Tradition
Ramnäs Bruk has pioneered the development of production, chain grades and quality for years and years. With the tradition of craftsmanship combined with new technology we keep setting new standards for reliability.

Quality
At Ramnäs Bruk, quality is a way of life. Without any mooring line failure due to fabrication defects in over 25 years, we have proven that quality is not only the number one issue on our everyday agenda. It is our only issue.

Technology
With continuous development of our high tech inspection and production tools, we always strive to offer you the best possible mooring chain for any demanding offshore project. That is how we maintain our quality leadership.
Ramnäs Bruk strives to be the best and most reliable alternative from all aspects between inquiry and delivered chain. We focus on always improving technology and quality, to make sure that our deliveries can be trusted in any demanding offshore project. Reliability is a must.

Innovation for quality
Innovations and increased efficiency are necessities to stay in a leading position. Ramnäs Bruk would not be in successful operation since 1590, and in the offshore mooring market for over 50 years, if we didn’t continuously consider our customers future needs and improve our products and services.

Ramnäs unique assymetrical stud design and our Phased Array ultrasonic inspection method are two examples of Ramnäs innovations that gives assurance to safe mooring systems.

Production and delivery
Manufacturing chain of large dimension is a heavy procedure where quality is the main concern in every part of the production. Each link has its own specific history, with full traceability of fabrication and inspection data stored on file. We cannot afford to take anything for granted.

Quality and quantity must go hand in hand. Ramnäs is in the process of soon reaching double delivery capacity by some of the largest investments in new production equipment since the seventies. Top quality chain at increased quantities, delivered with shorter delivery time to ensure the performance of your mooring system installation.

5 years quality warranty
We trust our quality to the degree that we always offer 5 years quality warranty in our General Conditions together with ORGALIME S 2012.

Ramnäs is extremely proud that many of our employees have decades of continuous service, but all of that knowledge can’t be fitted in a printed catalogue. The sooner we bring Ramnäs quality in to your mooring system the better. Please contact us as early as possible in your mooring process and let us support you.

For top quality mooring products
You can rely on our expertise

Our craftsmanship combined with new technological methods ensures that chains from Ramnäs Bruk keeps setting new standards of reliability in harsh conditions.

Short facts
- Ramnäs is located in the heart of Sweden, 140 km west of Stockholm and 30 km north of Västerås.
- With the railroad outside the window, we transport chain to the port of Gävle and Uddevalla.
- Approved as manufacturer by all major classification societies for all offshore chain grades.
- Preferred production range: 76 – 165 mm dia stud and studless chain.
- Certifications: ISO 9001, ISO 14001, OHSAS 18001.
- Standard terms of delivery are as per Incoterms 2010.
- Ramnäs Bruk Sales is represented in USA, Korea and Brazil.

Ramnäs Bruk

Daemyung Marine

Brastech

Vryhof Americas
Ramnäs Bruk has been successful since 1590, and in offshore mooring for over 50 years. Our long tradition has always been to continuously consider our customers future needs and to improve our products and services. During all these years we have proven that quality is our guiding principle.

Quality is a lifestyle
Ramnäs Bruk was one of the pioneers in the offshore industry to conform to the international standard of ISO 9001 back in the 90’s. To us, quality is a lifestyle where nothing can be assumed or taken for granted. There is no higher objective than quality, all the way from supplier deliveries, through the production process and the logistics to get the mooring in place.

We believe in our excellent product quality to the extent that we have introduced a 5 year quality warranty on all our chains. We understand that the quality we deliver controls the reliability you receive.

Certification is not our only goal
We know the importance of certification. But it is also our firm belief that certificates are only a proof that we have reached certain heights in our quality work. We always strive to go beyond that.

All material is passing through our acceptance control before it is taken into production. Every flash weld on each link is recorded to ensure the weld quality. Our heat treatment process is performed in continuously and automatically controlled furnaces to meet the desired criteria for mechanical properties. All links are verified in a proof load test and we use magnetic particle inspection and our developed ultrasonic inspection method Phased Array, to find any surface or internal indications.

All tests are documented, and every single link can be traced back to its source. Without any mooring line failure due to fabrication defects in 25 years we have proven that our quality is reliable. This is the kind of certification we are proud of.

Continuous Improvements towards reliability
Ramnäs Bruk occupational health and safety management system conforms to the international standard of OHSAS 18001.

Constantly encouraging our experienced and qualified staff to develop and further educate themselves in their professions. To improve in all processes, we apply thoughts of LEAN and 5S through our corporate development programme. The expertise of our staff are shared internally by using the methods and tools of continuous improvements, this is one of the main factors that have made Ramnäs the company that it is today.

