temperatures are needed, steam can provide many advantages compared to thermal oil.
**In General:**

Temperature controlled rolls must be operated in *closed loops only*, even when the temperatures of the thermal fluid are below the flash point.

Open loops can cause clogging of the internal channels and cause unbalance and barring in the roll and eventually uneven paper profiles.

- For roll stacks with several temperature controlled rolls, the heating system can have one or more than one zone; however, for heating systems with one zone to heat two or more rolls, SHW recommends auto flow valves to regulate flow to each roll and a stand-by pump common to all zones.

Your heating system should provide a flow speed that will insure a good heat transfer from the thermal fluid to the roll. The following are minimum flow speeds.

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Minimum Flow Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>&gt; 1 m/s (4 ft/sec)</td>
</tr>
<tr>
<td>Thermal Oil</td>
<td>&gt; 2 m/s (7 ft/sec)</td>
</tr>
</tbody>
</table>

Your system must have control equipment to limit the heating and cooling rate to plus or minus 2°C per minute (4°F).

Water systems require a maintained system pressure at a level where no flashing may occur.

Your system must provide safety features to protect your operating personnel: safety valves, temperature limiter, guards on the rotary joints to protect against leaking steam or thermal oil, and any other safety regulation required by law in your operating area.

**Other Considerations**

Heat output should be considered, especially when operating rolls at surface temperatures of more than 120°C (250°F) and with fluid temperatures of more than 180°C (350°F). It is critical to limit heat output of the system to the specified maximum.

Another consideration is a cooling exchanger. Having one in your heating systems will shorten the cooling down periods and minimize downtime, e.g. during roll changes.

Caution: Do not exceed the maximum cooling/heating rate of 4°F per minute. It is recommended to have filters in your systems to limit impurities or carbonized thermal oil. Once you have followed the proper procedures and recommendations regarding your thermal fluid and heating and/or cooling system on the previous pages, you are ready to operate your temperature controlled rolls.
The following points cover the correct procedures for operation:

- Filling must be done while the rolls are rotating. The complete venting of volume-displacer type rolls is only possible at increased rotating speeds when the centrifugal forces inside the roll become sufficient to completely fill the annulus between the roll shell and the displacer.

- Calender rolls should be kept rotating - at least slowly - at all times when the roll temperature or the temperature of the heat transfer fluid is above room temperature.

- When the temperature is increased by 100°C (180°F), the roll will expand by one-thousandth of its length (e.g., a 100” face length, the roll will expand approximately 0.10”). Make sure there is sufficient clearance to avoid damage to the bearings.

- When replacing a standard roll with a temperature controlled roll, you must check to determine whether the existing bearing can still be used. If the temperatures of the heating mediums are above 80°C (175°F), you may require roller bearings with an increased clearance. SHW offers you the option of journals with internal insulation that can be operated with existing bearings within certain limits.

- As soon as the rolls stop rotating, shut off the profile control systems (inductive or air blowers).

- When operating chrome-plated rolls, the rate of initial temperature increase must be limited to <10°C (18°F) per hour. If not, you run the danger of “crazing” or cracking the chrome plate.

When long and slim rolls (diameter-to-face length < 1:12) are put back into the stack after being in storage for a long period of time, make sure you turn them slowly for some time to correct natural roll sag and avoid vibrations. This normalizing process may have to be extended for several hours in extreme cases.

**IMPORTANT**

- **NEVER** spray water on hot rolls. Clean the roll surface with a light spray of kerosene or petroleum.

- If you ever use your temperature controlled rolls without a heating/cooling system, you must remove the rotary joints and the heating medium. Make sure the central bore is closed airtight.

- **NEVER** add cold water to rolls running at elevated operating temperatures. Do not exceed the maximum cooling/heating rate of 4°F per minute.

- **NEVER** switch cold rolls suddenly to a hot system.

- Chilled cast iron is very brittle!! Care must be taken when repairs are initiated. The surface of the roll must not be hit and cannot be welded. Please contact a SHW representative when attempting to repair defects in chilled cast iron.
**Maintenance**

Temperature controlled rolls are basically maintenance-free, except for regular regrinding.

Rotary joints should be serviced according to the manufacturer’s instructions.

When changing a roll or taking it out for service, make sure the temperature of the heat transfer fluid does not exceed 50ºC (120ºF) before opening the closed loop.

