ASO Hydraulics & Pneumatics | VISION

By leading an industrial revolution that impacts the perception of hydraulic & pneumatic products, we force the innovation.

ASO Hydraulics & Pneumatics | MISSION

We invest 100% of our efforts in continuous improvement by upgrading systems, processes and technology, applying marketing & sales customized strategies and by building a safe and proper environment for innovation.

How is all that possible?

Because we engage our employees through a culture of life, responsibility, values and courage.

Like this we contribute to our customers success.
ASO GROUP is a Manufacturing company originated from ASO Acciai Speciali Ospitaletto, established in 1971 by Aldo Artioli.

Aldo was a metallurgical chemistry expert with a strong business acumen.

Over the years, ASO GROUP has pursued a growth strategy through acquisition to become today one of the largest leading group on the international markets specializing in steel products, hydraulic & pneumatic components, power and industrial transformers, forgings and switchboards for industrial electric power distribution.

In 2011 ASO GROUP took over SPS S.p.A, a company founded in 1992 in Italy near Verona.

ASO Siderurgica SPA is a leading manufacturer of forge ingots that has managed to maintain its top-ranking market position thanks to its policy of providing regular personnel training, continuous improvement in manufacturing processes and heavy well-targeted investments, all in view of achieving the highest possible quality, in complete safety and respecting the environment.

ASO draws up plans and adopts methods to provide a more effective and more efficient customer service in terms of rapid examination of inquiries, advice on metallurgical matters, in-time deliveries and assessment of the supply results.

This method of operation has become routine and involves all the departments throughout the organisation.

Aldo Artioli

As part of its policy to expand its presence in different business sectors, the ASO Group has improved its versatility and strengthened its international presence by focusing on producing the special steel grades and alloys for high-tech applications.

ASO GROUP Board of Shareholders
Having more than 20 years of experience in chrome plated bars production for hydraulic cylinders, automotive and earth moving machinery, the merger has brought a new type of business to ASO GROUP. The acquisition of SPS SpA by ASO GROUP paved the way to new business opportunities on the Hydraulics & Pneumatics Market.

In 2014, ASO GROUP merged with Cromsteel Industries SA, one of the biggest players in the field of manufacturing high technology products for hydraulics & pneumatics, chrome plated bars and tubes plus linear shafts.

With this strategic move, ASO GROUP finalized the creation of ASO Hydraulics & Pneumatics formed by 2 plants: FDF (Italy) and ASO CROMSTEEL (Romania).

ASO Hydraulics & Pneumatics is considered the World’s leader in terms of capacity and range of products. The division is employing more than 800 people that are working in premises of 230,000 m². This numbers are the results of the prime quality standards.

Having a consolidated sales experience in over 80 countries, ASO H&P is considered the largest distributor in the world and the perfect partner for our Customers.
Due to ongoing global development, our industry has adapted to meet new client demands.

Collaborating with our customers has allowed us better insight to their needs, growth and quality. One of our most important mission is our focus on research and development of innovative technological solutions. This mission brings to our customers the best performance through Innovative Automatization Processes.

Our commitment to innovative research and development is supported by a remarkable integration of the processes involved both in equipment design and production stages.

An in-depth knowledge of processes and plants structure has allowed us to design not only in-house parts of our equipment but also all production lines for chrome plating, skiving and roller burnishing or honing. Our production team works with a smart 3D computer modeling system which is used to evaluate the correct equipment design, mechanical resistance as well as the main characteristics of the product — such as weight, volume and cost.

Our constant attention to customer demands has encouraged us to respond with innovative new products, services, new steel grades and machines.

ASO Hydraulics & Pneumatics is recognized as a thought leader in the chrome plating manufacturing industry providing the widest range of products along with the largest production plants throughout Europe.

Our product line is split into three main categories:

**A-CHROME series**
Chrome plated steel bars
INDUCTION HARDENED AND CHROME PLATED STEEL BARS

**A-TUBE series**
Chrome plated steel tubes Skived and roller burnished tubes

**A- LINE series**
Chrome plated linear shafts
INDUCTION HARDENED AND CHROME PLATED STEEL BARS

These categories are also divided in subcategories arriving to a total of around 3000 articles.

In Targoviste, Romania, where ASO CROMSTEEL is located, 100% of the chroming process is made through continuous chroming process. Why is this important? Because the resulted first class products are the image reflected in the eyes of our Customers. The production numbers are our guarantee, because ASO CROMSTEEL is capable of producing 15,000 meters of chromed products in Targoviste and ASO SPS can produce 4,000 meters in Verona daily. Why is this important? Because when you are a supplier for the most important OEM’s and Distributors of Chrome plated products you need to have the capabilities to provide big quantities of products as soon as possible.
ASO Hydraulics & Pneumatics has the biggest chrome plating capacity in Europe: in any given moment, more than 200 (bars, tubes and linear shafts) are simultaneously chrome plated in our two plants from Romania and Italy.

**Multi-Layer Chrome Plating lines**

In collaboration with the world’s biggest experts in this industry, the entire production conception has been re-designed in the past years: Peeling & Rolling, Laser Controlled Grinding, Multi-Layer Chrome Plating Technology, Laser Controlled Grinding-Polishing. This new conception is intensely increasing productivity and now combined with the best global raw material sourcing has led to first-class competitiveness.

Multi-Layer Chrome Plating is a Technology that consists in creating a layer of chrome from several overlapped substrates.

On certain diameters, we have reached the performance to apply up to 8 overlapped substrates of Chrome that are forming one of the best chrome layers on the Market.

This technology is helping us providing to our worldwide customers not only standard products but also products with custom made chrome layer thickness.

**Advantages:**

These substrates guarantee that the chrome micro-cracked structure does not let external agents such as water, humidity, corrosive moisture penetrate through the porous and uneven chrome surface and initiate corrosion. See alongside the comparison between 25 µm of “Single-Layer Chrome Plating Technology” and 25 µm “Multi-Layer Chrome Plating Technology” photographed under the microscope.

“Multi-Layer Chrome Plating Technology”, through higher number of chrome layers, grants a guarantee that overlapping substrates create a perfect barrier between the base steel and the external agents.

With our technology we create up to 8 overlapping substrates of Chrome for certain diameters and applications.

**Up to 8 overlapped substrates of Chrome**

Moreover, the particular micrographic structure of this chrome layer is different from all other producers in the world and can always be recognized under the microscope. We can say that is like having a fingerprint of the chroming process.

Another advantage is given by the perfectly circular anodes (used in the Continuous Chroming process). Due to this circularity a completely homogeneous and concentric chrome overlay is guaranteed all around, eliminating the need for additional grinding steps.
One of the most important steps taken by the Division Management has been the adoption of TQS (Total Quality System) together with “all in-house” production, allowing strict quality controls and immediate identification of critical points in every step of the process. Having two very well defined quality departments is helping to have a complete process control:

- **Quality Assurance Team - Q-TEAM**
- **Quality Control - QC**

ASO Hydraulics & Pneumatics Quality Assurance Team is dealing with the creation of procedural and administrative activities in order to have a Kaizen Management Process. All of these are implemented into a quality system in order to fulfill not only the goals and the requirements of the product but also the entire service that is provided to the Customer.

In the Quality Assurance we respect two very important principles:

- **Our products should fit for the intended purpose**
- **Errors must be eliminated**

Q-TEAM deals with the management of the raw materials, services related to production, assemblies and inspection of the processes used in controlling the production.

Our Q-TEAM is assuring the procedures to follow in order to have the quality of the production processes and our QC Team enters inside the process and is doing all the necessary controls.

QC - quality control is a process by which entities review the quality of all factors involved in production. Quality Control is only “A part of quality management focused on fulfilling quality requirements”.

**OUR QUALITY, YOUR GUARANTEE**

**QUALITY CHECKPOINTS:**

1. **RAW MATERIAL CHECK LIST:***
   - visual examination tolerance
   - roundness
   - straightness
   - length
   - macroscopic analysis
   - microscopic analysis
   - hardness chemical composition

2. **OUTPUT QUALITY CHECKLIST FOR THE PEELING & ROLLING LINE:***
   - diameter tolerance
   - roundness
   - laser diameter control
   - visual examination straightness

3. **OUTPUT QUALITY CHECKLIST FOR THE INDUCTION HARDENING LINES:***
   - diameter tolerance
   - hardening depth
   - visual examination
   - surface hardness OF induction depth

4. **OUTPUT QUALITY CHECKLIST FOR THE GRINDING LINES:***
   - diameter tolerance
   - visual examination
   - laser diameter control
   - roundness
   - straightness
   - Ra surface roughness (on request : Rz, Rt)

5. **OUTPUT QUALITY CHECKLIST FOR EVERY CHROME PLATING LINE:***
   - visual examination
   - chrome layer thickness diameter

6. **QUALITY CHECKLIST FOR EVERY PRODUCTION LOT:***
   - visual examination
   - diameter tolerance
   - chrome thickness
   - magnetism
   - chrome multi-layer structural integrity (all analysis results are registered)
   - chrome micro-crack consistency
   - chrome layer hardness
   - metallographic structure
   - corrosion resistance in Neutral Salt Spray (NSS) tests
**APPLICATION ENGINEER:**
an innovative role able to support costantly the customer during the phase of analysis and process for a new project.

**CORROSION RESISTANCE**
Corrosion resistance is tested According to ISO 9227 and evaluated acc. ISO 10289. These international standards describe the methods and the equipment to be used for corrosion resistance tests.

Upon request, the tests can be performed according to ASTM standards as the following: NSS according to ASTMB117; AASS according to ASTMB287; CASS according to ASTMB368.

ISO 9227 / ISO 10289 indicates three types of testing, progressively more aggressive:
- **NSS - Neutral Salt Spray** (according to ASTM B117) (standard)
- **AASS - Acetic Acid Salt Spray** according to ASTM B287 (upon request)
- **CASS - Copper Accelerated Acetic Acid Salt Spray** according to ASTM B368 (upon request)

Procedure:
Corrosion resistance tests are conducted in special chambers. The products are positioned in the chamber and exposed to the corrosive action of the spray using an angle of 22 degrees. Before beginning, the samples are prepared and identified with all traceability information. The start date and hour of the test are also recorded. Each day our chemists are verifying the rating of the samples. After the reach of the desired test, the samples are rinsed with water and examined according to the ISO 10289 norm, which regulates the evaluation of the results, assigning a “rating” to the surface under examination. A “Rating 9” means that corrosion has appeared on 0.1% of the total sample surface. A “Rating 10” means no corrosion at all. All the tests results are registered in our database.

**CHROME PLATING SOLUTION CONTROL**
Chemical analysis are performed in our laboratory, by chemists, according to our internal procedures. We pay a special attention to these tests because our plating lines produce over 17,000 m of chrome products every day in our plants. All analysis results are registered.

**OUTPUT QUALITY CHECKLIST FOR EVERY LINE:**
- visual examination
- diameter
- Ra and Rt surface roughness
- roundness
- concentricity / eccentricity, wall thickness

**Over 120 electronic and 180 mechanical units of Mitutoyo, Fischer & Vogel** state of the art measuring instruments guarantee precision on all the quality control parameters.

The instrument setup is made at the beginning of every shift by fully trained quality department personnel. During the manufacturing process and all the way down to customers’ warehouse, the Quality Assurance System ensures full raw material traceability for each production lot.

For a full traceability, each product is marked individually on the plastic/paper tube with information about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no, production order and so on. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade, total length of the batch, Weight, no of pieces in the batch.
APPLICATIONS FOR STANDARD CONDITIONS

PRODUCTS FROM THIS CATEGORY:

A-Chromed bars ACBP-C45-N (BAC), ACBP-C45-H (BATC), ACBP-20MV6-N (BACM), ACBP-20MV6-H (BATCM) and ACTP-E355-SR (TUC); ASTP-E355-SR (TUL); ASCTP -E355-SR (TUCL) for tubes according to E355 EN 10305-1/-2 standards.

