NB Series
The machining solution for Blisks
Model version 2017/2018
Starrag has established an excellent reputation around the world as a technology partner to leading turbine manufacturers. Whether for aero engine manufacturers and their suppliers or for manufacturers of gas and steam turbines for power generation, Starrag is the name the world uses.

This technology partnership includes everything from customer specific engineering to application development including CAM programming, tool and fixture design and automation.

Starrag offers comprehensive process know-how and for many years has successfully delivered complete turnkey projects. Our customers benefit from leading manufacturing technology, flexible production support, individual user training and a global service.

Chatter free production for Ra

<0.8µm

>20% productivity increase vs. Trunnion machines
Blisks
No matter if it is called a «Blisk» (bladed disk) or an «IBR» (integrally bladed rotor), no matter if it is single stage or multi stage, Starrag’s dedicated machine concept of the NB series provides the best solution for efficiently machining these parts.
Blisks made from Titanium, Nickel-based superalloys and the Blisks made of blade steels for stationary gas turbines triggered the development of the NB series. The challenges posed by the thin, unstable airfoils are easily met by the new productive manufacturing approaches that Starrag provides.

For all the necessary manufacturing operations Starrag provides the benchmark: Efficient roughing for Blisks machined from solid, adaptive machining for friction welded Blisks, high dynamic finishing of the airfoils in point contact. Shortest cycle times and zero scrap rate production are what the Starrag NB series stands for. The NB series is based on the very successful Starrag LX series.
Planning reliability, productivity and efficiency are the decisive factors in the industrial production of Blisks. Starrag strives continuously to increase the real life performance.

**Productivity**

Machine design and axis concept are critical for process stability during roughing and for high dynamics when finishing. Consequently shorter process times with reduced tool wear are possible.

In comparison to universal machine concepts used for Blisk milling today—like trunnion machines—the dedicated concept of Starrag’s NB series provides a number of advantages:

- No restricting element in the machine design (like quills) allows for much higher process stability and material removal rates
- Minimum rotating masses to increase machine dynamics
- Tilting movement of the NB series is (almost) around the tool center point. With that, the compensation movements required of the linear axes are much smaller in comparison to tilting the blisk (as on a trunnion)

In addition to the classical machine building methods, Starrag also provides productive solutions specific to the demands of machining of thin-walled airfoils where the low stiffness of the workpiece means the cutting conditions are not stable.

Machine and control systems are seen as a unit. Control behavior and NC path planning are developed and optimized in great detail to achieve the perfect combination of geometry precision, surface quality and of course productivity. Depending on the required application, the machine can be optimally set using five settings: roughing, pre-finishing, fast finishing, finishing and super finishing.

Starrag machines are built for milling. Non-productive times are systematically analyzed and eliminated, providing increased productivity without generating additional costs.

All in all, best in class productivity is reached both in roughing and finishing.

**Integrated turning functionality**

For all machines of the NB series, a full turning capability can be included (with freeform turning, specific measurement cycles etc.), making complete and accurate machining of Blisks in one setup possible.

**Surface quality**

Producing unblemished milled airfoil surfaces is Starrag’s explicit aim – milling workpieces in such a way that they can be assembled directly or after a minor additional process such as barrel finishing.

Any influence, which manifests itself as a defect in the workpiece’s quality is systematically analyzed by Starrag, and the system is subsequently optimized. Whether it is the elimination of chatter or reversal marks, or perfecting the quality of the milling path generation, Starrag sets new standards with the NB machine range.
Starrag strives to provide best in class solutions. With the substitution of shot peening or barrel finishing a significant reduction in cycle time and logistic overhead can be achieved.

The continual demand to increase the contour accuracy means «traditional» finishing methods such as hand or machine grinding are unsuitable due to the resulting geometrical deviations. In order to achieve the required surface quality, reducing the scallop height was the only possibility. The reduction of the line feed directly increases the machining time required, and the cost per piece.