**Problems Due to Water Quality**

If you do not use sufficient quality water during operation, corrosion and/or deposits may be generated in the loop. This can lead to distortion of the roll’s face due to precipitation and solidification of minerals during storage or a machine shutdown. Your rolls will run noisy, imbalance and roll barring may become an issue, and thickness variations in the sheet can occur.

Under the worst conditions, the annulus will become plugged on one side only. This will cause severe roll distortion. The result will be extreme vibrations in the stack and may cause a machine shutdown.

If it is not possible to clean the roll chemically, the roll must be returned to SHW for repair. Our roll specialists will remove the displacer, clean and hone the bore, and shrink-fit a new displacer. This is the only way to repair the roll.

**AQUITHERM-V ROLLS ONLY**

Under the worst conditions, the annulus will become plugged on one side only. This will cause severe roll distortion. The result will be extreme vibrations in the stack and may cause a machine shutdown.

If it is not possible to clean the roll chemically, the roll must be returned to SHW for repair. Our roll specialists will remove the displacer, clean and hone the bore, and shrink-fit a new displacer. This is the only way to repair the roll.

**Reasons for Plugged Ports in Peripherally Drilled Rolls**

- Insufficient water quality or carbonized heat transfer fluid.
- Chips from the piping installation.
- Foreign particles such as wood or rags.
- Carbon chips from rotary joint seals.

The results are the same as described for the displacer design. The plugged ports can possibly be located by taking circumferential temperature measurements of the slowly rotating rolls. The journals must be disassembled to remove the obstruction mechanically.
**TECHNICAL SPECIFICATIONS**

The surface of chilled cast iron rolls should be hard and free from inclusions. The core requires gray iron with good strength properties.

**Chill Depth for Chilled Cast Iron Rolls**

A. **Depth of Clean Chill** -- This pure chill depth is the outermost zone and ends at the first grey dots. In this region, the hardness remains constant.

B. **Partly Chilled** -- This region includes a certain amount of small grey dots.

C. **Usable Chill Depth** -- This is the total depth of regions (A) and (B). In this region, cementite crystals are embodied in pearlite.

D. **Total Depth Affected by Chill** -- This region begins at the depth of the clean chill and ends at the point where the roll structure is totally solidified as gray iron.

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**The Chilled Cast Iron Process**

Chilled cast iron is produced by a process in which iron is poured into a stack of cast iron rings, called chills. The iron enters tangentially from the bottom, forcing the heavier particles outward. The chills rapidly absorb the heat of the molten iron and cause the outer surface of the roll body to cool quickly, forming carbides. This outer area of the roll body is called the chill zone. The depth of the chill zone is a function of the roll diameter size, however, as an average, chill depth for any particular roll is approximately \( \frac{1}{2} \)”. This chill zone possesses much higher hardness characteristics than the gray iron inner core. In the center of the roll, where the iron cools more slowly, these carbides do not form, resulting in a gray iron structure. This gray iron area possesses excellent strength characteristics.
**Chill Depth**

For smaller rolls (< 10” diameter), the standard chill depth ranges from about 3/8” to 1/2”. For all other diameters, the standard chill depth ranges from ½” to 5/8”.

These measurements are those normally used for chilled cast iron rolls. For possible different executions, consult SHW Roll Specialists.

<table>
<thead>
<tr>
<th>Nominal Diameter</th>
<th>Usable Chill Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm inches</td>
<td>From</td>
</tr>
<tr>
<td>150 - 300</td>
<td>6</td>
</tr>
<tr>
<td>300 - 600</td>
<td>12</td>
</tr>
<tr>
<td>600 - 1200</td>
<td>24</td>
</tr>
</tbody>
</table>

**Hardness Test for Chilled Cast Iron Rolls**

The Vickers (DIN 50133) Hardness Testing Method and its testing apparatus are recommended for chilled cast iron. Other methods used to measure hardness are the Brinell and Shore “C” Hardness Testing Methods. These methods are often unreliable when testing chilled cast iron.

If Brinell or Shore “C” figures are required, you should first obtain a Vickers Hardness, and use an accepted comparison table to convert to the figure required (see Comparative Hardness Table).

If you choose to use the Brinell Testing Method, which uses a ball apparatus, you should be aware that the ball may become deformed when used on chilled cast iron. This can cause a larger impression on the test piece and result in a lower than actual hardness measurement.