Product applications:


- Long reach cylinders: we recommend the use of tubes ASTP-E355-SR or ASWTP-E355-SR that are the best option to build lighter cylinders. The standard characteristics can be improved by replacing the chrome plated bars used as piston of the cylinder with our ASTP-E355-SR H8 tubes. This solution is decreasing the weight of the piston by 50-60%.

- Telescopic cylinders: H8 ID skived and roller burnished and OD chrome f7 tolerance

- Concrete pumps, rotating cranes & platforms, chalk, plastic, rubber injection moulds, office chairs: we recommend inside chrome plated, skived and roller burnished tubes ASCTP-E355-SR

- Low speed & mostly agricultural cylinders: H9 ready to use tubes ASWTP-E355-SR are good enough if Ra < 0.80µm is acceptable, together with ACBP-C45-N, ACBP-C45-H (quality hydraulic cylinders)

Recommended Corrosion Resistance Coating:

Applications for standard conditions are defined as applications working in a non-particular corrosive environment. The choice must be made according to external factors like temperature, humidity and general weather conditions that vary from one environment to another. The choice can be critical for the product lifetime and great attention must be paid to it.

For standard or so called “multipurpose” hydraulic cylinders our Technical Department is recommending products with a corrosion resistance: R9/120hNSS and R9/200hNSS.

NSS test (according to ISO 9227) with rating 9 (according to ISO 10289) enhanced resistance.

Steel grade must be taken into consideration according to load withstand and mechanical properties required.

We recommend that customers discuss in detail all applications with ASO Hydraulics & Pneumatics Technical Department before proceed with production, in order to achieve the best possible solutions.
RECOMMENDED MATERIALS / PRODUCTS:

A | CHROME
ACBP-C45-N 
ACBP-C45-H
ACBP-20MV6-N
ACBP-20MV6-H

A | TUBE
ACTP-E355-H
ACTWP-E355-H
ASCTP-E355-SR
ASCTP-E355-H
ACTP-E355-SR
ACWTP-E355-SR
ASWTP-E355-SR
AICTP-E355-SR

APPLICATIONS:
• Garbage Compactors
• Dump Trucks
• Articulated Dump Trucks
• Compact Track Loaders
• Materials Handling
• Mini Skid Steers
• Skidders
• Logging & Forest Control Machinery
• Rotating Cranes
  (Forestry crane loaders etc)
• Forwarders
• Agricultural Machinery
• Backhoe Attachments
• Telehandlers & Long Reach Arms
• Wheeled & Crawler Platforms
• Mobile & Stationary Cranes
• Wheeled & Crawler Cranes
• Materials Processing
• Pneumatic cylinders
  with pressure > 200 bar
• Injection molds for chalk, plastic, rubber
• Auto racks and street cleaning equipment
• Tippers
• Building lifts
• Fork Lifts
• Hook lifts
• Tail Lifts/Platforms
• Asphalt Milling
• Asphalt Recyclers
• Material Processors
• Pedestal Boom Systems
• Hydraulic Crushers & Scissors
• Ag Forks
• Bale Spears
• Brush Tined Grapples
• Mulching Heads
• Scrap Grapples
• Shock Absorbers
• Gas springs
• Pneumatic cylinders
• Fitness equipment
• Hydraulic Presses
• Directional Drills
• Truck Cranes
**APPLICATIONS:**

- Excavators
- Snow Plows
- Drilling Equipment
- Mining Equipment
- Trenchers
- Long wall mining supports
- Garbage Compactors
- Dump Trucks
- Articulated Dump Trucks
- Compact Track Loaders
- Telehandlers & Long Reach Arms
- Mobile & Stationary Cranes
- Wheeled & Crawler Cranes
- Vacuum Trucks
- Tippers
- Tail Lifts/Platforms
- Crushers
- Wind Mills
- Crawler Dozers
- Crawler Loaders
- High Speed Dozers
- Landscape Loaders
- Votex Graders
- Skid Steers
- Wheel Loaders
- Feller Bunches
- Refuse Compactors
- Soil Compactors

**RECOMMENDED MATERIALS / PRODUCTS:**

**A | CHROME**

- ACBP-C45-N
  - BAC
- ACBP-C45-H
  - BATC
- ACBP-20MV6-H
  - BATCM
- ACBP-38MVS-N
  - BACV
- ACBP-42CD4-Q
  - BOC
- ACBP-42CD4-QH
  - BOTC
- ACBP-A431-Q
  - BACI 431

**A | TUBE**

- ACTP-E355-SR
  - TUC
- ACTP-E355-H
  - TUTC
- ASCTP-E355-SR
  - TUCL
- ASCTP-E355-H
  - TUTCCL
- ASTP-E355-SR
  - TUL
- AICTP-E355-SR
  - TUCI
APPLICATIONS FOR DEMANDING CONDITIONS

PRODUCTS FROM THIS CATEGORY:

The parts ASTP-E355-SR & ASWTP-E355-SR Hollow Rods ACTP-E355-SR with high quality mechanical characteristics are ideally suited for manufacturing high-stress hydraulic cylinders. Quality of raw material ensures uniform mechanical properties together with good impact resistance in both longitudinal and radial direction, down to -20°C.

Recommended Corrosion Resistance Coating:

- **R10/120h NSS** with 120 hours of corrosion resistance in NSS test (according to 153 9227) and rating 10 (according to ISO 10289) enhanced resistance.
- **R9/500h NSS** with 500 hours of corrosion resistance in NSS test (according to ISO 9227) and rating 9 (according to ISO 10289) enhanced resistance.
- **R10/500h NSS** with 500 hours of corrosion resistance in NSS test (according to ISO 9227) and rating 10 (according to ISO 10289) enhanced resistance.

PRODUCT applications:

For long reach cylinders we recommend hollow bars ACTP-E355-SR as the best option to build lighter cylinders. They also improve the standard characteristics of the chrome bars, by decreasing weight up to 50-60%. Coating solutions can be chosen according to the customer's needs.

Demanding applications are defined as those used in a heavy duty & corrosive environment. The choice must be made according to the work environment (external factors such as temperature, humidity and general weather conditions that vary from one geographical location or environment to another).

Often other factors might be taken into consideration, such as steel grade (according to load withstand) and mechanical properties of the steel used; in particular case, these properties have a critical impact on the application of the product.

The choice can be critical for the product's lifetime and attention to production details must be paid.

We recommend that customers discuss in detail all applications working in demanding conditions with ASO Hydraulics & Pneumatics Technical Department before proceed with production, in order to achieve the best possible solutions.
Recommended Corrosion Resistance Coating:

ACBP-A304-A series with R9/1000h NSS - applicable on stainless steel AISI materials with 1000 hours of corrosion resistance in NSS test (according to ISO 9227) and rating 9 (according to ISO 10289) enhanced resistance.

The choice of the material can be critical for the product lifetime and great attention must be paid to it.

Applications working in extreme conditions

- Chemical Industry with exposure to aggressive agents
- Mining Equipment
- Oil and Gas
- Power Generation
- Aerospace
- Marine Environment
- Boat Launch and Recovery systems

We recommend that customers discuss in detail all applications for extreme conditions with ASO Hydraulics & Pneumatics Technical Department before proceed with production, in order to achieve the best possible solutions.
ACBP-C45-N  
BAC  
CHROME PLATED STEEL BAR

ACBP-C45-H  
BATC  
CHROME PLATED STEEL BAR (induction hardened)

ACBP-20MV6-N  
BACM  
CHROME PLATED STEEL BAR

ACBP-20MV6-H  
BATCM  
CHROME PLATED STEEL BAR (induction hardened)

ACBP-38MVS-N  
BACV  
CHROME PLATED STEEL BAR

ACBP-38MVS-H  
BATCV  
CHROME PLATED STEEL BAR (induction hardened)

ACBP-CW85-N  
BACW  
CHROME PLATED STEEL BAR (induction hardened)

ACBP-CW85-H  
BATCW  
CHROME PLATED STEEL BAR

ACBP-42CD4-Q  
BOC  
CHROME PLATED STEEL BAR

ACBP-42CD4-QH  
BOTC  
CHROME PLATED STEEL BAR (induction hardened)

ACBP-A304-A  
BACI 304  
CHROME PLATED STAINLESS STEEL BAR

ACBP-A316-A  
BACI 316  
CHROME PLATED STAINLESS STEEL BAR

ACBP-A329-A  
BACI 329  
CHROME PLATED STAINLESS STEEL BAR

ACBP-A431-Q  
BACI 431  
CHROME PLATED STAINLESS STEEL BAR

ACBP-A630  
BACI 630  
CHROME PLATED STAINLESS STEEL BAR

ACBP-X20-B  
BACX  
CHROME PLATED STAINLESS STEEL BAR
Chrome Bars

A | CHROME

the rock way of chroming
GENERAL CHROMED BARS

PROPERTIES

ASO HYDRAULICS & PNEUMATICS CHROME PLATED STEEL BARS ARE MANUFACTURED FROM A FIRST CLASS STEELS HAVING THE FOLLOWING PROPERTIES:

STEEL GRADE CORRESPONDENTS

<table>
<thead>
<tr>
<th>ASO GROUP</th>
<th>EN</th>
<th>W</th>
<th>BS</th>
<th>AFNOR</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACBP-C45</td>
<td>C4E</td>
<td>1.1191</td>
<td>080N45</td>
<td>X45</td>
<td>1045</td>
</tr>
<tr>
<td>ACBP-20Mv6</td>
<td>20Mv6</td>
<td>1.5217</td>
<td>55M</td>
<td>E420</td>
<td>A572</td>
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<tr>
<td>ACBP-38Mv6</td>
<td>38Mv6</td>
<td>1.1303</td>
<td>–</td>
<td>30Mv6</td>
<td>1045V</td>
</tr>
<tr>
<td>ACBP-CW85</td>
<td>CW85*</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>ACBP-42CD4</td>
<td>42CrMo4+QT</td>
<td>1.7225</td>
<td>708M4O</td>
<td>42CD4</td>
<td>4140</td>
</tr>
</tbody>
</table>

*CW85 internally developed high quality alloy steel with CE(%) = C + (Mn/6) + (Cr+Mo+V)/5 + (Ni+Cu)/15

Table 1: Corresponding standards for the steel used

CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>V</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>C45E</td>
<td>0.42-0.50</td>
<td>max. 0.40</td>
<td>0.50-0.80</td>
<td>max. 0.030</td>
<td>max. 0.035</td>
<td>max. 0.40</td>
<td>max. 0.10</td>
<td>max. 0.40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>20Mv6</td>
<td>0.15-0.22</td>
<td>0.15-0.80</td>
<td>1.20-1.60</td>
<td>max. 0.025</td>
<td>0.02-0.06</td>
<td>max. 0.30</td>
<td>–</td>
<td>–</td>
<td>0.08-0.20</td>
<td>–</td>
</tr>
<tr>
<td>38Mv6</td>
<td>0.34-0.41</td>
<td>0.15-0.80</td>
<td>1.20-1.60</td>
<td>max. 0.025</td>
<td>0.020-0.060</td>
<td>max. 0.30</td>
<td>max. 0.08</td>
<td>–</td>
<td>0.08-0.20</td>
<td>–</td>
</tr>
<tr>
<td>CW85*</td>
<td>0.36-0.40</td>
<td>0.30-0.50</td>
<td>1.10-1.40</td>
<td>max. 0.035</td>
<td>0.020-0.035</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.11-0.16</td>
<td>max. 0.10</td>
</tr>
<tr>
<td>42CrMo4+QT</td>
<td>0.38-0.45</td>
<td>max. 0.40</td>
<td>0.60-0.90</td>
<td>max. 0.025</td>
<td>max. 0.035</td>
<td>0.90-1.20</td>
<td>0.15-0.30</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

*CW85 internally developed high quality alloy steel with CE(%) = C + (Mn/6) + (Cr+Mo+V)/5 + (Ni+Cu)/15