Taking care of our planet
Located in the heart of Sweden, surrounded by the beautiful Swedish nature, we are aware of our responsibility for the environment. Our environmental work goes through the entire business. Each department has their own activity plans to minimize waste and enhance recycling in compliance with the regulations of ISO 14001.

To further decrease our footprint on the environment we have made various investments over the years, for example a new cooling water system where excessive heat from cooling water are used to heat up our premises and decrease the CO2 emissions by converting furnaces to be powered by natural gas (LNG). To stay in the forefront even in the next generation chain production we are continuously improving to make our future environment sustainable.

Ramnäs Bruk has been successful since 1590, and in offshore mooring for over 50 years. Our long tradition has always been to continuously consider our customers future needs and to improve our products and services. During all these years we have proven that quality is our guiding principle.

Quality. Nothing else.

At Ramnäs Bruk
Quality is a way of life

A chain is never stronger than its weakest link. It is our mission to deliver top quality mooring chains to our customers.
With continuous development of our high tech inspection tools, we always strive to increase the reliability of the mooring chain. Our craftsmanship combined with new technological methods ensures that chains from Ramnäs Bruk keeps setting new standards for reliability in harsh conditions.

**Innovating reliability**

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**Material**
We continuously work to improve steel grades, and with more than 50 years of cooperation with steel suppliers and all major classification societies we ensure that our material grades meet or exceed the rigorous standards.

With specific steel recipes, pre-dispatch certification, detailed arrival control and continuous quality assurance routines, we make sure all material we use meet the high Ramnäs Bruk standards.

**Welding procedure**
Our verification procedures for weld quality are the result of decades of experience and have been incorporated into our processes to ensure 100% accuracy at all times.

But also with pre-set welding machines and full inspection of each weld by microprocessors, we will always rely on our operators craftsmanship to make sure all products are of supreme quality.

**Phased Array Inspection**
The Phased Array method, developed by Ramnäs Bruk, uses ultrasonic waves to check the interior of the welded area of the link. The versatility and high speed of the method enables 100% check of all welds, with faster and more accurate result than with traditional UT methods. And – the Phased Array method is of course approved by all major classification societies.

**Supersonic Corrosion Protection**
Offshore chains are particularly sensitive to corrosion in the splash zone, where salts of the sea and the oxygen on the surface create a highly corrosive environment. With Supersonic Corrosion Protection even partial coverage can reduce the corrosion rate up to four times, providing lifecycle cost savings.

**Heat treatment**
The settings and procedures for each individual grade or size of chain has been carefully developed through decades of experience.

Our heat treatment is performed in continuously and automatically controlled furnaces, operated by our experienced personnel. This gives every chain the best possible heat treatment, resulting in best-in-class mechanical properties.

**Inspection**
We put great pride in continuously developing the world’s most advanced inspection, and are always researching new ways of improving the process.

Thanks to the strict quality procedures at both our suppliers and in our manufacturing, we are proud to put the Ramnäs Bruk seal of approval on our chains.

**RFID Instant Traceability**
Ramnäs has, as first supplier, chains with RFID chip for instant traceability installed in stud link chains offshore. This solution for identification and tracking gives the possibility to track each link and obtain necessary information for evaluation.

**Automatic Magnetic Particle Inspection**
The final magnetic particle inspection eliminates the risk for surface defects on the finished chain. We use an Automatic Magnetizer to make the inspection more exact by ensuring full strength of the magnetic field in both directions simultaneously. By using both the Phased Array and Automatic Magnetic Particle inspection, we increase our efficiency by 50%, while further enhancing the Ramnäs Bruk quality.

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**Continuously improving world class reliability**

**Requires innovative minds**

At Ramnäs Bruk we focus on developing new methods and processes to improve every step from raw material to installed mooring. The perfection is in the details.

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**Ramnäs Bruk Technology Highlights**

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Combining tradition, quality and technology, we are constantly making sure that products from Ramnäs Bruk always are at the forefront of the mooring business. We take great pride in our products unsurpassed track record, and we continuously make improvements to our already top quality chains.

**Ramnäs Stud Chain**

With our unique manufacturing method, we make the best stud link mooring chain, with proven use even for LTM.

**Asymmetrical design**
Ramnäs Bruk has developed an asymmetric stud that is carefully installed and expanded to exact tolerance that was established through years of research and development. The asymmetrical design of the stud gives equal stud footprints and contributes to a symmetric stress-distribution in the link.