**Vickers Hardness Test Method**

SHW has found the Vickers Method to be the most suitable for chilled cast iron. However, even with the Vickers Method, accurate measurements can only be achieved by taking an average of at least 10 measurements because deviations due to the heterogeneous chilled cast iron structure can be expected.

The following is an example of how the Average Hardness and Measuring Tolerance is derived from 10 separate measurements. We have used the Vickers Hardness (HV) Testing Method.

**Example:** Material GH580 with a Vickers Hardness of 580 HV.
Vickers Hardness Tables

<table>
<thead>
<tr>
<th>Hardness Test:</th>
<th>Measuring Tolerance:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring</td>
<td>Vickers</td>
</tr>
<tr>
<td>Points</td>
<td>Lowest hardness</td>
</tr>
<tr>
<td>Hardness (HV)</td>
<td>measurement - average</td>
</tr>
<tr>
<td>1</td>
<td>578</td>
</tr>
<tr>
<td>2</td>
<td>590</td>
</tr>
<tr>
<td>3</td>
<td>568</td>
</tr>
<tr>
<td>4</td>
<td>595</td>
</tr>
<tr>
<td>5</td>
<td>598</td>
</tr>
<tr>
<td>6</td>
<td>594</td>
</tr>
<tr>
<td>7</td>
<td>610</td>
</tr>
<tr>
<td>8</td>
<td>584</td>
</tr>
<tr>
<td>9</td>
<td>604</td>
</tr>
<tr>
<td>10</td>
<td>599</td>
</tr>
<tr>
<td>average</td>
<td>592</td>
</tr>
<tr>
<td></td>
<td>+18</td>
</tr>
</tbody>
</table>

As shown in Table 1, the Average Measuring Tolerance for this material ±12; therefore, a hardness measurement of 580 HV can be expected when the roll is measured again.

List of available SHW chilled cast iron body materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Surface Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vickers HV</td>
</tr>
<tr>
<td>Standard GH550</td>
<td>550</td>
</tr>
<tr>
<td>Alloyed GH580</td>
<td>580</td>
</tr>
<tr>
<td>Alloyed GH600</td>
<td>600</td>
</tr>
<tr>
<td>Alloyed GH640</td>
<td>640</td>
</tr>
<tr>
<td>Special Alloyed GHHT550</td>
<td>550</td>
</tr>
<tr>
<td>(For High Heat Transfer Application)</td>
<td></td>
</tr>
<tr>
<td>Special Alloyed GHHT580</td>
<td>580</td>
</tr>
<tr>
<td>(For High Heat Transfer Application, and Improved Corrosion Resistance)</td>
<td></td>
</tr>
<tr>
<td>Special Alloyed GHST550</td>
<td>550</td>
</tr>
<tr>
<td>(Increased Tensile Strength)</td>
<td>550</td>
</tr>
<tr>
<td>Special Alloyed GHST600</td>
<td>600</td>
</tr>
<tr>
<td>(Increased Tensile Strength)</td>
<td>600</td>
</tr>
</tbody>
</table>

- All measurements are in Vickers (HV) and converted according to SAE Standards (Handbook 1964).
- Roll diameter can influence actual surface hardness.
### Comparative Hardness Table

<table>
<thead>
<tr>
<th>Vickers HV kp/mm²</th>
<th>Brinell HB kp/mm²</th>
<th>Rockwell mm HRC</th>
<th>Shore &quot;C&quot;</th>
<th>Vickers HV kp/mm²</th>
<th>Brinell HB kp/mm²</th>
<th>Rockwell mm HRC</th>
<th>Shore &quot;C&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagonal for P=20 kp</strong></td>
<td><strong>Diagonal for P=150 kp</strong></td>
<td><strong>Diagonal for P=20 kp</strong></td>
<td><strong>Diagonal for P=150 kp</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diamond Pyramid</strong></td>
<td><strong>Tungsten Carbide Ball 10 mm</strong></td>
<td><strong>Scleroscope American</strong></td>
<td><strong>Scleroscope American</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mm</td>
<td>Col. 1</td>
<td>Col. 4</td>
<td>Col. 7</td>
<td>Col. 12</td>
<td>mm</td>
<td>Col. 1</td>
<td>Col. 4</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>------------------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>0.198</td>
<td>940</td>
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<td>68.0</td>
<td>97</td>
<td>0.300</td>
<td>410</td>
<td>388</td>
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<tr>
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<td>920</td>
<td>--</td>
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<td>96</td>
<td>0.304</td>
<td>400</td>
<td>379</td>
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<td>--</td>
<td>0.514</td>
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<td>133</td>
</tr>
</tbody>
</table>