Table 2: Chemical composition in % by weight

MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Steel grade</th>
<th>Diameter</th>
<th>Tensile Strength</th>
<th>Yield Point</th>
<th>Elongation</th>
<th>Hardness Brinell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ø [mm]</td>
<td>Rm [MPa (Psi)]</td>
<td>Rp0.2 [MPa (Psi)]</td>
<td>A5 [%]</td>
<td>HB</td>
</tr>
<tr>
<td>ACBP-C45</td>
<td>C45E</td>
<td>≤16</td>
<td>min. 710 (103000)</td>
<td>min. 500 (72500)</td>
<td>min. 5</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16&lt;Ø≤19</td>
<td>min. 650 (94000)</td>
<td>min. 410 (59000)</td>
<td>min. 7</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20&lt;Ø≤100</td>
<td>min. 580 (84000)</td>
<td>min. 305 (44000)</td>
<td>min. 16</td>
<td>180-225</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100&lt;Ø≤200</td>
<td>min. 560 (81000)</td>
<td>min. 275 (40000)</td>
<td>min. 16</td>
<td>180-225</td>
</tr>
<tr>
<td>ACBP-20Mv6</td>
<td>20Mv6</td>
<td>6&lt;Ø≤19</td>
<td>min. 700 (101000)</td>
<td>min. 620 (90000)</td>
<td>min. 10</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20&lt;Ø≤90</td>
<td>min. 550 (78000)</td>
<td>min. 450 (65000)</td>
<td>min. 18</td>
<td>165-200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90&lt;Ø≤200</td>
<td>min. 550 (78000)</td>
<td>min. 420 (60000)</td>
<td>min. 19</td>
<td>165-220</td>
</tr>
<tr>
<td>ACBP-38Mv6</td>
<td>38Mv6</td>
<td>0&lt;Ø≤20</td>
<td>min. 850 (123000)</td>
<td>min. 600 (87000)</td>
<td>min. 6</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20&lt;Ø≤200</td>
<td>min. 800 (116000)</td>
<td>min. 520 (75000)</td>
<td>min. 12</td>
<td>230</td>
</tr>
<tr>
<td>ACBP-CW85</td>
<td>CW85*</td>
<td>20&lt;Ø≤140</td>
<td>850-1000 (123000-145000)</td>
<td>min. 580 (84000)</td>
<td>min. 12</td>
<td>250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤16</td>
<td>1000-1200 (145000-174000)</td>
<td>min. 900 (130000)</td>
<td>min. 9</td>
<td>295-350</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16&lt;Ø≤40</td>
<td>1000-1200 (145000-174000)</td>
<td>min. 750 (108000)</td>
<td>min. 11</td>
<td>295-350</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40&lt;Ø≤100</td>
<td>900-1100 (130000-159000)</td>
<td>min. 650 (94000)</td>
<td>min. 12</td>
<td>271-330</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100&lt;Ø≤160</td>
<td>800-950 (116000-138000)</td>
<td>min. 550 (78000)</td>
<td>min. 13</td>
<td>225-270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>160&lt;Ø≤250</td>
<td>750-900 (108000-130000)</td>
<td>min. 500 (73000)</td>
<td>min. 14</td>
<td>225-270</td>
</tr>
</tbody>
</table>

Table 3: Mechanical Properties for the steels used
STAINLESS STEEL CHROMED BARS

PROPERTIES

STAINLESS STEEL GRADE CORRESPONDENTS

<table>
<thead>
<tr>
<th>ASO GROUP</th>
<th>EN</th>
<th>W</th>
<th>BS</th>
<th>AFNOR</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACBP-A304</td>
<td>X5CrNi18-10</td>
<td>1.4301</td>
<td>304517</td>
<td>Z7ON18-09</td>
<td>AISI 304</td>
</tr>
<tr>
<td>ACBP-A316</td>
<td>X5CrNiMo17-12-2</td>
<td>1.4401</td>
<td>316S11</td>
<td>Z3ON11-02</td>
<td>AISI 316</td>
</tr>
<tr>
<td>ACBP-A329</td>
<td>X3CrNiMo27-5-2</td>
<td>1.4460</td>
<td>–</td>
<td>–</td>
<td>AISI 329</td>
</tr>
<tr>
<td>ACBP-A431</td>
<td>X17CrNi16-2</td>
<td>1.4057</td>
<td>–</td>
<td>–</td>
<td>AISI 431</td>
</tr>
<tr>
<td>ACBP-A630</td>
<td>X5CrNiCuNb16-4</td>
<td>1.4542</td>
<td>–</td>
<td>Z5 CNU-16-04</td>
<td>AISI 630</td>
</tr>
<tr>
<td>ACBP-X20</td>
<td>X20Cr13</td>
<td>1.4021</td>
<td>–</td>
<td>–</td>
<td>AISI 420 A</td>
</tr>
</tbody>
</table>

CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>C</th>
<th>Simax</th>
<th>Mnmax</th>
<th>Pmax</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>N</th>
<th>Cu</th>
<th>Nb</th>
</tr>
</thead>
<tbody>
<tr>
<td>X5CrNi18-10 (AISI 304)</td>
<td>max. 0.07</td>
<td>1.00</td>
<td>2.00</td>
<td>0.045</td>
<td>max. 0.03</td>
<td>17.0÷19.5</td>
<td>–</td>
<td>8.0÷10.50</td>
<td>max. 0.11</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>X5CrNiMo17-12-2 (AISI 316)</td>
<td>max. 0.07</td>
<td>1.00</td>
<td>2.00</td>
<td>0.045</td>
<td>max. 0.03</td>
<td>16.5÷18.5</td>
<td>2.0÷2.5</td>
<td>10.0÷13.0</td>
<td>max. 0.11</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>X3CrNiMo27-5-2 (AISI 329)</td>
<td>max. 0.05</td>
<td>1.00</td>
<td>2.00</td>
<td>0.035</td>
<td>max. 0.03</td>
<td>25.0÷28.0</td>
<td>1.3÷2.0</td>
<td>4.5÷6.5</td>
<td>0.05÷0.20</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>X17CrNi16-2 (AISI 431)</td>
<td>0.12÷0.22</td>
<td>1.00</td>
<td>1.50</td>
<td>0.040</td>
<td>max. 0.03</td>
<td>15.0÷17.0</td>
<td>–</td>
<td>1.50÷2.50</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>X5CrNiCuNb16-4 (AISI 630)</td>
<td>max. 0.07</td>
<td>0.70</td>
<td>1.50</td>
<td>0.040</td>
<td>max. 0.03</td>
<td>15.0÷17.0</td>
<td>max. 6.0</td>
<td>3.0÷5.0</td>
<td>–</td>
<td>3.0÷5.0</td>
<td>5x%C</td>
</tr>
<tr>
<td>X20Cr13 (AISI 420)</td>
<td>0.16÷0.25</td>
<td>1.00</td>
<td>1.50</td>
<td>0.040</td>
<td>0.015÷0.030</td>
<td>12.0÷14.0</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Delivery Condition</th>
<th>Diameter</th>
<th>Yield Point</th>
<th>Tensil Strength</th>
<th>Elongation</th>
<th>Hardness Brinell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>[mm]</td>
<td>[ MPa (Psi)]</td>
<td>[ MPa (Psi)]</td>
<td>A5 [%]</td>
<td>HB</td>
</tr>
<tr>
<td>ACBP-A304</td>
<td>+AT</td>
<td>&lt;16</td>
<td>min. 400 (58000)</td>
<td>600÷950 (87000÷138000)</td>
<td>25</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>16÷40</td>
<td>min. 190 (27000)</td>
<td>600÷850 (87000÷123000)</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>40÷63</td>
<td>min. 190 (27000)</td>
<td>580÷850 (84000÷123000)</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>250</td>
<td>min. 190 (27000)</td>
<td>500÷700 (72000÷101000)</td>
<td>45</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>&lt;16</td>
<td>min. 380 (55000)</td>
<td>580÷950 (84000÷135000)</td>
<td>25</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>16÷40</td>
<td>min. 200 (29000)</td>
<td>500÷850 (72000÷120000)</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>40÷63</td>
<td>min. 200 (29000)</td>
<td>500÷830 (72000÷120000)</td>
<td>30</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>250</td>
<td>min. 200 (29000)</td>
<td>500÷700 (72000÷101000)</td>
<td>40</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>+AT</td>
<td>≤160</td>
<td>min. 450 (65000)</td>
<td>680 (127000)</td>
<td>20</td>
<td>max. 260</td>
</tr>
<tr>
<td>ACBP-A316</td>
<td>+AT</td>
<td>&lt;160</td>
<td>min. 800 (70000)</td>
<td>800÷950 (116000÷138000)</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>ACBP-A329</td>
<td>+P930</td>
<td>≤100</td>
<td>min. 720 (104000)</td>
<td>930÷1100 (135000÷159000)</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>ACBP-X20</td>
<td>+</td>
<td>8÷40</td>
<td>–</td>
<td>max. 910 (132000)</td>
<td>–</td>
<td>max. 290</td>
</tr>
</tbody>
</table>

DIMENSIONAL PROPERTIES

ASO HYDRAULICS & PNEUMATICS CHROME PLATED STEEL/STAINLESS STEEL BARS HAVE THE FOLLOWING STANDARD DIMENSIONS:

<table>
<thead>
<tr>
<th>A-CROME</th>
<th>DIAMETER RANGE*</th>
<th>STANDARD LENGTH**</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-CROME</td>
<td>[mm]</td>
<td>[mm]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACBP-C45</td>
<td>5÷57</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td></td>
<td>60÷200</td>
<td>6.200÷7.200</td>
</tr>
<tr>
<td>ACBP-20MV6</td>
<td>5÷57</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td></td>
<td>60÷200</td>
<td>6.200÷7.200</td>
</tr>
<tr>
<td>ACBP-38MVS</td>
<td>20÷115</td>
<td>approx. 7.320</td>
</tr>
<tr>
<td></td>
<td>120÷200</td>
<td>6.200÷7.200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC-CROME</th>
<th>DIAMETER RANGE*</th>
<th>STANDARD LENGTH**</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-CROME</td>
<td>[mm]</td>
<td>[mm]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACBP-CW8S</td>
<td>22÷57</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td></td>
<td>60÷115</td>
<td>6.200÷7.200</td>
</tr>
<tr>
<td>ACBP-42CD4</td>
<td>5÷57</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td></td>
<td>60÷200</td>
<td>6.200÷7.200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A-CROME</th>
<th>DIAMETER RANGE*</th>
<th>STANDARD LENGTH**</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-CROME</td>
<td>[mm]</td>
<td>[mm]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACBP-A304</td>
<td>8÷100</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td>ACBP-A316</td>
<td>8÷100</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td>ACBP-A329</td>
<td>8÷100</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td>ACBP-A431</td>
<td>20÷100</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td>ACBP-A630</td>
<td>20÷100</td>
<td>5.600÷6.200</td>
</tr>
<tr>
<td>ACBP-X20</td>
<td>8÷40</td>
<td>5.600÷6.200</td>
</tr>
</tbody>
</table>

*) Some diameters may be subject to a minimum quantity requested.

** Lengths may vary depending on the Chroming process used. Other diameters, lengths/cut lengths can be provided at premium price. All inches sizes available in the mentioned interval of dimensions.
A CHROME PLATED STEEL BAR

STEEL

<table>
<thead>
<tr>
<th>STEELGRADE</th>
<th>C45</th>
<th>20MV6</th>
<th>38MV6</th>
<th>CW85</th>
<th>42CD4</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAT TREAT</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Q</td>
</tr>
<tr>
<td>WELDABILITY</td>
<td>G</td>
<td>E</td>
<td>G</td>
<td>E</td>
<td>G</td>
</tr>
<tr>
<td>MACHINABILITY</td>
<td>G</td>
<td>E</td>
<td>G</td>
<td>E</td>
<td>G</td>
</tr>
</tbody>
</table>

Corrosion Resistance

Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>ISO9227</th>
<th>ASTM</th>
<th>DIN50021</th>
<th>Salt Spray Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSS</td>
<td>B117</td>
<td>SS</td>
<td>Neutral Salt Spray</td>
</tr>
<tr>
<td>AASS</td>
<td>B287</td>
<td>ESS</td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
<tr>
<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td></td>
</tr>
</tbody>
</table>

Weldability & Machinability

Weldability - good using conventional or friction welding.
Machinability - good compare to the other steel grades and can achieve a good cutting speed using the proper coated carbide tools.