**No more loose studs**
Our stud link chain is superior compared to all other available stud link mooring chain today. The design combined with Ramnäs Bruk's controlled stud expansion, is the standard method in our production process since 1991.

The built-in "spring" effect makes a tremendous difference in avoiding loose studs. The percentage of loose studs has been reduced to zero. In fact, many of our customers have experienced Ramnäs Bruk stud chains with intact studs for over 20 years. It is safe to say that our studs stay in place.

**Ramnäs Studless Chain**

Our studless link can deliver the same performance as a stud link in terms of static strength – while offering a saving of 9% in weight.

Ramnäs Studless Chain for deepwater applications offers a potential reduction in weight, and consequently cost savings. Alternatively, the weight can be kept constant and fatigue strength correspondingly increased by opting for larger diameter chain. This option also gives a higher margin of safety against the incidence of corrosion.

**Design**
Compared to a stud link that has a width of 3.6 x d, Ramnäs Bruk standard studless link has a width of 3.35 x d. The length of the studless link is 6 x d which is the same as for stud link.

**Static Strength**
Ramnäs studless chain withstands the same peak load as a stud link chain with the same nominal diameter.

**The key benefits in short**
- Higher proof load
- At least three times increased fatigue life
- Reduced risk of stress corrosion in the weld
- Improved utilisation of the base material ductility
- Increased peak loads without any deformation
- Facilitate installation, no kink and knots
- Low life cycle cost
When joining two mooring chains, a solid connector can be used. The RF Connector has the same outside shape as a traditional Kenter joining connector, but with an outside thickness (D) of 1.30 x d. The slim shape will enable the RF connector to be used on every mooring system on semisubmersibles, offshore loading system, and will fit any wildcat.

Through the unique robotized heat treatment process that is used in producing the connector, the results are identical for quenching and tempering. The unique heat treatment also ensures visible deformation in good time before the components fails – all in favour to provide the highest quality product for any and all offshore project.

Its six teeth locking head provides a larger bearing area and a better stress distribution. Compared with standard or slim type connectors the side load resistance is larger and it has a better shock load resistance as well.

**Key benefits of RF Connector in short:**
- +5% proof and break load compared to standard grade RF
- Locking mechanism with a larger bearing area
- Robotized heat treatment process
- RF design improves fatigue life
- A designed spot for RFID chip as standard
- All parts are CNC/DNC machined
- Available in all grades
- Also available with pinless locking system

**RF Connector**

The RF Anchor Connectors are very similar to the RF Connectors. The one thing that differs is the small end of the shackle, designed to accept a common link. This eliminates costly enlarged links and end links, saving you money.

The RF Anchor Connector is dismantled and assembled in a similar way as the RF Connector.

**Accessories**

Ramnäs Bruk is not just a renowned Swedish chain manufacturer. With our experience and cutting edge research, we can support you during the design and engineering phase. So – in addition to our standard products, we can supply specific connecting parts to suit your every need.

**Customer specific connectors**

In addition to our standard products, we can help you produce specific connecting parts for your every need. Below are some examples of customer specific connectors.

sales@ramnas.com
The Ramnäs Bruk production system

Securing premium quality all the way

1 Inquiry and Quotation
Inquiry from customer is sent to Ramnäs Bruk Sales Department and a quotation meeting customer specifications is prepared.

2 Order
A delivery from Ramnäs often starts with engineering and detailed design. Every project gets a dedicated Project Manager that will be the customer’s link to Ramnäs. During the project, the Project Manager will supply progress reports on a regular basis.

3 Planning the project
For larger scale projects, a Kick Off Meeting is held together with the customer to define project specific requirements. Project documentation and procedures are initiated.

4 Arrival control of material
When the steel arrives to Ramnäs a thorough arrival control is made. The arrival control consists of checking the melt identification, checking the surface condition, dimension and tolerances etc.

5 Cutting bars
Bars are cut by a cold circular saw and the blank length is checked.

6 Heating of blanks
The blanks are heated by electrical resistance heaters to the optimal temperature to bending the bars into links.

7 Forming of links
The heated blank is bent into the forged chain length in the bending machine. Visual control of the shape of each link is performed. Forging of new links is done per sampling frequency specified in the classification society rules and per each melt of steel.

8 Welding of links
Links are flash butt welded according to a specific welding recipe that depends on chain grade and size. Every flash weld is recorded.