Barrel finishing puts high requirements on the preceding milling process as a very smooth surface is needed which again increases the cycle time. The Starrag «Dengeling» process overcomes these disadvantages.

After milling, a tungsten carbide ball oscillating axially with high frequencies smoothen the surface. The process is completely automatic, including tool change. This process works fully automatically, with automatic tool changes after milling. The path of the Dengeling tool is controlled by the NC control.

Additional requirements such as increased resistance against fatigue and wear result in a higher lifetime of the part. Increased component lifetime opens new possibilities in blade design.
Precision / process capability

In modern production, quality is an absolute must. For Starrag this means that reliable manufacturing must be possible in less than ideal conditions such as fluctuating temperatures or lack of warm-up phases. Additionally energy cost for temperature stabilization of shop and machine can be reduced.

To achieve standard deviations of just a few microns on consecutive parts, a number of approaches are followed:

- The prerequisite is to have a basic mechanical design of the NB machines based on engineering principles. This includes symmetry, suitable cooling, efficient chip removal etc.
- Homogeneous temperature level in the machine is the basis for thermal stability. The temperature of the cooling agents is controlled to match the ambient temperature.
- Expansion of the spindle through thermal drift or centrifugal forces is constantly measured and compensated for by direct measurement.
- The effects of machine displacements due to thermal drift can be corrected directly on the workpiece before the green button process starts.

With all of these measures a new level of process capability is achieved. Expensive scrap can be avoided. Subject to the application, external measuring operations are eliminated and air conditioning requirements reduced.

Adaptive machining

Productivity and accuracy are no longer just a question of machine and tool. Adaptive machining of the individual workpiece is a quantum leap for many applications.

The actual shape of the workpiece is captured on the machine using Starrag’s own 5-axis measuring cycles. The NC program can than be specifically adapted or created anew – reliably, and fully automated. This technology provides advantages for a multitude of applications:

- Non-machining time («air cut») on forged blanks is eliminated
- Adaptive machining of blade edges and snubbers on precision-forged blades that blend seamlessly to the finished airfoil
- Detection and compensation of blade distortion
- Detection and compensation of thermal drift of the machine

Adaptive machining is completely integrated and the process is fully automated. The potential of adaptive machining is perhaps best illustrated by Starrag’s subsidiary TTL in their adaptive repair of turbine components.
Innovative clamping concepts

The special workpiece geometries create specific demands on the clamping fixtures. Starrag has in-house specialists who develop individual clamping concepts to meet the specific requirement of Blisk machining. As a customer, you benefit from:

- Use of a standard adapter system makes manual machine loading very easy. The workpiece is mechanically clamped onto the adapter outside of the machine, the adapter is then loaded into the machine by crane. The adapter can be clamped hydraulically via foot pedal.
- A single adapter design solution is used for all NB machine sizes.
- Workpiece specific fixtures on the adapter can be integrated for optimal clamping and highest repeatability.
- Besides mechanical clamping, hydraulic or vacuum solutions can be implemented on the adapter.
- Geometric deviations between multiple fixtures can be stored in the control system. Measuring of blank position can therefore often be eliminated.

Optimal process cooling

One key factor to lowering your tooling costs and increasing your productivity is selecting the right cooling method.

All state-of-the-art through-spindle cooling medias are available throughout the NB range.

- High pressure coolant (water-based or oil)
- Through spindle air
- Aerosol (minimum quantity lubrication)
- CO₂ cryogenic cooling through the spindle
- Aerosol plus CO₂ through spindle

Of course external cooling with coolant or CO2 is possible too. With these options, breakthroughs in tool life are achievable, giving your largest saving on consumable items.
Starrag – CAM experts.

PSI+ is Starrag’s dedicated CAD/CAM solution specifically for the efficient programming and subsequent milling of multiblade components such as impellers, blisks/IBRs, diffusers or nozzle guide rings.

In PSI+ the extensive experiences of both Starrag and Openmind in programming and machining complex free form parts are combined.