Certification

<table>
<thead>
<tr>
<th>ISO 9001</th>
<th>ISO 14001</th>
<th>OHSAS 18001</th>
</tr>
</thead>
</table>

Marking

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

Packaging

A-CHROME products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
Extra protection with additional cost – wooden boxes.
Corrosion Resistance
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>ISO9227</th>
<th>ASTM</th>
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<tbody>
<tr>
<td>NSS</td>
<td>B117</td>
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<td>Neutral Salt Spray</td>
</tr>
<tr>
<td>AASS</td>
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<td>ESS</td>
<td>Acetic Acid Salt Spray</td>
</tr>
<tr>
<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
</tbody>
</table>

A-CHROME
Standard Corrosion resistance for Ø<20 R9/120h NSS; for Ø≥20 R9/200h NSS.

A-CHROME EXTRA
Standard Corrosion resistance for Ø≥20-140 R10/120h NSS and for Ø≥20-140 R9/500h NSS.

A-CHROME EXTRA PLUS
Standard Corrosion resistance for Ø≥20-140 R10/500h NSS.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

Properties

Residual Magnetism Standard
max. 50 Gauss
*Special magnetism can be provided at premium price

Surface Roughness
Ra = max. 0.20 [µm]

Surface Hardness
Chrome Layer hardness: min. 900 HV 0.1

Chrome Layer thickness
Ø≤19.05 [mm] min. 15 [µm]
Ø≥20 [mm] min. 20 [µm]

Diameter tolerance
Standard ISO-f7
*Special Tolerance can be provided at premium price

Straightness
Ø≤20 [mm] max. 0.3 [mm]/1000 [mm]
Ø≥20 [mm] max. 0.2 [mm]/1000 [mm]

Roundness
max. ½ from diameter tolerance

Hardening Depth

<table>
<thead>
<tr>
<th>Ø [mm]</th>
<th>SHD [mm]</th>
<th>Ø [mm]</th>
<th>SHD [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.5-0.8</td>
<td>25</td>
<td>1.5-1.7</td>
</tr>
<tr>
<td>8</td>
<td>0.6-0.9</td>
<td>28</td>
<td>1.5-1.8</td>
</tr>
<tr>
<td>10</td>
<td>0.7-1.0</td>
<td>30-38</td>
<td>1.5-1.9</td>
</tr>
<tr>
<td>12-14</td>
<td>0.8-1.2</td>
<td>40-45</td>
<td>1.6-2.0</td>
</tr>
<tr>
<td>14</td>
<td>0.9-1.3</td>
<td>50-85</td>
<td>2.2-3.6</td>
</tr>
<tr>
<td>15</td>
<td>1.0-1.4</td>
<td>90-100</td>
<td>2.2-3.2</td>
</tr>
<tr>
<td>16-18</td>
<td>1.1-1.5</td>
<td>105-140</td>
<td>2.4-3.3</td>
</tr>
<tr>
<td>20-22</td>
<td>1.2-1.5</td>
<td>150-203.2</td>
<td>2.5-3.5</td>
</tr>
<tr>
<td>24</td>
<td>1.4-1.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Surface Hardness
Steel-grade C45E IH: Min 55HRC

Weldability & Machinability
Weldability - good
Machinability - good

Packaging
A-CHROME products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags
Extra protection with additional cost – wooden boxes

Marking
For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.
**Properties**

**Surface Roughness**
Ra = max. 0.20 [µm]

**Surface Hardness**
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**
Standard ISO-f7
*Special Tolerance can be provided at premium price

**Chrome Layer thickness**
Ø≥19.05 [mm] min. 20 [µm]
Ø≥20 [mm] min. 20 [µm]

**Straightness**
Ø≥20 [mm] max. 0.3 [mm]/1000 [mm]
 Ø≥20 [mm] max. 0.2 [mm]/1000 [mm]

**Roundness**
max. ½ from diameter tolerance

---

**Corrosion Resistance**

A-CHROME
Standard Corrosion resistance
R9/1200h NSS For reference only.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

---

**Marking**
For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

---

**Packaging**
A-CHROME products can be supplied in 3 different packaging options:
- Standard – plastic sleeves or paper tubes (depending on the diameter size)
- Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
- Extra protection with additional cost – wooden boxes
**Properties**

**Surface Roughness**
\[ \text{Ra} = \text{max. 0.20} \ [\mu\text{m}] \]

**Surface Hardness**
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**
Standard ISO-f7
*Special Tolerance can be provided at premium price

**Chrome Layer thickness**
- Ø\(\leq19.05\) [mm]: min. 15 [µm]
- Ø\(\geq20\) [mm]: min. 20 [µm]

**Straightness**
- Ø\(<20\) [mm]: max. 0.3 [mm]/1000 [mm]
- Ø\(\geq20\) [mm]: max. 0.2 [mm]/1000 [mm]

**Roundness**
max. \(\frac{1}{2}\) from diameter tolerance

**Corrosion Resistance**

**A-CHROME**
Standard Corrosion resistance R9/1440h NSS For reference only.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Marking**
For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

**Packaging**
A-CHROME products can be supplied in 3 different packaging options:
- **Standard** – plastic sleeves or paper tubes (depending on the diameter size)
- **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
- **Extra protection with additional cost** – wooden boxes

**Certification**
- ISO 9001
- ISO 14001
- OHSAS 18001

**Steelgrade**
- AISI 316
**Properties**

**Residual Magnetism Standard**  
max. 50 Gauss  
*Special magnetism can be provided at premium price*

**Surface Roughness**  
Ra = max. 0.20 [µm]

**Surface Hardness**  
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**  
Standard ISO-f7  
*Special Tolerance can be provided at premium price*

**Chrome Layer thickness**  
Ø≥20 [mm]  
min. 20 [µm]

**Straightness**  
Ø≥20 [mm]  
max. 0.2 [mm]/1000 [mm]

**Roundness**  
max. ½ from diameter tolerance

---

**Marking**

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

---

**Corrosion Resistance**

**A-CHROME**  
Corrosion Resistance Performance provided on request.  
* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Packaging**

A-CHROME products can be supplied in 3 different packaging options:  
**Standard** – plastic sleeves or paper tubes (depending on the diameter size)  
**Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.  
**Extra protection with additional cost** – wooden boxes
Properties

Residual Magnetism Standard
max. 50 Gauss
"Special magnetism can be provided at premium price"

Surface Roughness
Ra = max. 0.20 [µm]

Surface Hardness
Chrome Layer hardness: min. 900 HV 0.1

Diameter tolerance
Standard ISO-f7
"Special Tolerance can be provided at premium price"

Chrome Layer thickness
Ø≥20 [mm] min. 20 [µm]

Straightness
Ø≥20 [mm] max. 0.2 [mm]/1000 [mm]

Roundness
max. ½ from diameter tolerance

Corrosion Resistance

A-CHROME
Standard Corrosion resistance
R9/840h NSS For reference only.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

Marking

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no. production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

Packaging

A-CHROME products can be supplied in 3 different packaging options:

Standard – plastic sleeves or paper tubes (depending on the diameter size)

Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.

Extra protection with additional cost – wooden boxes

Certification

ISO 9001 | ISO 14001 | OHSAS 18001

Steelgrade

AISI 431
Properties

Residual Magnetism Standard
max. 50 Gauss
*Special magnetism can be provided at premium price

Surface Roughness
Ra = max. 0.20 [µm]

Surface Hardness
Chrome Layer hardness: min. 900 HV 0.1

Diameter tolerance
Standard ISO-f7
*Special Tolerance can be provided at premium price

Chrome Layer thickness
Ø≥20 [mm] min. 20 [µm]

Straightness
Ø≥20 [mm] max. 0.2 [mm]/1000 [mm]

Roundness
max. ½ from diameter tolerance

Corrosion Resistance

A-CHROME
Corrosion Resistance Performance provided on request.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

Marking

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

Packaging

A-CHROME products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
Extra protection with additional cost – wooden boxes

Steelgrade | AISI 630
**Corrosion Resistance**

A-CHROME

Corrosion Resistance Performance provided on request.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Properties**

**Residual Magnetism Standard**

max. 50 Gauss

*Special magnetism can be provided at premium price

**Surface Roughness**

Ra = max. 0.2 [µm]

**Surface Hardness**

Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**

Standard ISO-f7

*Special Tolerance can be provided at premium price

**Chrome Layer thickness**

Ø≥19.05 [mm] min. 20 [µm]  
Ø≥20 [mm] min. 20 [µm]

**Straightness**

Ø≥20 [mm] max. 0.2 [mm]/1000 [mm]

**Roundness**

max. ½ from diameter tolerance

**Marking**

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

**Packaging**

A-CHROME products can be supplied in 3 different packaging options:

- **Standard** – plastic sleeves or paper tubes (depending on the diameter size)
- **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
- **Extra protection with additional cost** – wooden boxes

**Certification**

<table>
<thead>
<tr>
<th>ISO 9001</th>
<th>ISO 14001</th>
<th>OHSAS 18001</th>
</tr>
</thead>
</table>

**Steel Grade**

| AISI 431 |
Cylinder Tubes

- **ACTP-E355-SR**
  - OD CHROME PLATED TUBE

- **ACTP-E355-H**
  - OD CHROME PLATED TUBE AND INDUCTION HARDENED

- **ASCTP-E355-SR**
  - OD CHROME PLATED TUBE

- **ASCTP-E355-H**
  - OD CHROME PLATED TUBE AND INDUCTION HARDENED

- **ASTP-E355-SR**
  - OD CHROME PLATED TUBE

- **ASWTP-E355-SR**
  - OD CHROME PLATED TUBE

- **AICTP-E355-SR**
  - OD CHROME PLATED TUBE
# GENERAL CYLINDER TUBES

**PROPERTIES**

ASO HYDRAULICS & PNEUMATICS TUBES ARE MADE FROM A FIRST CLASS RAW MATERIAL HAVING THE FOLLOWING PROPERTIES:

## CHEMICAL COMPOSITION OF THE STEEL

<table>
<thead>
<tr>
<th>EN</th>
<th>W</th>
<th>DIN</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Al</th>
<th>V</th>
<th>Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>10305-1</td>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>E355</td>
<td>1.0580</td>
<td>St52</td>
<td>max. 0.22</td>
<td>max. 0.55</td>
<td>max. 1.60</td>
<td>max. 0.025</td>
<td>0.015-0.025</td>
<td>min. 0.040</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>E410</td>
<td>1.0509</td>
<td>–</td>
<td>min. 0.16</td>
<td>min. 0.10</td>
<td>min. 1.30</td>
<td>–</td>
<td>min. 0.01</td>
<td>min. 0.08</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

*CEV calculated with the formula: % C + Mn/6 + Ni/0.15 + Cr/5 + Mo/4 + V/4 ≤ 0.45

## MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>STEEL GRADE</th>
<th>Delivery Condition</th>
<th>Tensile Strength</th>
<th>Yield Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 10305-1</td>
<td></td>
<td>Rm [MPa (Psi)]</td>
<td>Rp0.2 [MPa (Psi)]</td>
</tr>
<tr>
<td></td>
<td>+SR</td>
<td>min. 620 (90000)</td>
<td>min. 520 (75000)</td>
</tr>
<tr>
<td></td>
<td>+C</td>
<td>min. 620 (90000)</td>
<td>min. 520 (75000)</td>
</tr>
</tbody>
</table>