9 Trimming of links
The flash-weld burr is trimmed by a flash removal tool working along the periphery of the weld.

10 Inspection and control at forging
Hot bend test for each melt. Manual gauging of link length and width.

11 Insertion of asymmetric studs or shaping of studless links
Ramnäs Bruk’s stud chain is fitted with drop forged studs. The asymmetrical design of the stud gives equal stud footprints and contributes to a symmetric stress-distribution in the link.

12 Pre Heat treatment inspection
Magnetic Particle Inspection of each link. Visual control of shape, studs and surface of each link.

13 Heat Treatment
The heat treatment is performed in continuous automatically controlled furnaces and consists of quenching and tempering, both operations followed by water cooling.

14 Mechanical testing
The sample sets for the tensile, impact test and break test are retrieved as per sampling frequency specified in the classification society rules and per each melt of steel.

15 Proof loading and gauging
The proof loading is performed by continuous testing machine. 5-11 links are proof loaded with 1 link overlap. Every link is load tested to the proof load specified by the pertinent classification society. Continuous recording of loads and plastic elongation.

16 Visual inspection and gauging
Visual Control of each link. Measuring of five link length, single link length and width.

17 Controlled Stud Expansion (not applicable for studless link)
Ramnäs controlled stud expansion, performed after proof loading, is the standard method in Ramnäs Bruk production process since 1991 and it replaces all forms of stud welding. The stud expansion fixes the stud and creates a spring effect that improves the fatigue life of the chain.

18 Ultrasonic inspection with Phased Array method
Phased Array method uses ultrasonic waves with a large number of scanning beams to check the interior of the welded area on the link. The versatility and high speed of the PA method enables 100% check of all welds.

19 Magnetic Particle Inspection
All links are checked with Magnetic Particle Inspection on the surfaces which have been in contact with the electrode clamps of the welding machine, the weld itself and its vicinity. 10% of the links are subject to surface control of all accessible surfaces.

20 Shotblasting
The surface of the chain is cleaned by shotblasting. Clean surfaces make the final non-destructive testing efficient and reliable.

21 Dispatch, Logistics and Transportation
The chain is bundled with certified wire slings. The chain is loaded by overhead cranes onto railway wagon or truck for transport to the final destination or to the loading port of carrying vessel.

22 Documentation
After delivery the customer will receive the final documentation as specified by the classification society and customer requirements.
### Proof and break loads (kN)

LOAD (in kN) = \( c \times d^2 \times (44 – 0.08 \times d) \) (d in mm)

LOAD (in KIP) = \( c \times d^2 \times \frac{(44 – 2.032 \times d)}{1000} \) (d in inch)

Due to the application of different rounding-off-principles for calculation of loads, individual classification societies show slightly different load values in their tables.

<table>
<thead>
<tr>
<th>Grade</th>
<th>ORQ</th>
<th>R3</th>
<th>R3S</th>
<th>R4</th>
<th>R4S</th>
<th>R5</th>
<th>Stud Less</th>
<th>Stud Less</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Proof Load</td>
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</tr>
</tbody>
</table>

Due to the application of different rounding-off-principles for calculation of loads, individual classification societies show slightly different load values in their tables.

Weights in table are calculated and can therefore differentiate from as-built weights.
### Classification Society API Spec 4F Ramnäs Inhouse Offshore Mooring Chain (AACS W22) DNV-OS-E302 October 2013

#### Quality

**Tensile test**
- Yield strength Re (N/mm²)
  - ORQ
  - ORQ+20% R3
  - R3S
  - R4
  - R4S
  - R5

**Ultimate tensile strength Rm (N/mm²)**
- 641
- 750
- 690
- 770
- 860
- 960
- 1000

**Elongation A5 (%)**
- 17
- 15
- 17
- 15
- 12
- 12
- 12

**Reduction of area Z (%)**
- 40
- 40
- 15
- 15
- 12
- 12
- 12

**Impact strength**
- Min average energy, parent material (J)
  - 58
  - 40
  - 58
  - 60
  - 40
  - 65
  - 45
  - 50
  - 56
  - 58
- Min average energy, weld (J)
  - 49
  - 36
  - 34
  - 50
  - 30
  - 53
  - 33
  - 36
  - 40
  - 42

**Test temperature °C**
- 0
- -15
- 0
- 0
- -20
- 0
- -20
- -20
- -20
- -20

1) At the option of the Society the impact test of grade R3 and R3S may be carried out at 0°C or -20°C.
2) For cast accessories, the minimum value shall be 40%.
3) For cast accessories, the minimum value shall be 35%.