With PSI+, Starrag offers a complete package including:

- professional direct application support by experienced process engineers specialized in Blisk and Impeller applications
- the leading CAD/ CAM solution for blisks and impellers: Hypermill from Openmind
- the comprehensive Starrag postprocessor providing access to all Starrag functionality related to optimal milling of freeform surfaces (like dynamic parameter adaptation, 5-axis measuring functionality and adaptive milling)

With PSI+ a versatile but very powerful solution is offered. The automated generation of the cycles guarantees average programming times of less than one day for standard impellers or blisks – even for less experienced programmers.

A complete solution is provided here, from the CAD file – with direct interfaces to formats such as IGES, STEP, NX, Catia, ProE or Solidworks – to the optimized NC data for shortest milling times and highest surface quality including all options available on Starrag’s NB or STC machines with a few button clicks.

Setting the machine up specifically for an operation is easy with the Starrag postprocessor, supporting all imaginable options from machine dynamics through to the coolant settings. The postprocessor provides the harmonized interface to the machine control, providing optimal path information for highest dynamics and best surface finish.

Furthermore it features an external interface to supply information about the tools, be it to the pre-setter or directly into the tool table on the controller.
PSI+ is designed to be the optimal link between the CAD data of the designer and the perfectly milled workpiece of the production engineer. The purpose of PSI+ is to provide real benefits for real production.

The structure of PSI+ is tailored to suit the different applications in multiblade machining. The «PSI+ Classic» package contains the necessary machining strategies for machining open impellers and blisks, such as:
- Airfoil point milling cycles
- Hub milling cycles
- Airfoil flank milling cycles
- Edge milling cycles
- Fillet milling cycles

Also included in the PSI+ Classic package are a number of Openmind's standard milling cycles giving the user greater flexibility when defining strategies and generating programs.

The «PSI+ Advanced» package provides the necessary cycles for more challenging workpieces such as closed impellers or side-entry blisks plus a variety of more versatile cycles.

The «PSI+ Part Measuring» package provides direct access to the Starrag measuring cycles on the machine. Critical part dimensions can be logged. Pre-machined features on the workpiece can be measured to optimize the position and orientation of new milling paths in order to achieve highest relative accuracies between the features.

With the measuring cycles an automated detection and compensation of thermal drift of the machine becomes possible, leading to highest geometric accuracy of the finished workpiece. Productivity and accuracy are no longer just a question of machine and tool. The «PSI+ Adaptive Machining» package module is a quantum leap for many applications. With it the actual shape of the workpiece is captured on the machine using Starrag measuring cycles. The NC program can then be specifically adapted or newly generated. This is especially beneficial in the case of friction welded blisks. The exact location and shape of each blade can be determined. The adapted NC program makes a perfect blending between the hub and the airfoil possible, despite location and form errors of the airfoil in the order up to 1 mm. Adaptive machining is completely integrated and the process is fully automated.
PSI+ Classic Package
Contains all the necessary milling strategies for machining all «open» impellers and «tip entry» blisks.

- **Multi-Blade 5X Roughing Cycles**
  Highly efficient 5 axis roughing strategies for the pockets between airfoils.

- **Multi-Blade Flank Milling Cycles**
  For the semi finishing or finishing of impeller airfoils that have been designed as a ruled surface.

- **Multi-Blade Hub Milling Cycles**
  For the semi finishing or finishing of hub surfaces for both blisk and impeller parts.

- **Multi-Blade Point Milling Cycles**
  For the semi finishing or finishing of arbitrary surfaces for both blisk and impeller airfoils.

- **Multi-Blade Edge Milling Cycles**
  For the semi finishing or finishing of the aerofoils leading and trailing edges.

- **Multi-Blade Fillet Milling Cycles**
  For the milling of special fillet radi at the intersection between the airfoils and hub surface.
**PSI+ Advanced Package**

Is an extension of the PSI+ Classic Package and contains advanced milling strategies for the more challenging Multi-Blade components.