*By request we can offer Yield Point min.540 for E355 and min.620 for E410

## TYPES, DIMENSIONS AND LENGTHS

<table>
<thead>
<tr>
<th>A-TUBE</th>
<th>TYPE</th>
<th>DIAMETER*</th>
<th>WALL THICKNESS</th>
<th>STANDARD LENGTH**</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACPT</td>
<td>cold drawn seamless EN 10305-1/</td>
<td>12÷200</td>
<td>2.0÷20.0</td>
<td>6000÷7200</td>
</tr>
<tr>
<td></td>
<td>OD chrome plated f7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACWTP</td>
<td>cold drawn welded EN 10305-2 /</td>
<td>40÷200</td>
<td>4.76÷12.5</td>
<td>5000÷7000</td>
</tr>
<tr>
<td></td>
<td>ID SRB or honed finished H9 /</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OD chrome plated f7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTP</td>
<td>cold drawn seamless EN 10305-1 /</td>
<td>40÷300</td>
<td>4.76÷27.5</td>
<td>6000÷8000</td>
</tr>
<tr>
<td></td>
<td>ID SRB finished or honed H8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASWTP</td>
<td>cold drawn welded EN 10305-2 /</td>
<td>40÷230</td>
<td>4.76÷12.5</td>
<td>5000÷7000</td>
</tr>
<tr>
<td></td>
<td>ID SRB finished or honed H8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AICTP</td>
<td>cold drawn seamless EN 10305-1 /</td>
<td>40÷300</td>
<td>4.76÷27.5</td>
<td>2000÷2500</td>
</tr>
<tr>
<td></td>
<td>ID honed and chrome plated H9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) Some diameters may be subject to a minimum quantity requested

**) Lengths may vary depending on the Chroming process used. Other diameters, lengths/cut lengths can be provided at premium price. All inches sizes available in the mentioned interval of dimensions
**Properties**

**Surface Roughness – OD**
Ra = max. 0.20 [µm]

**Surface Hardness**
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**
Standard ISO-17
*Special Tolerance can be provided at premium price*

**Straightness**
Ø≥20 [mm]  max. 0.2 [mm]/1000 [mm]
Ø≥20 [mm]  max. 0.3 [mm]/1000 [mm]

**Chrome Layer thickness**
Ø≥20 [mm]  min. 20 [µm]
*Special chrome layer at premium price*

**Roundness**
max. ½ from OD diameter tolerance

**Eccentricity**
max. 10% of the wall thickness

**Corrosion Resistance**
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>Test</th>
<th>ISO9227 acronym</th>
<th>Value</th>
<th>DIN50021 value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSS</td>
<td>B117</td>
<td>SS</td>
<td></td>
<td>Neutral Salt Spray</td>
</tr>
<tr>
<td>AASS</td>
<td>B287</td>
<td>ESS</td>
<td></td>
<td>Acetic Acid Salt Spray</td>
</tr>
<tr>
<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td></td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
</tbody>
</table>

**A-CHROME**
Standard Corrosion resistance for Ø<20 R9/120h NSS; for Ø≥20 R9/200h NSS.

**A-CHROME EXTRA**
Standard Corrosion resistance for Ø≥20-140 R10/120h NSS and for Ø≥20-140 R9/500h NSS.

**A-CHROME EXTRA PLUS**
Standard Corrosion resistance for Ø≥20-140 R10/500h NSS.
* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Weldability & Machinability**
Weldability - excellent
Machinability - excellent

**Marking**
For a full traceability each tube is marked individually on the plastic/paper tube with info about the date, heat no., production order tolerance etc. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.

**Packaging**
A-TUBE products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
Extra protection with additional cost – wooden boxes, pallets for machined and cut parts.
**Properties**

**Surface Hardness**
Steel-grade E355 IH: min. 35HRC
Hardness Depth: from 1.0-4.0 [mm]
Chrome Layer Hardness: min. 900 HV 0.1

**Surface Roughness – OD**
Ra = max. 0.20 [µm]

**Diameter tolerance**
Standard ISO-17
*S*pecial Tolerance can be provided at premium price

**Straightness**
Ø≤20 [mm]  max. 0.3 [mm]/1000 [mm]
Ø>20 [mm]  max. 0.2 [mm]/1000 [mm]

**Chrome Layer thickness**
Ø>20 [mm]  *Special chroming layer at premium price*

**Roundness**
max. ½ from OD diameter tolerance

**Eccentricity**
max. 10% of the wall thickness

**Corrosion Resistance**
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>ISO9227</th>
<th>ASTM</th>
<th>DIN50021</th>
<th>Salt Spray Test</th>
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<td>NSS</td>
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<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
</tbody>
</table>

**A-CHROME**
Standard Corrosion resistance for Ø<20 R9/120h NSS; for Ø≥20 R9/200h NSS.

**A-CHROME EXTRA**
Standard Corrosion resistance for Ø≥20-140 R10/120h NSS and for Ø≥20-140 R9/500h NSS.

**A-CHROME EXTRA PLUS**
Standard Corrosion resistance for Ø≥20-140 R10/500h NSS.
* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Weldability & Machinability**
Weldability - excellent
Machinability - excellent

**Marking**
For a full traceability each tube is marked individually on the plastic/paper tube with info about the date, heat no., production order tolerance etc. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.

**Packaging**
A-TUBE products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
Extra protection with additional cost – wooden boxes, pallets for machined and cut parts.
Properties

Surface Roughness – OD
- **OD**  \( Ra = \text{max. } 0.20 \) [µm]
- **ID**  \( Ra = \text{max. } 0.25 \) [µm]
- **ID**  \( Ra = \text{max. } 0.40 \) [µm] for honed tubes

Surface Hardness
Chrome Layer hardness: min. 900 HV 0.1

Diameter tolerance
- **OD**: ISO-f7
- **ID**: ISO-H8/H9 depending on the wall thickness
*Special Tolerance can be provided at premium price

Straightness
max. 0.2 [mm]/1000 [mm] for diameter Ø>40 [mm]

Chrome Layer thickness
min. 20 [µm]
*Special chroming layer at premium price

Roundness
max. ½ from OD diameter tolerance
For ID - within the limits of its tolerance

Eccentricity
max. 3% of the wall thickness according to EN 10305-2

Corrosion Resistance
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>ISO9227</th>
<th>ASTM</th>
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<td>B368</td>
<td>CASS</td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
</tbody>
</table>

A-CHROME
Standard Corrosion resistance for Ø<20 R9/120h NSS; for Ø≥20 R9/200h NSS.

A-CHROME EXTRA
Standard Corrosion resistance for Ø≥20-140 R10/120h NSS and for Ø≥20-140 R9/500h NSS.

A-CHROME EXTRA PLUS
Standard Corrosion resistance for Ø≥20-140 R10/500h NSS.
* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

Weldability & Machinability
Weldability - excellent
Machinability - excellent

Marking
For a full traceability each tube is marked individually on the plastic/paper tube with info about the date, heat no., production order tolerance etc. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.

Packaging
A-TUBE products can be supplied in 3 different packaging options:
- **Standard** – plastic sleeves or paper tubes (depending on the diameter size)
- **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
- **Extra protection with additional cost** – wooden boxes, pallets for cut and machined parts, special oil for higher protection.
*The oil used for the internal surface of the tubes is guaranteed for 6 months.*
Corrosion Resistance
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
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<tr>
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<th>DIN50021</th>
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<tr>
<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td>Copper-accelerated acetic acid salt spray</td>
</tr>
</tbody>
</table>

A-CHROME
Standard Corrosion resistance for Ø<20 R9/120h NSS; for Ø≥20 R9/200h NSS.

A-CHROME EXTRA
Standard Corrosion resistance for Ø≥20-140 R10/120h NSS and for Ø≥20-140 R9/500h NSS.

A-CHROME EXTRA PLUS
Standard Corrosion resistance for Ø≥20-140 R10/500h NSS.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

Weldability & Machinability
Weldability - excellent
Machinability - excellent

Packaging
A-TUBE products can be supplied in 3 different packaging options:
Standard – plastic sleeves or paper tubes (depending on the diameter size)
Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.
Extra protection with additional cost – wooden boxes, pallets for cut and machined parts, special oil for higher protection.
*The oil used for the internal surface of the tubes is guaranteed for 6 months.

Marking
For a full traceability each tube is marked individually on the plastic/paper tube with info about the date, heat no., production order tolerance etc. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.

Diameter tolerance
- OD: ISO-47
- ID: ISO-H9 depending on the wall thickness
*Special Tolerance can be provided at premium price

Straightness
max. 0.2 [mm]/1000 [mm] for diameter Ø>40 [mm]

Chrome Layer thickness]
min. 20 [µm]
*Special chroming layer at premium price

Roundness
max. ½ from OD diameter tolerance
For ID - within the limits of its tolerance

Eccentricity
max. 3% of the wall thickness according to EN 10305-2
Properties

**Straightness**
- max. 1.0 [mm] / 1000 [mm]
- max. 3.5 [mm] / 6000 [mm]
- max. 4.0 [mm] / 7000 [mm]
- max. 4.5 [mm] / 8000 [mm]

**Surface Roughness – OD**
- **ID:** Ra = max. 0.25 [µm]
- **ID:** Ra = max. 0.40 [µm] for honed tubes

**Eccentricity**
max. 10% of the wall thickness according to EN 10305-1

**Roundness**
within the limits of ID tolerance

**Surface Hardness**
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**
- **ID:** ISO H8 (EN ISO 286-2) for WT > 5mm
- **ID:** ISO H9 (EN ISO 286-2) for WT = 5mm

*Special Tolerance can be provided at premium price

Weldability & Machinability

**Weldability** - excellent
**Machinability** - excellent

Marking
For a full traceability each tube is marked individually on the plastic/paper tube with info about the date, heat no., production order tolerance etc. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.

Packaging
A-TUBE products are oiled and sealed with plastic caps on both ends.

**Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.

**Extra protection with additional cost** – wooden boxes, pallets for cut and machined parts, special oil for higher protection.

Important info: the oil used for the tubes preservation is guaranteed against corrosion for maximum 6 months from the shipment date.
Properties

Straightness
- max. 1.0 [mm] / 1000 [mm]
- max. 3.5 [mm] / 6000 [mm]
- max. 4.0 [mm] / 7000 [mm]

Surface Roughness – OD
- ID  Ra = max. 0.25 [µm]
- ID  Ra = max. 0.40 [µm] for honed tubes

Eccentricity
max. 3.0-3.5% of the wall thickness according to EN 10305-2

Roundness
within the limits of ID tolerance

Surface Hardness
Chrome Layer hardness: min. 900 HV 0.1

Diameter tolerance
- ID:  ISO H8 (EN ISO 286-2)
*Special Tolerance can be provided at premium price

Weldability & Machinability

Weldability - excellent
Machinability - excellent

Packaging

A-TUBE products are oiled and sealed with plastic caps on both ends.

Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags.

Extra protection with additional cost – wooden boxes, pallets for cut and machined parts, special oil for higher protection.

Important info: the oil used for the tubes preservation is guaranteed against corrosion for maximum 6 months from the shipment date.