---

**Twist of stud link mooring chain**

A twist of 45 degrees over 5 links is acceptable without noticeable decrease of chain strength. More twist under load will deform the chain. Thus a 90-foot length of chain may be twisted under load according to the formula:

\[
\theta_{\max} = \frac{2500 \times 45}{4 \times d} \times \frac{1}{5} = 618.75
\]

Where d is chain nominal diameter in mm.

---

**Coefficient of friction for mooring chain**

The coefficient of friction depends upon the actual ocean bottom at the anchor location. General friction factors for chains are given in the table. The starting friction factor may be used to compute the holding power of the chain. The sliding friction factor may be used to compute forces on the chain during deployment.

<table>
<thead>
<tr>
<th>Ocean bottom</th>
<th>Friction factors</th>
<th>Starting</th>
<th>Sliding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>0.25</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Mud with sand</td>
<td>0.32</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>Firm mud</td>
<td>1.01</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Soft mud</td>
<td>0.90</td>
<td>0.46</td>
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</tr>
<tr>
<td>Clay</td>
<td>1.25</td>
<td>0.81</td>
<td></td>
</tr>
</tbody>
</table>

Chain holding power generalised friction factors for mooring chain:

\[
\text{Submerged weight} = \left[ \frac{v_s - v_p}{v_p} \right] \times \text{weight of chain in air} = 0.87 \times \text{weight of chain in air}
\]

\[
v_s = \text{Density of steel} = 785 \text{ kg/dm}^3
\]

\[
v_p = \text{Density of seawater} = 1.02 \text{ kg/dm}^3
\]

---

**Submerged weight of chain**

The submerged weight of chain varies with the density of the seawater, but can be roughly estimated using this formula.
### Approximate weight of details (kg)

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Type D</th>
<th>LTM</th>
<th>Link</th>
<th>Type</th>
<th>LTM</th>
<th>Link</th>
<th>Link</th>
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</thead>
<tbody>
<tr>
<td>6 9/16</td>
<td>1600</td>
<td>2620</td>
<td>2845</td>
<td>4340</td>
<td>4630</td>
<td>910</td>
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<td>3475</td>
<td>5950</td>
<td>6295</td>
<td>1085</td>
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<tr>
<td>5 3/8</td>
<td>860</td>
<td>1215</td>
<td>1340</td>
<td>1655</td>
<td>1815</td>
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<td>117</td>
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<td>345</td>
<td>385</td>
<td>505</td>
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### Approximate weight of details (lbs)

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<td>125</td>
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</tbody>
</table>

### Links

- **Common Stud Link**
- **Common Studless Link**
- **End Link**
- **Enlarged Link**

### Anchor and Joining shackles

- **Common Anchor**
- **Joining**

### RF Connector

- **Dimensions for RF connector**

### Conversion Factors for SI-units

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conversion Factor</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>1 m = 3.281 ft</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>1 kg = 2.205 lb</td>
<td></td>
</tr>
<tr>
<td>Force</td>
<td>1 N = 0.225 lbf</td>
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Weights in table are calculated and can therefore differentiate from actual weights.
Swedish wrought iron played an important role in Swedish export for 300 years. During the second half of the eighteenth century the wrought iron manufacture in Ramnäs was completed with a rolling mill, thus creating a fully integrated manufacture of steel bars from pig iron. With good access to bar material, chain production started.

Modern fabrication with flash butt welding of anchor chains was first developed and introduced by Ramnäs.

By developing the first offshore grade, ORQ, Ramnäs Bruk was the first supplier of offshore chain in the world.

The traditional chain for ships was delivered in 15 fathom lengths. The offshore industry requested continuous lengths without shackles, and Ramnäs Bruk responded to the customers’ wishes by building a factory for manufacture of continuous lengths of chain.

A new stud chain design was introduced. Stud welding for stud fastening was replaced by stud expansion. This expansion preloads the link thus maintaining long-time stud contact in spite of the loss of material by corrosion in the contact surfaces of the stud.

The uneven heat distribution in the link during stud insertion is compensated by the creation of the asymmetric stud.

Microprocessor control and recording of every flash weld was introduced.

In order to be able to utilise existing winches with stronger chains Grade 4+ was developed. A stronger steel was utilised in combination with 82 mm bar diameter for chain with the five-link length of 76 mm diameter.

The first delivery of studless chain. Over the years more than 30 000 tonnes studless chain has been delivered from Ramnäs since then.

Ramnäs Bruk continues to invest for the future by building a new furnace system consisting of both quenching and tempering furnaces. The new furnaces will increase the production capacity by double and also give Ramnäs Bruk the potential to develop future chain grades, as R6.