**Multi-Blade Shrouded cycles for closed Impellers**

Special cycles designed for the roughing and finishing of the pockets on closed impellers.

**Multi-Blade Plunging Cycles**

Automated plunging routines for roughing the pockets for all «open» impellers and blisks.

**Multi-Blade Side Entry cycles for Blisks**

Special cycles designed for the roughing and finishing of the pockets using «side entry» strategies on blisks with larger airfoils size or an integral shroud.

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**PSI+ Part Measuring Package**

For measuring features on Multi-Blade components directly on the Starrag NB or STC machines using the specially developed 3D measuring cycles.

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**PSI+ Adaptive Machining Package**

Is designed for the adaptive milling of the intersection area on Linear Friction Welded blisks.
Starrag – Technology partner.

To have the overall most efficient production running, every factor must be taken into account. Starrag strives to be a technological partner for the blisks manufacturers. In close collaboration a continuous improvement in productivity can be achieved.

**Technology support**

Precision and efficiency in the production of blisks are dependent on the process expertise of the application engineer.

To continuously improve productivity, Starrag constantly is very active in the field of process development. Newly developed milling cycles and tools allow the process time to be significantly reduced. To be able to use the new machines to their full potential, the process is analyzed in great detail and the optimization potential is evaluated. Strategies, tools, cutting conditions and fixtures are constantly evaluated and improved by Starrag.

Starrag strives to work closely together with blisks manufacturers so that they can benefit from these innovations. Within such a partnership, Starrag can contribute in different fields:

- **Process development and optimization**: Based on the individual customer needs, the machining technology can be developed according to the latest state of the art
- **Process analysis**: In depth analysis can be made for challenging applications to come to optimal solutions, e.g. FEM analysis and tool geometry optimization, NC path analysis for blade geometry optimization
- **Fixture design**: Optimized fixtures can be provided that allow for highest cutting stability and lowest distortion, no matter if they are for blanks or forgings
- **Post processors**: State-of-the-art postprocessors making full use of all the capabilities and functionalities of the NB machines can be provided for the leading CAD systems
- **Machine upgrades**: Starrag wants customers to profit from the continuous progress made at Starrag for existing machines. Control and mechanical upgrades are on offer that allow existing NB machines to become more productive

With Starrag, continuous productivity improvement can be made even with existing machines. With such technological collaboration the competitiveness can be constantly increased. These customer-specific improvements are effective, target-oriented and cost transparent.
Virtual Machining
Virtual machining is a highly-developed simulation program for Starrag blade machining centers which enables users of PSI+ CAM software to simulate, check and optimize complex blade manufacturing processes in full on a computer screen.

Tools
Customers in the turbine and aviation sectors require milling tools of the highest quality. Modern machine tools and increasingly complex parts, made from materials that are difficult to machine, require tools with specific contours, corners, radii and micro geometries. Starrag provides special tools which are adept to these very tasks. These tools are tested intensively in our modern machine park (Center of Production Excellence) and undergo constant development. Starrag offers not only standard industry tools but also tools manufactured to customers’ individual specifications.

CPE Center of Production Excellence
In the CPE (Center of Production Excellence) new and demanding machining processes are tested and optimized and small and one-off series are produced. For this purpose, the most modern 4- and 5-axis machining centers are available for producing the complex work-pieces that the industry demands, ranging from the heavy-duty milling of titanium alloys to high-speed machining of light metals with an IT 5 finish quality.

Automation / FMS
For over 30 years Starrag has been acting as a main contractor designing and supplying linked FMS systems for the fully-automated manufacturing of complex parts across multiple machines. Other operations and follow-up processes such as washing, measuring, labeling, deburring or grinding can of course be integrated into the FMS system. The complete manufacturing process is planned, steered, monitored and documented by user-friendly central computer software with integrated PPC (production planning and control).

Each automation solution is customer-specific designed and delivered as a turn-key solution. To ensure the required reliability for fully-automated and unmanned production in an FMS, at the design and development stage of the machine, considerations are already made on the best methods to integrate the FMS including the various clamping solutions necessary. The modular buildup also allows a gradual expansion of the system.
The NB machine range.

Starrag has established an excellent reputation around the world as a technology partner to leading manufacturers in Blisk production.

NB machines are designed and built for optimum Blisk machining. All technical parameters, such as axis strokes, forces, torques and accelerations are set according to the application requirements. With its application-specific design, the NB series offers a number of unique advantages:

- Highest dynamics due to low masses of linear and rotary axes
- Shorter cycle times due to greatly reduced compensation movements (tilting around the tool center point)
- Efficient roughing with high material removal rates due to an axis concept without weak points (like e.g. quills)
- Ergonomic manual workpiece loading with a dedicated adapter solution (automated loading via FMS possible)
- Optimal chip flow into the chip conveyor

The NB series distinguishes itself through specific design features:

- All rotary and linear axes are backlash-free with high stiffness and damping to achieve the best finishing qualities.
- All vertical axes use counterbalances to provide the highest levels of dynamic contour accuracy.
- Intelligent Starrag motor spindles are specifically designed for Blisk manufacturing and are used throughout the entire series as well as on the LX series for turbine blade manufacturing.
- The design and build up of the NB machines is modular, allowing for utmost reliability whilst simultaneously enabling continuous system improvements.
- Critical components such as motor spindles and rotary axes are maintained by Starrag exchange pools, ensuring the shortest repair time in case of replacement since only an existing assembly must be replaced as a whole.

**Axis concepts**

The NB machine’s axis concepts have been optimized for manufacturing blisks in their respective sizes. For smaller blisks such as the ones produced on the NB 151, turning the workpiece around two axes is easier.

For larger blisks the NB 251 concept is ideal, since the second axis of rotation is on the spindle side. The smallest moving mass concept means that the highest dynamics can always be achieved in airfoil machining. Furthermore, the so-called compensation movements – the movements of the linear axes that are necessary to stay at the same position on the work-piece during movements of the rotary axes - are kept to a minimum.

The Starrag specific inclined B-axis (LX and NB Series) allows, for example, a movement of the B-axis where hardly any compensation movements are required in the X-direction.

The offset of the two rotary axes on the NB 151 in the Z-direction fulfils the same objective.
**Axis configuration diagram**

**Workpiece dimension**

<table>
<thead>
<tr>
<th>ø  = Swing Diameter</th>
<th>L  = Max. Workpiece length incl. Fixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø 600</td>
<td>L = 450</td>
</tr>
<tr>
<td>ø 780</td>
<td>L = 510</td>
</tr>
<tr>
<td>ø 1100</td>
<td>L = 810</td>
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</tbody>
</table>

**Machining of side-entry Blisks**

The NB series provides the optimum solution for so-called tip-entry Blisks. There the single airfoils are finished by spiral milling around the blades. The highest dynamic capability of the machine is key here. With very long blades, e. g. for fan stages designed as Blisks, this spiral milling is no longer applicable. The blades are then finished from upper and lower side (so-called side-entry).

For such parts, the excellent access to the part from top and bottom in one set-up and the high accuracy to guarantee for perfect blending between upper and lower milled parts on the airfoils must be given. For this side entry application, Starrag provides the optimum solution with its STC series.

**Machine intelligence**

The installation of intelligent systems can today significantly increase the productivity and the availability of machine tools. The NB machines are pioneers in this respect:

- Process analysis and evaluation is greatly simplified by integrated sensors.
- Critical parts of the program are automatically identified enabling systematic process optimization.
- Damages caused by collisions are significantly reduced thanks to rapid detection and machine shutdown. This is an excellent addition to Starrag’s simulation solutions.
- The imbalance of all tools and the state of the spindle bearings are automatically monitored.
- Any spindle displacements due to centrifugal forces or thermal drift are directly measured and compensated.
The right tools for getting parts right

Highest flexibility, benchmark quality – that is what Starrag cutting tools sets apart

Specific applications require specific tools. For any batch size, Starrag is an experienced and flexible partner to provide custom-made tools quickly and reliably.

With the specific applications in mind, carbide grades, specific contours, angles and radii are selected. For stable machining of instable workpieces, Starrag designs and provides part-specific tooling that significantly increases your productivity and lowers your cost per part.

Starrag works directly with the end-user to deliver the best tools for your parts, and you profit from the expert knowledge of our application engineers who deliver complete turnkey solutions for productivity breakthroughs.

In Starrag’s unique «Center of Production Excellence», we machine turbine and aero structure parts under benchmark conditions.

Customer-specific tool solutions.

Starrag designs and produces milling tools based on the requirements for your specific parts. Your components are machined using innovative solid carbide milling tools produced the highest quality for aluminum, steel, titanium, and nickel-based material applications.
Global reconditioning service
with oerlikon balzers.

Additionally to regrinding worn tools in its facility in Switzerland, Starrag has partnered up with the global leader for coatings – oerlikon balzers. Oerlikon balzers uses the original grinding processes from Starrag, applying the same coating as on the original tool.

With this partnership, you save on inventory and receive OEM grinding standards globally in short lead times.

We can offer professional reconditioning services in:
- Rorschacherberg, Switzerland
- Bursa, Turkey
- Querétaro, Mexico
- Wuhan, China
- Suzhou, China
- Pune, India
- Chennai, India
- Pyeongtaek, Korea
- Gunsan, Korea
- Busan, Korea
- Buenos Aires, Argentinia
- Ontario, Canada
- Maracineni, Romania

To find your local regrinding support center, please contact us.
Tools for Blisks/IBRs.

Chatter free airfoil machining.

Efficient and chatter free finishing of Blisks or IBRs is one of the most difficult tasks in machining.

For such challenging components, Starrag has developed special tools for point milling. The product range starts with taper ball nose cutters that provide good access to the part.

Starrag also developed special geometries like the torus and barrel cutter to reduce cutting pressure on the airfoil flank. To reduce workpiece regenerative excitation that leads to chatter, Starrag also delivers variable pitch cutters. With the help of in-house testing, such tools can be adjusted ideally to your specific part.

Taper ball nose cutters

<table>
<thead>
<tr>
<th>units</th>
<th>d₁</th>
<th>R</th>
<th>d₂</th>
<th>l₁</th>
<th>l₂,₃</th>
<th>angle</th>
<th>z</th>
</tr>
</thead>
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<tr>
<td>mm</td>
<td>4-20</td>
<td>2-10</td>
<td>6-32</td>
<td>50-330</td>
<td>var.</td>
<td>var.</td>
<td>2-6</td>
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<tr>
<td>inch</td>
<td>0.16-0.8</td>
<td>0.08-0.4</td>
<td>¼ - 1¼</td>
<td>2-13</td>
<td>var.</td>
<td>var.</td>
<td>2-6</td>
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</tbody>
</table>

Material: Solid carbide
Torus cutter

Note

Standard: coated, also available raw.
Other cutter dimensions and coatings are available on request.

Torus cutters

<table>
<thead>
<tr>
<th>units</th>
<th>(d_1)</th>
<th>(R)</th>
<th>(d_2)</th>
<th>(l_1)</th>
<th>(l_{2,3})</th>
<th>angle</th>
<th>(z)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>4 - 20</td>
<td>var.</td>
<td>6 - 32</td>
<td>50 - 330</td>
<td>var.</td>
<td>var.</td>
<td>4 - 14</td>
</tr>
<tr>
<td>inch</td>
<td>0.16 - 0.8</td>
<td>var.</td>
<td>(\frac{1}{4}) - (\frac{1}{4})</td>
<td>2 - 13</td>
<td>var.</td>
<td>var.</td>
<td>4 - 14</td>
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</table>

Material: Solid carbide
Service: Expertise and Availability.

Machines from the Starrag Group are known for their extremely high levels of productivity and precision. In order for a customer to achieve a rapid return on investment, a high level of availability and working in three-shift operation must be assured at all production sites.

A further factor for reliably high availability numbers is preventative maintenance tailored to the operating conditions and production requirements. With the aid of condition monitoring along with planned component inspections, consistently high availability rates are achieved, and unplanned downtime is reduced to a minimum.

Retrofits and upgrades ensure that machines are brought fully up to date regarding technology, and are adapted to meet new requirements. This safeguards the machine’s value and extends its life cycle.

With these service products Starrag can guarantee machine availabilities. Starrag is fully transparent so that the total cost of ownership (full like cycle cost) can be calculated in detail.

Key benefits:
- Planning reliability due to guaranteed uptimes
- Optimized life cycle costs
- Sustained machine value

With its 300 employees, the Starrag Group’s global service network is specifically set up to meet these requirements. The range of services offered covers everything from the supply of spare parts, a repair service, to guaranteed availability and optimized life cycle costs. Together with the customer, our service experts draw up individually tailored service solutions, and offer advice as they are implemented.

Every incident is dealt quickly with the 24/7 hotline support, remote diagnostic tools, a local network of technicians close to the customer, and a global spare parts supply service through regional hubs.

Qualified operating and maintenance staff are important key factors in maintaining a high level of plant availability. This is why the Starrag Group offers comprehensive training programmes in the relevant language, both at its training centers at its own plants, and at the customer’s own site.
On-site around the world

Europe
Benelux / Denmark / Germany / Finland
France / United Kingdom / Italy / Austria
Poland / Russia / Sweden / Switzerland
Slovakia / Spain / Czech Republic / Belarus

Middle East
Israel / Turkey

Americas
USA / Canada / Mexico / Brazil

Asia
China / India / Indonesia / Japan / Korea
Malaysia / Singapore / Thailand / Taiwan

Oceania
Australia / New Zealand

Africa
Egypt / South Africa

Logistics Center
Service Center
Service technicians
## Technical Data.

<table>
<thead>
<tr>
<th></th>
<th>NB 151</th>
<th>NB 251</th>
<th>NB 351</th>
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<tbody>
<tr>
<td><strong>Working Range</strong></td>
<td></td>
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</tr>
<tr>
<td>Number of Spindles</td>
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</tr>
<tr>
<td>Speed rpm</td>
<td>18,000</td>
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<td>18,000</td>
</tr>
<tr>
<td>Tool Taper</td>
<td>HSK-A63 (A80)</td>
<td>HSK-A63 (A80)</td>
<td>HSK-A63 (A80)</td>
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<tr>
<td><strong>Tool Deposit / Chain Magazine</strong></td>
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</tr>
<tr>
<td>Max. Tool Weight kg</td>
<td>10</td>
<td>6.5</td>
<td>6.5</td>
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<tr>
<td>Max. Tool Diameter mm</td>
<td>160</td>
<td>250</td>
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<tr>
<td>Max. Tool Length mm</td>
<td>300</td>
<td>300</td>
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</tr>
<tr>
<td>Standard / Max. number of Tools</td>
<td>80 / 320</td>
<td>60 / 80</td>
<td>60 / 80</td>
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<tr>
<td>Tool Chance Time Double Gripper sec</td>
<td>4.5</td>
<td>8</td>
<td>8</td>
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<tr>
<td><strong>Dimensions and Weight</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Weight kg</td>
<td>13,000</td>
<td>12,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Lenght x Width x Height mm</td>
<td>5,200 x 3,100 x 3,110</td>
<td>5,000 x 3,260 x 3,200</td>
<td>5,500 x 4,000 x 3,800</td>
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<tr>
<td>Safety Concept</td>
<td>CE-compliant</td>
<td>CE-compliant</td>
<td>CE-compliant</td>
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<tr>
<td>CNC-Control</td>
<td>Siemens 840D</td>
<td>Siemens 840D</td>
<td>Siemens 840D</td>
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