Marking

For a full traceability each tube is marked individually with info regarding the product name, steel grade, norm, OD x ID, heat no. The batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, OD x ID; total length of the batch, Weight, no. of pieces in the batch.
**Properties**

**Surface Roughness – ID**
Rα = max. 0.40 [μm]

**Surface Hardness**
Chrome Layer hardness: min. 900 HV 0.1

**Diameter tolerance**
min. ID 35 [mm]
- ID: ISO-H9 (EN ISO 286-2)

**Straightness**
max. 1.0 [mm]/1000 [mm]

**Eccentricity**
max. 10% of the wall thickness according to EN 10305-1

**Roundness**
max. ½ from OD diameter tolerance
For ID - within the limits of its tolerance

**Chrome Layer thickness**
min. 20 [μm]
*Special chroming layer at premium price

For special applications: concrete pumps, cylinders
max. 200 [μm] at premium price

**Corrosion Resistance**
Based on a salt spray test following the ISO 9227 standard combined with the ISO 10289 for the evaluation of the rating

<table>
<thead>
<tr>
<th>Salt Spray Test</th>
<th>ISO9227</th>
<th>ASTM</th>
<th>DIN50021</th>
</tr>
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<tbody>
<tr>
<td>NSS</td>
<td>B117</td>
<td>SS</td>
<td></td>
</tr>
<tr>
<td>AASS</td>
<td>B287</td>
<td>ESS</td>
<td></td>
</tr>
<tr>
<td>CASS</td>
<td>B368</td>
<td>CASS</td>
<td></td>
</tr>
</tbody>
</table>

Neutral Salt Spray
Acetic Acid Salt Spray
Copper-accelerated acetic acid salt spray

**A-CHROME**
Standard Corrosion resistance for Ø≥40 R9/200h NSS.

**A-CHROME EXTRA**
Standard Corrosion resistance for Ø≥40-140 R9/500h NSS.

* DOUBLE CHROME LAYER ON REQUEST AT PREMIUM PRICE

**Weldability & Machinability**

Weldability: excellent
Machinability: excellent

**Marking**
For a full traceability each batch has a label with the following information: Order no., Item no., Heat no., Steel Grade, Outside Diameter x Inside Diameter OD x ID; total length of the batch, Weight, no. of pieces in the batch.

**Packaging**
A-TUBE products can be supplied in 3 different packaging options:
- Standard – plastic sleeves or paper tubes (depending on the diameter size), packed in bundles oiled inside and closed with end caps
- Special requirements with additional cost – Seaworthy protected – aluminum foil or vacuum bags
- Extra protection with additional cost – wooden boxes, pallets for cut and machined parts.
Linear Shafts

**ALP-C53-H | W**
Induction hardened and ground linear shaft

**ALP-C53-H | WZ**
Induction hardened and ground linear shaft

**ACL-P-C53-H | W**
Chrome plated linear shaft (induction hardened and ground)

**ACL-P-C53-H | WZ**
Chrome plated linear shaft (induction hardened and ground)

**ALTP-C60-H | WH**
Induction hardened and ground hollow linear shaft

**ACLTP-C60-H | WHV**
Chrome plated hollow linear shaft (induction hardened and ground)

**ALP-A440B-H | WRA**
Induction hardened and ground stainless steel linear shaft

**ALP-A440B-H | WRAZ**
Induction hardened and ground stainless steel linear shaft

**ALP-X46-H | WRB**
Induction hardened and ground stainless steel linear shaft

**ALP-X46-H | WRBZ**
Rod end will induction hardened and ground stainless steel linear shaft

**ACL-P-X46-H | WRBV**
Chrome plated linear shaft (induction hardened and ground)
ASO HYDRAULICS & PNEUMATICS PRECISION SHAFTS ARE INDUCTION HARDENED SHAFTS ACCORDING TO THE STEEL QUALITY, DIAMETER AND HARDNESS DEPTH NEEDED. A-LINE PRODUCTS ARE MANUFACTURED FROM STEELS HAVING THE FOLLOWING PROPERTIES:

STEEL GRADE CORRESPONDENTS

<table>
<thead>
<tr>
<th>ASO GROUP TYPE</th>
<th>EN</th>
<th>BS</th>
<th>W</th>
<th>AFNOR</th>
<th>ASTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALP-C53-H Hardened and ground</td>
<td>Ci53</td>
<td>070MS</td>
<td>1.1213</td>
<td>XC48TS</td>
<td>1024</td>
</tr>
<tr>
<td>ALP-C60-H Hardened and chrome plated</td>
<td>C60E</td>
<td>080A62</td>
<td>1.1221</td>
<td>1C60</td>
<td>1060</td>
</tr>
<tr>
<td>ALP-X46-H Hardened and ground</td>
<td>X80CrMoV18</td>
<td>–</td>
<td>1.4112</td>
<td>–</td>
<td>440B</td>
</tr>
<tr>
<td>ALP-X46-H Hardened and chrome plated</td>
<td>X46Cr13</td>
<td>–</td>
<td>1.4034</td>
<td>Z44Cr13</td>
<td>420C</td>
</tr>
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</table>

CHEMICAL COMPOSITION IN % BY WEIGHT

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Pmax</th>
<th>S</th>
<th>Cr</th>
<th>Ni</th>
<th>Mo</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cf53</td>
<td>0.50÷0.57</td>
<td>0.15÷0.35</td>
<td>0.40÷0.70</td>
<td>0.025</td>
<td>max. 0.035</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>C60E</td>
<td>0.57÷0.65</td>
<td>max. 0.40</td>
<td>0.60÷0.90</td>
<td>0.030</td>
<td>max. 0.035</td>
<td>max. 0.40</td>
<td>max. 0.10</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>X90CrMoV18</td>
<td>0.85÷0.95</td>
<td>max. 1.00</td>
<td>max. 1.00</td>
<td>0.040</td>
<td>0.015÷0.030</td>
<td>17.00÷19.00</td>
<td>–</td>
<td>0.90÷1.30</td>
<td>0.07÷0.12</td>
</tr>
<tr>
<td>X46Cr13</td>
<td>0.43÷0.50</td>
<td>max. 1.00</td>
<td>max. 1.00</td>
<td>0.040</td>
<td>max. 0.030</td>
<td>12.00÷14.00</td>
<td>–</td>
<td>–</td>
<td>–</td>
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</table>

MECHANICAL PROPERTIES

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Steel grade</th>
<th>Diameter/ Nominal Thickness [mm]</th>
<th>Tensile Strength [MPa (Psi)]</th>
<th>Yield Point [MPa (Psi)]</th>
<th>Elongation A5 [%]</th>
<th>Hardness Brinell</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALP-C53-H</td>
<td>Ci53</td>
<td>Ø &lt; 18</td>
<td>min. 700 (101000)</td>
<td>min. 475 (69000)</td>
<td>min. 8</td>
<td>223</td>
</tr>
<tr>
<td>ALP-C53-H</td>
<td>C45E</td>
<td>Ø &gt; 100</td>
<td>min. 560 (81000)</td>
<td>min. 275 (40000)</td>
<td>min. 16</td>
<td>241</td>
</tr>
<tr>
<td>ALP-C60-H</td>
<td>C60E</td>
<td>≤16</td>
<td>min. 710 (103000)</td>
<td>min. 380 (55000)</td>
<td>min. 10</td>
<td>241</td>
</tr>
<tr>
<td>ALP-C60-H</td>
<td>X80CrMoV18</td>
<td>Ø &lt; 60</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>max. 265</td>
</tr>
<tr>
<td>ALP-X46-H</td>
<td>X46Cr13</td>
<td>Ø &lt; 60</td>
<td>max. 910 (132000)</td>
<td>–</td>
<td>–</td>
<td>max. 305</td>
</tr>
</tbody>
</table>
**Properties**

- **Surface Hardness C53**: 62±2HRC
- **Surface Roughness**: $\text{Ra} = \text{max. } 0.20 \ [\mu\text{m}]$
- **Length tolerance**: $0.4 - 200 \ [\text{mm}]$
- **Diameter tolerance**: Standard ISO-h6

*Special tolerance can be provided at premium price*

**Packaging**

Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia.

**Extra protection with additional cost** – wooden boxes

**Marking**

For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.
**ALP C53-H**

**INDUCTION HARDENED AND GROUND LINEAR SHAFT**

**WZ**

---

**DIMENSIONAL PROPERTIES:**

<table>
<thead>
<tr>
<th>Shaft Diameter**</th>
<th>Shaft Diameter**</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth</th>
<th>Standard tolerance</th>
<th>Roundness (circular)</th>
<th>Parallelism (cylindric)</th>
<th>Straightness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>d</strong> [in]</td>
<td><strong>d</strong> [mm]</td>
<td><strong>w</strong> [kg]</td>
<td><strong>L</strong></td>
<td><strong>t</strong> [in]</td>
<td><strong>t1</strong> [mm]</td>
<td><strong>t2</strong> [mm]</td>
<td><strong>t3</strong> [mm]</td>
<td></td>
<td><strong>L3</strong> [mm/m]</td>
</tr>
<tr>
<td>1/4</td>
<td>6.35</td>
<td>0.25</td>
<td>WZ 6</td>
<td>237</td>
<td>0.019-0.031</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
</tr>
<tr>
<td>3/8</td>
<td>9.525</td>
<td>0.56</td>
<td>WZ 9</td>
<td>237</td>
<td>0.027-0.039</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
</tr>
<tr>
<td>1/2</td>
<td>12.7</td>
<td>0.99</td>
<td>WZ 12</td>
<td>237</td>
<td>0.031-0.047</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>5/8</td>
<td>15.875</td>
<td>1.55</td>
<td>WZ 15</td>
<td>237</td>
<td>0.043-0.059</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>3/4</td>
<td>19.05</td>
<td>2.24</td>
<td>WZ 19</td>
<td>237</td>
<td>0.047-0.059</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.008</td>
</tr>
<tr>
<td>1</td>
<td>25.4</td>
<td>3.97</td>
<td>WZ 25</td>
<td>237</td>
<td>0.059-0.066</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.008</td>
</tr>
<tr>
<td>1 1/4</td>
<td>31.75</td>
<td>6.22</td>
<td>WZ 31</td>
<td>237</td>
<td>0.059-0.074</td>
<td>-0.0005/-0.001</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>1 1/2</td>
<td>38.1</td>
<td>8.95</td>
<td>WZ 38</td>
<td>237</td>
<td>0.062-0.078</td>
<td>-0.0006/-0.0011</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.004</td>
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<tr>
<td>2</td>
<td>50.8</td>
<td>15.91</td>
<td>WZ 50</td>
<td>237</td>
<td>0.086-0.102</td>
<td>-0.0006/-0.0013</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>2 1/4</td>
<td>57.15</td>
<td>20.13</td>
<td>WZ 57</td>
<td>237</td>
<td>0.086-0.102</td>
<td>-0.0007/-0.0015</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
<tr>
<td>2 1/2</td>
<td>63.5</td>
<td>24.85</td>
<td>WZ 63</td>
<td>276</td>
<td>0.086-0.102</td>
<td>-0.0007/-0.0015</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
<tr>
<td>3</td>
<td>76.2</td>
<td>35.76</td>
<td>WZ 76</td>
<td>276</td>
<td>0.086-0.102</td>
<td>-0.0008/-0.0017</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price  /  **Some diameters may be subject to a minimum quantity requested

---

**Properties**

- **Surface Hardness** Cf53 | 62±2HRC
- **Surface Roughness** | $Ra = \text{max. } 0.20 \, \mu\text{m}$
- **Length tolerance** | $0^{+8} \, [\text{in}]$
- **Diameter tolerance** | Standard Class “L”

*Special Tolerance can be provided at premium price

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**Packaging**

Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia.

**Extra protection with additional cost** – wooden boxes

**Marking**

For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.
### Properties

**Chrome Layer** | min. 10 [µm], usually 15 [µm]  
**Chrome Layer Hardness** | 900 HV 0.1 min.  
*Special chroming layer at premium price*  
**Surface Hardness C53** | 62±2HRC  
**Surface Roughness** | Ra = max. 0.20 [µm]  
**Length tolerance** | Ø+200 [mm]  
**Diameter tolerance**  
Standard ISO-h7  
*Special Tolerance can be provided at premium price*

### Packaging

- **Chrome Plated Linear Shaft** (Induction hardened and ground)
- Chromed Linear shafts supplied in 3 different packaging options:
  - **Standard** – plastic sleeves or paper tubes.
  - **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
  - **Extra protection with additional cost** – wooden boxes

### Marking

- For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.