Note: Impressions diagonal (1st col.) not listed in SAE table. Due to the conversion, the 3rd digit after the decimal point is rounded to the nearest thousandth.
### Standard Precision Finish Grinding Tolerances for Straight Calender Rolls

<table>
<thead>
<tr>
<th>Face Lengths</th>
<th>Shape</th>
<th>Station to Station</th>
<th>Taper</th>
<th>Concentricity T.I.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 100</td>
<td>.0004</td>
<td>.0003</td>
<td>.001</td>
<td>.0005</td>
</tr>
<tr>
<td>101 to 150</td>
<td>.0005</td>
<td>.0003</td>
<td>.001</td>
<td>.0005</td>
</tr>
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<td>151 to 200</td>
<td>.0005</td>
<td>.0003</td>
<td>.001</td>
<td>.0005</td>
</tr>
<tr>
<td>201 to 250</td>
<td>.0005</td>
<td>.0003</td>
<td>.001</td>
<td>.0005</td>
</tr>
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<td>251 to 300</td>
<td>.0005</td>
<td>.0003</td>
<td>.0012</td>
<td>.0006</td>
</tr>
<tr>
<td>301 to 350</td>
<td>.0008</td>
<td>.0005</td>
<td>.0012</td>
<td>.0006</td>
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<tr>
<td>351 and Up</td>
<td>.0008</td>
<td>.0005</td>
<td>.0012</td>
<td>.0006</td>
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</tbody>
</table>

* Material to be Removed is .010” off the Diameter.

### Special Precision Finish Grinding Tolerances for Straight Calender Rolls

<table>
<thead>
<tr>
<th>Face Lengths</th>
<th>Shape</th>
<th>Station to Station</th>
<th>Taper</th>
<th>Concentricity T.I.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 to 100</td>
<td>.0003</td>
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<td>.0004</td>
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</tr>
<tr>
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<td>.0005</td>
<td>.0003</td>
</tr>
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<td>151 to 200</td>
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<td>251 to 300</td>
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</tr>
<tr>
<td>301 to 350</td>
<td>.0005</td>
<td>.00025</td>
<td>.0006</td>
<td>.0005</td>
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</tbody>
</table>
### Surface Finish Conversions

#### Surface Roughness

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<th>2</th>
<th>4</th>
<th>8</th>
<th>16</th>
<th>32</th>
<th>63</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra (µm)</td>
<td>.025</td>
<td>.05</td>
<td>.1</td>
<td>.2</td>
<td>.4</td>
<td>.8</td>
<td>1.6</td>
<td>3.2</td>
<td>6.3</td>
<td>12.5</td>
<td>25.0</td>
<td>50.0</td>
</tr>
<tr>
<td>RMS (µin.)</td>
<td>1.1</td>
<td>2.2</td>
<td>4.4</td>
<td>8.8</td>
<td>17.6</td>
<td>35.2</td>
<td>69.3</td>
<td>137.5</td>
<td>275</td>
<td>550</td>
<td>1100</td>
<td>2200</td>
</tr>
<tr>
<td>Rt (µm)</td>
<td>.3-.4</td>
<td>.5-.7</td>
<td>.9-.1.1</td>
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<td>10-12</td>
<td>16-20</td>
<td>30</td>
<td>50</td>
<td>100</td>
<td>200</td>
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<td>N 4</td>
<td>N 5</td>
<td>N 6</td>
<td>N 7</td>
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<td>N 10</td>
<td>N 11</td>
<td>N 12</td>
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<td>Swiss Stds</td>
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<td>▼▼▼</td>
<td>▼▼▼</td>
<td>▼▼▼</td>
</tr>
</tbody>
</table>

#### Dimensional

1 Microinch = 1 µin. = 10⁻⁶ in. = 254Å = 25.4nm = .206 seconds per inch

1 Micrometer = 1 micron = 1µm = 10⁻⁶ meters = 10⁴ Å = 39.37 µin.

1 Manometer = 10⁻⁹ meters = 10Å = 3.937 x 10⁻⁸ in.

1 Angstrom - 1Å = 10⁻¹⁰ meters = 0.1 nm = 3.937 x 10⁻⁹ in.