### Dimensional Properties:

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth SHD</th>
<th>Standard tolerance</th>
<th>Roundness (circular)</th>
<th>Parallelism (cylindric)</th>
<th>Straightness</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mm]</td>
<td>[kg]</td>
<td>[mm]</td>
<td>[mm]</td>
<td>[µm]</td>
<td>[µm]</td>
<td>[µm]</td>
<td>[µm]</td>
<td>[mm/m]</td>
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<tr>
<td>4</td>
<td>0.10</td>
<td>WW 4</td>
<td>4000</td>
<td>0.5-0.8</td>
<td>0/-12</td>
<td>6</td>
<td>10</td>
<td>0.16</td>
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<tr>
<td>5</td>
<td>0.16</td>
<td>WW 5</td>
<td>6000</td>
<td>0.5-0.8</td>
<td>0/-12</td>
<td>6</td>
<td>10</td>
<td>0.16</td>
</tr>
<tr>
<td>6</td>
<td>0.23</td>
<td>WW 6</td>
<td>6000</td>
<td>0.5-0.8</td>
<td>0/-12</td>
<td>6</td>
<td>10</td>
<td>0.16</td>
</tr>
<tr>
<td>8</td>
<td>0.40</td>
<td>WW 8</td>
<td>6000</td>
<td>0.6-0.9</td>
<td>0/-15</td>
<td>6</td>
<td>10</td>
<td>0.16</td>
</tr>
<tr>
<td>10</td>
<td>0.62</td>
<td>WW 10</td>
<td>6000</td>
<td>0.7-1.0</td>
<td>0/-15</td>
<td>6</td>
<td>10</td>
<td>0.12</td>
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<tr>
<td>12</td>
<td>0.89</td>
<td>WW 12</td>
<td>6000</td>
<td>0.8-1.2</td>
<td>0/-18</td>
<td>8</td>
<td>12</td>
<td>0.12</td>
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<td>1.21</td>
<td>WW 14</td>
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<td>12</td>
<td>0.12</td>
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<td>15</td>
<td>1.39</td>
<td>WW 15</td>
<td>6000</td>
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<td>8</td>
<td>12</td>
<td>0.10</td>
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<tr>
<td>18</td>
<td>2.00</td>
<td>WW 18</td>
<td>6000</td>
<td>1.1-1.5</td>
<td>0/-18</td>
<td>8</td>
<td>12</td>
<td>0.10</td>
</tr>
<tr>
<td>20</td>
<td>2.47</td>
<td>WW 20</td>
<td>6000</td>
<td>1.2-1.5</td>
<td>0/-21</td>
<td>9</td>
<td>12</td>
<td>0.10</td>
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<tr>
<td>22</td>
<td>2.98</td>
<td>WW 22</td>
<td>6000</td>
<td>1.2-1.5</td>
<td>0/-21</td>
<td>9</td>
<td>12</td>
<td>0.10</td>
</tr>
<tr>
<td>24</td>
<td>3.55</td>
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<td>6000</td>
<td>1.4-1.6</td>
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<td>9</td>
<td>12</td>
<td>0.10</td>
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<tr>
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<td>3.85</td>
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<td>9</td>
<td>12</td>
<td>0.10</td>
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<tr>
<td>28</td>
<td>4.83</td>
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<td>0/-21</td>
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<tr>
<td>30</td>
<td>5.55</td>
<td>WW 30</td>
<td>6000</td>
<td>1.5-1.9</td>
<td>0/-21</td>
<td>11</td>
<td>12</td>
<td>0.10</td>
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<tr>
<td>32</td>
<td>6.31</td>
<td>WW 32</td>
<td>6000</td>
<td>1.5-1.9</td>
<td>0/-25</td>
<td>11</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>35</td>
<td>7.55</td>
<td>WW 35</td>
<td>6000</td>
<td>1.5-1.9</td>
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<td>11</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>40</td>
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<td>1.6-2.0</td>
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<td>11</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>45</td>
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<td>1.6-2.0</td>
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<td>11</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>50</td>
<td>15.40</td>
<td>WW 50</td>
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<td>2.2-2.6</td>
<td>0/-25</td>
<td>11</td>
<td>15</td>
<td>0.10</td>
</tr>
<tr>
<td>55</td>
<td>18.64</td>
<td>WW 55</td>
<td>6000</td>
<td>2.2-2.6</td>
<td>0/-30</td>
<td>12</td>
<td>15</td>
<td>0.10</td>
</tr>
<tr>
<td>60</td>
<td>22.20</td>
<td>WW 60</td>
<td>7000</td>
<td>2.2-2.6</td>
<td>0/-30</td>
<td>12</td>
<td>15</td>
<td>0.10</td>
</tr>
<tr>
<td>65</td>
<td>26.03</td>
<td>WW 65</td>
<td>7000</td>
<td>2.2-2.6</td>
<td>0/-30</td>
<td>12</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>70</td>
<td>30.20</td>
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<td>7000</td>
<td>2.2-2.6</td>
<td>0/-30</td>
<td>12</td>
<td>15</td>
<td>0.10</td>
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<tr>
<td>75</td>
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<td>0.20</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price / **Some diameters may be subject to a minimum quantity requested  
***Lengths may vary depending on the Chroming process used*
**Certification**  | ISO 9001 | ISO 14001 | OHSAS 18001
---|---|---|---
**IMPERIAL Steel grade**  | ASTM-1024 or EN-Cf53

**A LINE**

**LINE C53-H**

**CHROME PLATED LINEAR SHAFT**

**(INDUCTION HARDENED AND GROUND)**

---

**DIMENSIONAL PROPERTIES:**

<table>
<thead>
<tr>
<th>Shaft Diameter**</th>
<th>Shaft Diameter d**</th>
<th>Weight per meter</th>
<th>Shaft Part number</th>
<th>Standard length</th>
<th>Hardening depth</th>
<th>Standard Tolerance h7</th>
<th>Roundness (circular)</th>
<th>Parallelism (cylindrical)</th>
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<th>Standard ISO-h7</th>
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<td>(in)</td>
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<td>(kg)</td>
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<td>(in)</td>
<td>(in/m)</td>
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*Lengths may vary depending on the Chroming process used
**Some diameters may be subject to a minimum quantity requested
** Other diameters, lengths/cut lengths can be provided at premium price

---

**Properties**

**Chrome Layer** | min. 10 [µm], usually 15 [µm]
**Chrome Layer Hardness** | 900 HV 0.1 min.
*Special chroming layer at premium price
**Surface Hardness Cf53** | 62±2HRC
**Surface Roughness** | Ra = max. 0.20 [µm]
**Length tolerance** | Ø+8 [in]
**Diameter tolerance** | Standard ISO-h7
*Special Tolerance can be provided at premium price*Special Tolerance can be provided at premium price including Class L

**Packaging**

Chromed Linear shafts supplied in 3 different packaging options:

**Standard** – plastic sleeves or paper tubes.
**Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
**Extra protection with additional cost** – wooden boxes

**Marking**

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.
## Certification
- ISO 9001
- ISO 14001
- OHSAS 18001

## Steelgrade
- C60E

### ALTP C60-H
**INDUCTION HARDENED AND GROUND HOLLOW LINEAR SHAFT**

### Properties
- **Surface Roughness**: $Ra = \text{max. } 0.20$ [µm]
- **Surface Hardness C60**: 62±2HRC
- **Length tolerance**: $0^\prime+200$ [mm]
- **Diameter tolerance**
  - Standard ISO-h6
  - *Special Tolerance can be provided at premium price*

### Packaging
- Tube Linear shafts are degreased (OD and ID), oiled OD, placed in bundles that are wrapped in wax paper and raffia. **Standard** - plastic sleeves or paper tubes.
- **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
- **Extra protection with additional cost** – wooden boxes

### Marking
- For full traceability, each batch has a label that contains info-about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

### Dimensions Properties:

<table>
<thead>
<tr>
<th>Out Dia. ØD</th>
<th>Inner Dia. Ød</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth SHD DIN 15787</th>
<th>Standard tolerance ISO h6</th>
<th>Roundness (circular) t1</th>
<th>Parallelism (cylindric) t2</th>
<th>Straightness t3</th>
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<td>[mm]</td>
<td>[kg]</td>
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<td>[mm]</td>
<td>[µm]</td>
<td>[µm]</td>
<td>[µm]</td>
<td>[mm/m]</td>
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<tr>
<td>12</td>
<td>4.0</td>
<td>0.79</td>
<td>WH 12</td>
<td>6000</td>
<td>0.6-1.3</td>
<td>0/-11</td>
<td>5</td>
<td>8</td>
<td>0.12</td>
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<tr>
<td>14</td>
<td>7.0</td>
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<td>WH 14</td>
<td>6000</td>
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<td>6000</td>
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<td>8</td>
<td>0.12</td>
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<td>0.10</td>
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<td>9</td>
<td>0.10</td>
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<td>9</td>
<td>0.10</td>
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<td>6000</td>
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<td>7</td>
<td>11</td>
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<tr>
<td>50</td>
<td>29.7</td>
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<td>6000</td>
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<td>0/-16</td>
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<td>11</td>
<td>0.10</td>
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<td>60</td>
<td>36.0</td>
<td>14.20</td>
<td>WH 60</td>
<td>6000</td>
<td>2.2-3.0</td>
<td>0/-19</td>
<td>8</td>
<td>13</td>
<td>0.10</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price

**Some diameters may be subject to a minimum quantity requested**
A LINE

Certification  |  ISO 9001  |  ISO 14001  |  OHSAS 18001
Steel grade  |  C60E

### CHROME PLATED HOLLOW LINEAR SHAFT
(INDUCTION HARDENED AND GROUND)

#### ACLTP C60-H
WHV

**DIMENSIONAL PROPERTIES:**

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<thead>
<tr>
<th>Out Dia. (ØD)</th>
<th>Inner Dia. (Ød)</th>
<th>Weight per Meter</th>
<th>Shaft Part Number</th>
<th>Standard Length</th>
<th>Hardening Depth SHD DIN 15787</th>
<th>Standard Tolerance</th>
<th>Roundness (Circular)</th>
<th>Parallelism (Cylindrical)</th>
<th>Straightness</th>
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<td>(µm)</td>
<td>(µm)</td>
<td>(µm)</td>
<td>(mm/m)</td>
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<tr>
<td>12</td>
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<td>8</td>
<td>0.12</td>
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<tr>
<td>14</td>
<td>7.0</td>
<td>0.91</td>
<td>WH 14</td>
<td>6000</td>
<td>0.6-1.3</td>
<td>0/-11</td>
<td>5</td>
<td>8</td>
<td>0.12</td>
</tr>
<tr>
<td>16</td>
<td>7.0</td>
<td>1.28</td>
<td>WH 16</td>
<td>6000</td>
<td>0.6-1.6</td>
<td>0/-11</td>
<td>5</td>
<td>8</td>
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<tr>
<td>20</td>
<td>14.0</td>
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<td>6</td>
<td>9</td>
<td>0.10</td>
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<tr>
<td>25</td>
<td>15.6</td>
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<td>30</td>
<td>18.3</td>
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<td>0.10</td>
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<td>0/-19</td>
<td>8</td>
<td>13</td>
<td>0.10</td>
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</tbody>
</table>

*Lengths may vary depending on the Chroming process used
**Some diameters may be subject to a minimum quantity requested
***Other diameters, lengths/cut lengths can be provided at premium price

---

**Properties**

**Chrome Layer** | min. 10 [µm], usually 15 [µm]

**Chrome Layer Hardness** | 900 HV 0.1 min.

*Special chroming layer at premium price

**Surface Hardness C60** | 62-65 HRC

**Surface Roughness** | Ra = max. 0.20 [µm]

**Length tolerance** | 0/+200 [mm]

**Diameter tolerance**

Standard ISO h7

*Special Tolerance can be provided at premium price

---

**Packaging**

Chromed Linear shafts supplied in 3 different packaging options:

**Standard** – plastic sleeves or paper tubes

**Special requirements with additional cost** – seaworthy protected – aluminum foil or vacuum bags.

**Extra protection with additional cost** – wooden boxes

**Marking**

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.
**Certification**
- ISO 9001
- ISO 14001
- OHSAS 18001

**Steelgrade**
- X90CrMoV18

---

**Induction Hardened and Ground Stainless Steel Linear Shaft**

---

**Properties**

**Surface Hardness** X90CrMoV18 | 56±3HRC

**Surface Roughness** | Ra = max. 0.20 [µm]

**Length tolerance** | ø/200 [mm]

**Diameter tolerance**
- Standard ISO-h6

*Special Tolerance can be provided at premium price*

---

**Packaging**

Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia.

**Extra protection with additional cost** – wooden boxes

**Marking**

For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

---

**DIMENSIONAL PROPERTIES:**

<table>
<thead>
<tr>
<th>Shaft Diameter**</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth</th>
<th>Standard tolerance</th>
<th>Roundness (circular)</th>
<th>Parallelism (cylindrical)</th>
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<td>[mm]</td>
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<td>[µm]</td>
<td>[µm]</td>
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<td>0.10</td>
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</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price

**Some diameters may be subject to a minimum quantity requested**
**Properties**

- **Surface Hardness**: X90CrMo18 | 56±3HRC
- **Surface Roughness**: Ra = max. 0.20 [µm]
- **Length tolerance**: 0/+8 [in]
- **Diameter tolerance**: Standard Class "L"

*Special Tolerance can be provided at premium price

**Packaging**

Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia.

_Every protection with additional cost_ – wooden boxes

**Marking**

For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

**Dimensial Properties:**

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Shaft Diameter d**</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth SMD</th>
<th>Standard tolerance</th>
<th>Roundness (circular) t1</th>
<th>Parallelism (cylindric) t2</th>
<th>Straightness t3</th>
</tr>
</thead>
<tbody>
<tr>
<td>[in]</td>
<td>[mm]</td>
<td>[kg]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4</td>
<td>6.35</td>
<td>0.25</td>
<td>WRAZ 6</td>
<td>237</td>
<td>0.019-0.031</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
</tr>
<tr>
<td>3/8</td>
<td>9.525</td>
<td>0.56</td>
<td>WRAZ 9</td>
<td>237</td>
<td>0.027-0.039</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
</tr>
<tr>
<td>1/2</td>
<td>12.7</td>
<td>0.99</td>
<td>WRAZ 12</td>
<td>237</td>
<td>0.031-0.047</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>5/8</td>
<td>15.875</td>
<td>1.55</td>
<td>WRAZ 15</td>
<td>237</td>
<td>0.043-0.059</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>3/4</td>
<td>19.05</td>
<td>2.24</td>
<td>WRAZ 19</td>
<td>237</td>
<td>0.047-0.059</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>1</td>
<td>25.4</td>
<td>3.97</td>
<td>WRAZ 25</td>
<td>237</td>
<td>0.059-0.066</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>1 1/4</td>
<td>31.75</td>
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<td>WRAZ 31</td>
<td>237</td>
<td>0.069-0.074</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>1 1/2</td>
<td>38.1</td>
<td>8.95</td>
<td>WRAZ 38</td>
<td>237</td>
<td>0.094-0.114</td>
<td>-0.0006/-0.0011</td>
<td>0.0003</td>
<td>0.0004</td>
<td>0.004</td>
</tr>
<tr>
<td>2</td>
<td>50.8</td>
<td>15.91</td>
<td>WRAZ 50</td>
<td>237</td>
<td>0.106-0.125</td>
<td>-0.0006/-0.0013</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
<tr>
<td>2 1/4</td>
<td>57.15</td>
<td>20.13</td>
<td>WRAZ 57</td>
<td>237</td>
<td>0.114-0.129</td>
<td>-0.0007/-0.0015</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price

**Some diameters may be subject to a minimum quantity requested
**Certification**
- ISO 9001
- ISO 14001
- OHSAS 18001

**Steelgrade**
- X46Cr13

**Packaging**
Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia. 
*Extra protection with additional cost – wooden boxes*

**Marking**
For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

**Properties**
- **Surface Hardness X46Cr13**: 55±3 HRC
- **Surface Roughness**: Ra = max. 0.20 [µm]
- **Length tolerance**: Ø +200 [mm]
- **Diameter tolerance**: Standard ISO-h6
  *Special Tolerance can be provided at premium price*

**Packaging**
Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia.
*Extra protection with additional cost – wooden boxes*

**Marking**
For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

---

**DIMENSIONAL PROPERTIES:**

<table>
<thead>
<tr>
<th>Shaft Diameter d [mm]</th>
<th>Weight per meter [kg]</th>
<th>Shaft part number</th>
<th>Standard length [mm]</th>
<th>Hardening depth SHD DIN 15787</th>
<th>Standard tolerance ISO h7</th>
<th>Roundness (circular) t1 [µm]</th>
<th>Parallelism (cylindrical) t2 [µm]</th>
<th>Straightness t3 [mm/m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.16</td>
<td>WRB 5</td>
<td>6000</td>
<td>0.5-0.8</td>
<td>0/-8</td>
<td>4</td>
<td>5</td>
<td>0.16</td>
</tr>
<tr>
<td>6</td>
<td>0.23</td>
<td>WRB 6</td>
<td>6000</td>
<td>0.5-0.8</td>
<td>0/-8</td>
<td>4</td>
<td>6</td>
<td>0.16</td>
</tr>
<tr>
<td>8</td>
<td>0.40</td>
<td>WRB 8</td>
<td>6000</td>
<td>0.6-0.9</td>
<td>0/-9</td>
<td>4</td>
<td>6</td>
<td>0.16</td>
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<tr>
<td>10</td>
<td>0.62</td>
<td>WRB 10</td>
<td>6000</td>
<td>0.7-1.0</td>
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<td>6</td>
<td>0.16</td>
</tr>
<tr>
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<td>0.89</td>
<td>WRB 12</td>
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<td>0.8-1.2</td>
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<td>5</td>
<td>8</td>
<td>0.12</td>
</tr>
<tr>
<td>14</td>
<td>1.21</td>
<td>WRB 14</td>
<td>6000</td>
<td>0.9-1.3</td>
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<td>5</td>
<td>8</td>
<td>0.12</td>
</tr>
<tr>
<td>15</td>
<td>1.39</td>
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<td>8</td>
<td>0.12</td>
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<td>16</td>
<td>1.58</td>
<td>WRB 16</td>
<td>6000</td>
<td>1.1-1.5</td>
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<td>5</td>
<td>8</td>
<td>0.12</td>
</tr>
<tr>
<td>20</td>
<td>2.47</td>
<td>WRB 20</td>
<td>6000</td>
<td>1.2-1.5</td>
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<td>9</td>
<td>0.10</td>
</tr>
<tr>
<td>25</td>
<td>3.85</td>
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<td>6000</td>
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<td>9</td>
<td>0.10</td>
</tr>
<tr>
<td>30</td>
<td>5.55</td>
<td>WRB 30</td>
<td>6000</td>
<td>1.5-1.9</td>
<td>0/-13</td>
<td>6</td>
<td>9</td>
<td>0.10</td>
</tr>
<tr>
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<td>0/-16</td>
<td>7</td>
<td>11</td>
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<tr>
<td>50</td>
<td>15.40</td>
<td>WRB 50</td>
<td>6000</td>
<td>2.2-2.6</td>
<td>0/-16</td>
<td>7</td>
<td>11</td>
<td>0.10</td>
</tr>
<tr>
<td>60</td>
<td>22.20</td>
<td>WRB 60</td>
<td>6000</td>
<td>2.9-3.3</td>
<td>0/-19</td>
<td>8</td>
<td>13</td>
<td>0.10</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price
**Some diameters may be subject to a minimum quantity requested
**ALP X46-H**

**INDUCTION HARDENED AND GROUND STAINLESS STEEL LINEAR SHAFT**

**Properties**

**Surface Hardness** X46Cr13 | 55±3HRC

**Surface Roughness** | $Ra = \max 0.20 \, [\mu m]$

**Length tolerance** | $\pm 8 \, [\text{in}]$

**Diameter tolerance** | Standard Class "L"

*Special Tolerance can be provided at premium price

**Packaging**

Linear shafts are degreased and oiled, placed in bundles that are wrapped in wax paper and raffia. **Extra protection with additional cost** – wooden boxes

**Marking**

For full traceability, each batch has a label that contains info about: manufacturing date, product name, diameter, tolerance range, number of linear shafts, heat no.

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**DIMENSIONAL PROPERTIES:**

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Shaft Diameter $d^{**}$</th>
<th>Weight per meter</th>
<th>Shaft part number</th>
<th>Standard length</th>
<th>Hardening depth $SHD$</th>
<th>Standard tolerance</th>
<th>Roundness (circular) $t_1$</th>
<th>Parallelism (cylindrical) $t_2$</th>
<th>Straightness $t_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>[in]</td>
<td>[mm]</td>
<td>[kg]</td>
<td></td>
<td>[in]</td>
<td>[mm]</td>
<td>CLASS L</td>
<td>[in]</td>
<td>[in]</td>
<td>[in/m]</td>
</tr>
<tr>
<td>1/4</td>
<td>6.35</td>
<td>0.25</td>
<td>WRBZ 6</td>
<td>237</td>
<td>0.019-0.031</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
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<td>3/8</td>
<td>9.525</td>
<td>0.56</td>
<td>WRBZ 9</td>
<td>237</td>
<td>0.027-0.039</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.008</td>
</tr>
<tr>
<td>1/2</td>
<td>12.7</td>
<td>0.99</td>
<td>WRBZ12</td>
<td>237</td>
<td>0.031-0.047</td>
<td>-0.0005/-0.001</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.008</td>
</tr>
<tr>
<td>5/8</td>
<td>15.875</td>
<td>1.55</td>
<td>WRBZ15</td>
<td>237</td>
<td>0.043-0.059</td>
<td>-0.0005/-0.001</td>
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</tr>
<tr>
<td>1</td>
<td>25.4</td>
<td>3.97</td>
<td>WRBZ 25</td>
<td>237</td>
<td>0.059-0.066</td>
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<td>WRBZ 38</td>
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<td>2</td>
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<td>15.91</td>
<td>WRBZ 50</td>
<td>237</td>
<td>0.106-0.125</td>
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<td>57.15</td>
<td>20.13</td>
<td>WRBZ 57</td>
<td>237</td>
<td>0.114-0.129</td>
<td>-0.0007/-0.0015</td>
<td>0.0003</td>
<td>0.0005</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*Other diameters, lengths/cut lengths can be provided at premium price

**Some diameters may be subject to a minimum quantity requested
**Properties**

**Chrome Layer** | min. 10 [µm], usually 15 [µm]

**Chrome Layer Hardness** | 900 HV 0.1 min.

*Special chroming layer at premium price*

**Surface Hardness X46Cr13** | 55±3 HRC

**Surface Roughness** | Ra = max. 0.20 [µm]

**Length tolerance** | 0/+200 [mm]

**Diameter tolerance**

Standard ISO h7

*Special tolerance can be provided at premium price*

---

**Packaging**

Chromed Linear shafts supplied in 3 different packaging options:

- **Standard** – plastic sleeves or paper tubes.
- **Special requirements with additional cost** – Seaworthy protected – aluminum foil or vacuum bags.
- **Extra protection with additional cost** – wooden boxes

**Marking**

For a full traceability each bar is marked individually on the plastic/paper tube with info about the date, product series, diameter, tolerance, resistance at saltwater spray test, heat no., production order etc. The batch has a label with information regarding: Order no., Item no., Heat no., Steel Grade; total length of the batch, Weight, no. of pieces in the batch.
CUSTOMIZED SERVICES

Luckily we are all different and we understand that also our Customers have different needs. That is why we are performing special customized operations in order to provide a wide range of custom finished or semi-finished products.

HERE ARE SOME EXAMPLES OF WHAT WE ARE CAPABLE OF DOING: