

The world's first ready heat-treated tool steel. Ready hardened to approximately 45 HRC.

Hardened tool steel, originally developed for plastic molds, is excellent for polishing and photoetching. Due to its extraordinary toughness, excellent temperature resistance, and minimal distortion, Toolox® 44 is now widely used for metal die-casting molds, bending and forming tools, tough machine blades, high-strength machine parts, wear-resistant slide guides, wear plates, fixtures, and precision components. The remarkable damping properties recommend Toolox® 44 round material, especially for vibration-critical machine spindles.

Surprisingly, Toolox® 44 is easy to machine, while remaining remarkably dimensionally stable. New manufacturing concepts are possible because heat treatment and subsequent adjustments are eliminated with this ready-hardened material. You save time, reduce technical effort, gain safety, and extend the lifespan of your components.

Nitriding treatment or PVD coating is easily possible, and further heat treatment is unnecessary and not recommended.

As an "Approved Dealer," Gebr. Recknagel is the authorized distribution partner for the Swedish manufacturer SSAB in Germany.

Color coding:
Red (Toolox® 44)



| | |
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Toolox 44

TOOLOX® 44

PräziPlan® - Precision flat steel (according to DIN 59350)

Execution:
hardened to 410–475 HB (41–47 HRC), thickness ground with Ra = 6 µm, width finely machined, decarburization-free machining on all sides.

Tolerances:
width: +0.2 / -0 mm
thickness: +0.2 / -0 mm
length: +40.0 / -0 mm

Toolox 44

| | | length: 1,000 mm | | | | | | | | | | | | price per piece | | | | |
|------------|-------|------------------|-----|-----|-----|------|------|------|------|------|------|------|------|-----------------|--|--|--|--|
| | | thickness [mm] | | | | | | | | | | | | | | | | |
| | | 4.2 | 5.2 | 6.2 | 8.2 | 10.4 | 12.4 | 15.4 | 20.4 | 25.4 | 30.4 | 40.4 | 50.4 | 60.4 | | | | |
| width [mm] | 20.3 | 46 | 55 | 55 | 58 | 62 | 66 | 73 | 81 | 92 | 106 | 126 | | | | | | |
| | 25.3 | 48 | 56 | 56 | 58 | 62 | 66 | 73 | 81 | 92 | 106 | 126 | | | | | | |
| | 30.3 | 50 | 59 | 59 | 62 | 66 | 73 | 78 | 84 | 92 | 106 | 126 | 164 | | | | | |
| | 40.3 | 60 | 66 | 66 | 73 | 81 | 84 | 92 | 106 | 126 | 137 | 164 | 178 | | | | | |
| | 50.3 | 78 | 86 | 92 | 100 | 102 | 119 | 139 | 150 | 158 | 169 | 178 | | | | | | |
| | 60.3 | 88 | 99 | 106 | 116 | 121 | 130 | 150 | 158 | 164 | 171 | 194 | 228 | | | | | |
| | 70.3 | 96 | 108 | 110 | 125 | 126 | 136 | 158 | 164 | 167 | 173 | 217 | 236 | 256 | | | | |
| | 80.3 | 102 | 117 | 121 | 144 | 146 | 153 | 164 | 169 | 174 | 178 | 218 | 241 | 270 | | | | |
| | 100.3 | 106 | 139 | 144 | 154 | 158 | 165 | 173 | 187 | 207 | 225 | 256 | 292 | 332 | | | | |
| | 120.3 | | | | | | | 208 | 218 | 228 | 244 | 297 | 330 | | | | | |
| | 150.3 | | | | 187 | 193 | 211 | 236 | 264 | 279 | 309 | 350 | 370 | 418 | | | | |
| | 200.3 | | | | 272 | 278 | 286 | 309 | 321 | 321 | 384 | 454 | 489 | 598 | | | | |
| | 250.3 | | | | 307 | 313 | 363 | 400 | 412 | 412 | 454 | 537 | 583 | | | | | |
| 300.3 | | | | 337 | 344 | 374 | 430 | 473 | 473 | 504 | 581 | 657 | | | | | | |
| 400.3 | | | | | | | 492 | 509 | 509 | 613 | 711 | 854 | | | | | | |
| 500.3 | | | | 454 | 472 | 527 | 544 | 583 | 583 | 709 | 825 | 969 | | | | | | |

| | | square, length: 1,000 mm | | | | | | | | price per piece | | |
|--|--|--------------------------|------|------|------|------|------|------|------|-----------------|--|--|
| | | 10.4 | 12.4 | 15.4 | 20.4 | 25.4 | 30.4 | 40.4 | 50.4 | 60.4 | | |
| | | 83 | 86 | 88 | 88 | 114 | 146 | 174 | 188 | 255 | | |

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EcoPlan® 150 / 400 / 800 - Precision flat steel
(according to DIN 59350) in favorable short lengths

Execution:

Hardened to 410–475 HB (41–47 HRC),

Thickness ground with Ra = 6 µm, Width finely machined, Decarburization-free machining on all sides.

Tolerances:

width: +0.2 / -0 mm

thickness: +0.2 / -0 mm

length: +0.4 / -0 mm

length: 400.3 mm

price per piece

| 400 | | thickness [mm] | | | | | | | | | | | | |
|------------|-------|----------------|------|------|------|------|------|------|------|------|------|------|-------|--|
| | | 8.4 | 10.4 | 12.4 | 15.4 | 20.4 | 25.4 | 30.4 | 40.4 | 50.4 | 60.4 | 80.4 | 100.4 | |
| width [mm] | 20.3 | 24 | 26 | 28 | 29 | 40 | | | | | | | | |
| | 25.3 | 26 | 28 | 29 | 32 | 44 | 51 | | | | | | | |
| | 30.3 | 28 | 29 | 32 | 34 | 48 | 57 | 65 | | | | | | |
| | 40.3 | 32 | 37 | 38 | 41 | 55 | 61 | 72 | 72 | | | | | |
| | 50.3 | 45 | 46 | 53 | 56 | 60 | 65 | 76 | 80 | 84 | | | | |
| | 60.3 | 52 | 55 | 58 | 60 | 64 | 69 | 76 | 87 | 100 | 113 | | | |
| | 80.3 | 63 | 63 | 64 | 66 | 72 | 78 | 80 | 98 | 109 | 121 | 166 | | |
| | 100.3 | 69 | 69 | 70 | 72 | 82 | 93 | 101 | 115 | 131 | 149 | 197 | 232 | |
| | 120.3 | 74 | 75 | 76 | 80 | 92 | 102 | 110 | 134 | 148 | 187 | 227 | 269 | |
| | 150.3 | 82 | 82 | 85 | 92 | 105 | 122 | 138 | 157 | 167 | 188 | 274 | 325 | |
| | 200.3 | 98 | 98 | 103 | 111 | 130 | 144 | 172 | 204 | 220 | 269 | 350 | 417 | |
| | 250.3 | 115 | 115 | 121 | 130 | 153 | 181 | 204 | 241 | 262 | 345 | 428 | 510 | |
| | 300.3 | 132 | 132 | 138 | 150 | 178 | 209 | 226 | 261 | 295 | 406 | 505 | 604 | |
| | 400.3 | 165 | 165 | 174 | 189 | 225 | 229 | 276 | 320 | 384 | 528 | 659 | 789 | |



length: 150.3 mm

price per piece

| 150 | | thickness [mm] | | | | | | | | | | | | |
|------------|-------|----------------|------|------|------|------|------|------|------|------|--|--|--|--|
| | | 8.4 | 10.4 | 12.4 | 15.4 | 20.4 | 25.4 | 30.4 | 40.4 | 50.4 | | | | |
| width [mm] | 20.3 | 13 | 14 | 15 | 16 | 22 | | | | | | | | |
| | 25.3 | 14 | 15 | 16 | 19 | 25 | 28 | | | | | | | |
| | 30.3 | 15 | 16 | 19 | 20 | 27 | 31 | 37 | | | | | | |
| | 40.3 | 19 | 21 | 21 | 23 | 30 | 34 | 41 | 44 | | | | | |
| | 50.3 | 25 | 26 | 30 | 34 | 38 | 40 | 42 | 44 | 47 | | | | |
| | 60.3 | 29 | 30 | 32 | 38 | 40 | 41 | 42 | 48 | 57 | | | | |
| | 80.3 | 35 | 37 | 39 | 41 | 42 | 44 | 44 | 55 | 60 | | | | |
| | 100.3 | 39 | 40 | 41 | 43 | 47 | 51 | 57 | 64 | 73 | | | | |
| | 120.3 | 43 | 44 | 45 | 52 | 55 | 57 | 61 | 73 | 81 | | | | |
| | 150.3 | 47 | 48 | 52 | 59 | 63 | 67 | 77 | 84 | 93 | | | | |

length: 800.3 mm

price per piece

| 800 | | thickness [mm] | | | | | | | | | | | | |
|------------|-------|----------------|------|------|------|------|------|------|------|------|------|------|-------|--|
| | | 8.4 | 10.4 | 12.4 | 15.4 | 20.4 | 25.4 | 30.4 | 40.4 | 50.4 | 60.4 | 80.4 | 100.4 | |
| width [mm] | 80.3 | 92 | 92 | 95 | 112 | 126 | 139 | 141 | 174 | 192 | 216 | 288 | | |
| | 100.3 | 100 | 100 | 104 | 123 | 140 | 161 | 180 | 204 | 234 | 265 | 339 | 399 | |
| | 120.3 | 110 | 110 | 114 | 136 | 155 | 179 | 196 | 238 | 263 | 320 | 391 | 461 | |
| | 150.3 | 122 | 122 | 128 | 154 | 179 | 207 | 243 | 280 | 296 | 346 | 468 | 555 | |
| | 200.3 | 145 | 145 | 152 | 184 | 216 | 253 | 300 | 355 | 391 | 479 | 596 | 711 | |
| | 250.3 | 167 | 167 | 175 | 214 | 253 | 299 | 356 | 426 | 467 | 583 | 724 | 867 | |
| | 300.3 | 189 | 189 | 200 | 243 | 291 | 346 | 403 | 465 | 525 | 685 | 854 | 1022 | |
| | 400.3 | 233 | 233 | 247 | 303 | 366 | 408 | 490 | 569 | 683 | 888 | 1110 | 1335 | |
| | 500.3 | 277 | 277 | 299 | 363 | 440 | 486 | 567 | 687 | 804 | 1090 | 1368 | 1647 | |
| | 600.3 | 322 | 322 | 352 | 422 | 516 | 625 | 752 | 922 | 1095 | 1293 | 1625 | 1959 | |

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VarioPlan®

Finely milled semi-finished products in freely selectable dimensions.

- Flexible in width, thickness, and length
- Edges sawn or milled
- Optionally with chamfers and/or corner radii
- Production in 2 to 3 days
- Easy calculation



Use our online calculation tool on the WebShop: www.varioplan.de

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VarioRond®

Round stock sections with freely selectable length at unit price

Execution and tolerances:

| | |
|-----------------|-------------|
| length, sawn | +3.0 / -0mm |
| diameter: | |
| 16–121mm | +3.0 / -0mm |
| 126–162mm | +4.0 / -0mm |
| 172–202mm | +5.0 / -0mm |
| >202mm | +8.0 / -0mm |
| diameter range: | 16–353mm |

Flexible Online Calculation:

www.variorond.de

- Desired length is freely selectable.
- Unit prices for your desired length.
- Sawing costs included.
- No additional surcharges.

VarioRond Rundmaterial Toolox 44

Toleranzen
Durchmesser: +3/0 mm
Länge: +3/0 mm

Kalkulation (Länge frei wählbar / Preise stückzahlabhängig)

Ihr gewählter VarioRond
Durchmesser: 56,00 mm x Länge: 264,00 mm

55,30 €/Stück

Anzahl: 1

Durchmesser: 56 mm x Länge: 264 mm x Anzahl: 1

| Länge [mm] | Durchmesser [mm] | | | | | | | | | | | | | | |
|------------|------------------|---------|---------|---------|---------|---------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | 16 | 21 | 28 | 31 | 36 | 41 | 46 | 51 | 56 | 61 | 66 | 71 | 81 | 91 | 101 |
| 1.002,0 | 25,00 € | 34,10 € | 46,80 € | 61,80 € | 76,20 € | 97,10 € | 119,80 € | 144,70 € | 170,20 € | 198,80 € | 229,30 € | 269,20 € | 292,30 € | 341,00 € | 422,10 € |

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TOOLOX® 44

Raw material

Plates or forged parts and cuttings therefrom, hardened to 410 - 475 HB (41 - 47 HRC), plate surface shot-blasted and primed.

| | thickness [mm] | | | | | | | | | | | | | | |
|--|----------------|----|-----|------|------|-----|------|-----|-----|------|------|----|------|----|----|
| | 6 | 8 | 9.2 | 10 | 11.6 | 12 | 13.6 | 14 | 16 | 16.7 | 17.6 | 18 | 20 | 22 | 25 |
| | 27 | 28 | 30 | 32.5 | 35 | 40 | 43 | 45 | 50 | 53.5 | 55 | 60 | 63.5 | 65 | |
| | 70 | 74 | 80 | 84 | 90 | 100 | 104 | 110 | 120 | 125 | 130 | | | | |

Select affordable raw materials online, including as cut-to-size.

www.ResteShop.de

Fast, clear, and transparent:

Offcut Shop and Quick Finder at www.stahlnetz.de

Offcut Shop

- All materials
- With cutting service
- Available from stock
- Special discounted prices for remnants
- While supplies last

Quick finder

- All products in comparison
- Your special parts fully calculated
- Easy selection of the optimal solution

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Toolox 44

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Material specification sheet

Toolox® 44 is a hardened and tempered tool steel designed to have minimal residual stresses. As a result, this material exhibits excellent dimensional stability during machining. Despite having a hardness of 45 HRC, Toolox® 44 offers good machinability.

This tool steel is specifically intended for plastic molds and is exceptionally well-suited for polishing and achieving a smooth surface finish.

It can also be used in other applications, including sheet metal forming tools, wear parts, structural components, and machine spindles.

Toolox 44

- hardness**_(guaranteed value) HBW 410–475 (corresponds to 41–47 HRC)
- Impact toughness**_(guaranteed value) testing temperature 20°C impact toughness Charpy-V in traverse direction ≤ 130mm mind. 18 J
- tensile strength**_(equivalent value) tensile strength approx. 1450 MPa
- ultrasonic testing**_(guaranteed value) In accordance with EN 10160 (plates) or EN 10228-3 (forgings) and additional requirements per SSAB V6.
- etching properties**_(warranty obligation) Toolox® 44 meets the requirements as per NADCA 207-2006.
- dimensions** Toolox® 44 is supplied in plate thicknesses ranging from 6 to 130mm.
- delivery condition** It is hardened and tempered at a minimum of 590°C..
- heat treatment** Nitriding or coating is possible at temperatures below 590°C. Toolox® 44 is not intended for further heat treatment. If this material is subjected to further heat treatment above 590°C, the properties are no longer guaranteed.
- testing** Testing in accordance with EN 10025 and EN ISO 6506-1. Hardness tested on a machined surface 0.5 - 2mm below the plate surface.
- tolerances** For plates: According to SSAB's standard for tool steels. For forgings: According to DIN 7527. For round steel: EN 10060.
- welding** Please refer to page 73 for additional information..
- products** Precision flat steel (standard and special dimensions), EcoPlan®, VarioPlan®, VarioRond®, and raw material cuttings. Machine parts and guide rails manufactured to your specifications and drawings.

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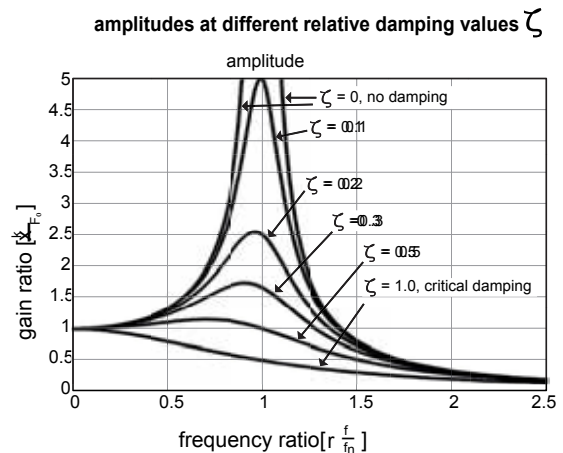
TOOLOX® 44

damping characteristics

Toolox® 44 was early on successfully used in Sweden as a base material for high-quality cutting tools such as WP drills, milling cutters, and grooving tools. In doing so, it demonstrated smooth operation and extended tool life, especially when compared to traditional materials. Several scientific studies, including those conducted at the Royal Institute of Technology in Stockholm and by Dr. Svenningsson, attribute these benefits to the excellent damping properties of the material.

The outstanding damping characteristics of Toolox® have led to an increased critical depth of cut for Toolox® milling tools compared to conventional tools, enabling the use of slimmer and more overhanging tools. These properties make Toolox® 44 round material a suitable choice for shafts, spindles, and other machine components where external excitations influence the process and vibrations need to be minimized.

The faster attenuation of amplitudes due to higher damping significantly enhances the durability of the component, reducing material fatigue. Over a wide frequency range from 65Hz to 4,000Hz, damping is notably effective and increases with the excitation frequency. The damping factor ranges from 1.2% at 120Hz to 2.2% at 4,000Hz, significantly surpassing that of other steels and even approaching the level of cast iron in certain cases. While ongoing studies have not yet concluded, they effectively explain and confirm the observed advantages in practical use. Feel free to contact us; we are more than willing to support you in optimizing your components.



Toolox 44

| Amplitude | |
|-------------------------------------|-------------------------|
| material | damping ratio ζ % |
| GG [cast iron] | ≈ 2.1 – 2.3 |
| Toolox 44 | 1.9 |
| Toolox 33 | 1.0 |
| S355 [St52] | 0.8 |
| high strength steels (heat treated) | ≈ 0.1 – 0.3 |

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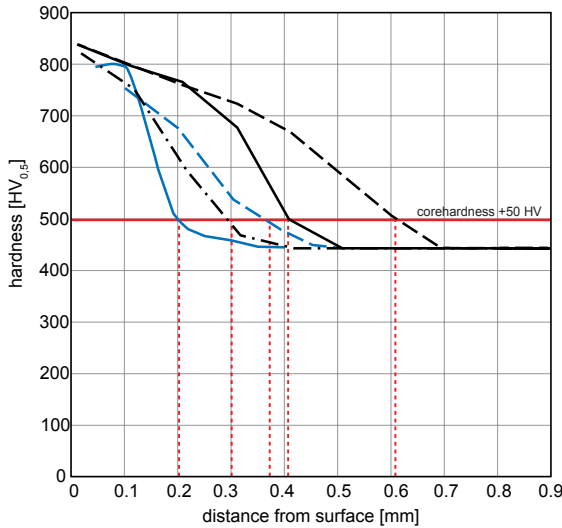
TOOLOX® 44

metallurgical information

Hardness profile

Determination of nitriding depth NHD according to DIN 50190-3 at core hardness +50 HV

Note: The high core hardness of approximately 450 HV can lead to an underestimation of the effective nitriding depth compared to low-tempered materials.



- Gas nitriding in an ammonia gas atmosphere, 36 hours, 510°C: NHD = 0.40mm
- - - Gas nitriding in an ammonia gas atmosphere, 84 hours, 510°C: NHD = 0.60mm
- · - Gas-nitro-carburizing, 5 hours, 580°C: NHD = 0.30mm
- Plasma nitriding, short time: NHD = 0.23mm, VS = 7µm
- Plasma nitriding, long time: NHD = 0.38mm, VS = 7µm

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chemical composition analysis [%]

| | C | Si | Mn | P | S | Cr | Mo | V | Ni |
|------|------|-----|-----|------|-------|------|-----|------|-----|
| max. | 0.32 | 1.1 | 0.8 | 0.01 | 0.003 | 1.35 | 0.8 | 0.14 | 1.0 |
| min. | | 0.6 | | | | | | | |

inclusion content (typical values)

| | |
|--|---------------|
| inclusion rating (equivalent diameter) area fraction | 6µm 0,015% |
| length-to-width ratio | 1.2 |

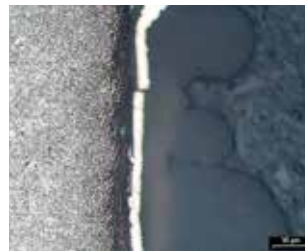
physical properties (typical values)

thermal expansion coefficient [$10^{-6}/K$]
at +20–200°C: 13.5

thermal conductivity

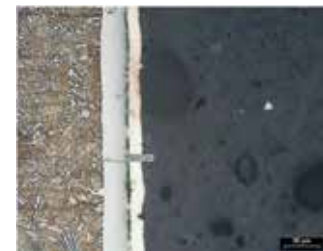
| | |
|--------|-----------|
| | 34.0 W/mK |
| +200°C | 32.0 W/mK |
| +400°C | 31.0 W/mK |
| +600°C | 21.0 W/mK |

short time



diffusion zone,
no binding layer

long time



diffusion zone,
binding layer 34 µm

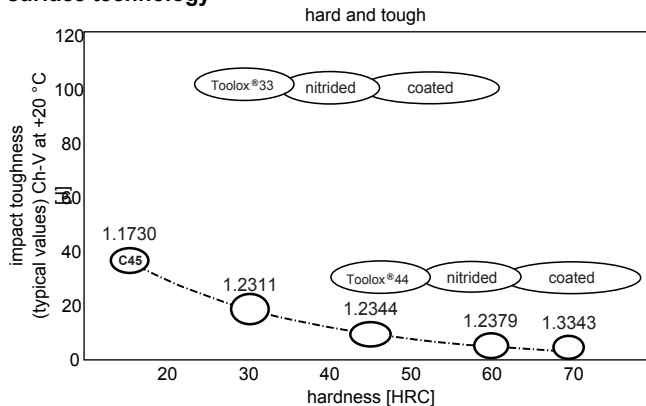
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Toolox 44

TOOLOX® 44

surface technology



mechanical properties (typical values*)

| | guaranteed hardness [HBW] | hardness typical [HRC]* | guaranteed impact toughness Min [J] | typical impact toughness [J]* | typical yield strength $R_{p0.2}$ [MPa]* | typical tensile strength R_m [MPa]* | typical elongation at break A_5 [%]* | typical compression yield strength MPa* | compression yield strength after 170 hours of dwell time MPa* | thickness [mm] |
|--------|---------------------------|-------------------------|-------------------------------------|-------------------------------|--|---------------------------------------|--|---|---|----------------|
| -40°C | | | | 14 | | | | | | 6–130 |
| -20°C | | | | 19 | | | | | | |
| +20°C | 410–475 | 45 | 18 | 30 | 1300 | 1450 | 13 | 1250 | | |
| +200°C | | | | 60 | 1200 | 1380 | 10 | 1120 | | |
| +300°C | | | | 80 | | | | 1120 | | |
| +400°C | | | | 80 | | | | 1060 | 1060 | |
| +500°C | | | | | | | | 930 | 910 | |

Toolox® is tested for hardness and impact toughness at room temperature.

All other provided values are from supplementary tests and are for informational purposes only, and they are not guaranteed.

* Reference values for information purposes only

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Toolox 44

Hardness comparison table for Toolox® and Hardox®

| | | | | | | | | | | | | | | | | | |
|-------------------------|-----|------|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|
| tensile strength MPa | 715 | 790 | 820 | 861 | 935 | 995 | 1011 | 1090 | 1169 | 1245 | 1328 | 1412 | 1494 | 1580 | 1758 | 1940 | 2130 |
| Vickers hardness HV | 205 | 233 | 243 | 261 | 289 | 311 | 317 | 345 | 373 | 401 | 429 | 458 | 485 | 514 | 569 | 627 | 682 |
| Brinell hardness HBW | 225 | 250 | 260 | 275 | 300 | 320 | 325 | 350 | 375 | 400 | 425 | 450 | 475 | 500 | 550 | 600 | 650 |
| Rockwell HRC | 19 | 22.5 | 24 | 26 | 29 | 32 | 32.5 | 35.5 | 38 | 40 | 42.5 | 44.5 | 46.5 | 49 | 52.5 | 55 | 57.5 |

Toolox
44

TOOLOX® 33 / TOOLOX® 44

machining of Toolox®

All major tool manufacturers are now well-prepared for machining Toolox®. It is advisable to seek advice on suitable tools and cutting parameters. These recommendations should be strictly followed to achieve optimal results and productive performance. It is essential to avoid reducing the feed rate out of misplaced caution. Good chip formation leads to success, and Toolox® rewards you with extended tool life and faster machining.

Toolox
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Toolox
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Drilling

Drilling with HSS tools is reserved for less stable machines and low production quantities. HSS-Co tools with the cutting parameters provided below have proven to be effective. Ensure a continuous machine feed and use sharp tools. A pointed cross-edge would be advantageous to ensure optimal chip formation.

Drilling with solid carbide (VHM) tools is productive and efficient. It is recommended to use internal coolant supply with a higher concentration. Ensure that you drill with a continuous feed rate (not lower than the manufacturer's recommendation).

| | Toolox® 33 | Toolox® 44 |
|--------------------------|---|-------------------|
| cutting speed: v [m/min] | ~ 15 | ~ 7 |
| diameter [mm] | feed: f [mm/U] / rotational speed [1/min] | |
| 5 | 0.10/950 | 0.05/445 |
| 10 | 0.10/475 | 0.09/220 |
| 15 | 0.16/325 | 0.15/150 |
| 20 | 0.23/235 | 0.20/110 |
| 25 | 0.30/195 | 0.25/90 |
| 30 | 0.35/165 | 0.30/75 |
| *35 | 0.40/136 | 0.35/63 |
| *40 | 0.45/119 | 0.40/55 |

| | Toolox® 33 | | Toolox® 44 | |
|--------------------------|-------------------|-------------|-------------------|-------------|
| cutting speed: v [m/min] | 65–90 | | 40–65 | |
| diameter [mm] | feed [mm/U] | | | |
| | min.–max. | start value | min.–max. | start value |
| 3.0–5.0 | 0.08–0.15 | 0.10 | 0.06–0.11 | 0.07 |
| 5.01–10.0 | 0.09–0.16 | 0.12 | 0.08–0.13 | 0.10 |
| 10.01–15.0 | 0.16–0.22 | 0.18 | 0.12–0.18 | 0.15 |
| 15.01–20.0 | 0.22–0.28 | 0.25 | 0.16–0.20 | 0.18 |

Solid carbide exchangeable inserts or brazed tips are used for medium diameters. Refer to the table for cutting parameters.

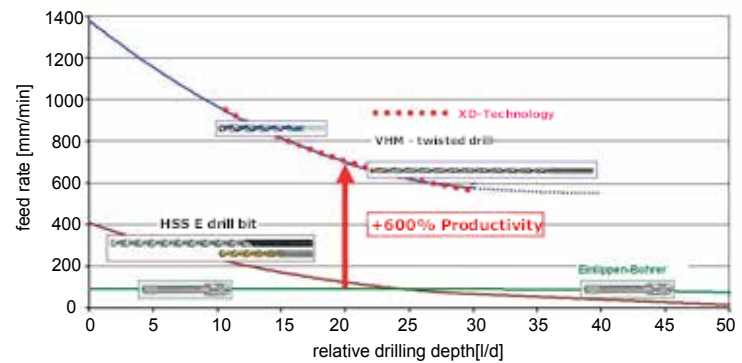
| | Toolox® 33 | | Toolox® 44 | |
|--------------------------|-------------|-------------|------------|-------------|
| cutting speed: v [m/min] | 50–80 | | 40–60 | |
| diameter [mm] | feed [mm/U] | | | |
| | min.–max. | start value | min.–max. | start value |
| 7.5–12.0 | 0.10–0.16 | 0.13 | 0.08–0.14 | 0.11 |
| 12.01–20.0 | 0.15–0.23 | 0.20 | 0.12–0.20 | 0.15 |
| 20.01–25.0 | 0.18–0.27 | 0.22 | 0.14–0.22 | 0.17 |
| 25.01–30.0 | 0.20–0.30 | 0.24 | 0.16–0.25 | 0.19 |

Überlange Bohrungen bis zu über 50 x D können auch auf Bearbeitungszentren mit IKZ sehr produktiv hergestellt werden, wenn man VHM-Bohrer mit spezieller Geometrie verwendet. Typische Schnittwerte zeigt die nachstehende Tabelle.



| material | hardness | diameter d [mm] | depht l [mm] | rel. depht l/d | cutting parameters | | | cooling emulsion |
|------------|----------|--------------------|-----------------|-------------------|--------------------|--------|-------------|---------------------|
| | | | | | vc [m/min] | f [mm] | vf [mm/min] | |
| Toolox® 33 | 300 HB | 5 | 10 | 20 | 50 | 0.15 | 477 | IK, p=20bar |
| Toolox® 44 | 45 HRc | 5 | 100 | 20 | 36 | 0.15 | 344 | IK, p=20bar |

Factory specifications Titex



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Deep drilling in Toolox® presents a special challenge that the renowned manufacturer Botek successfully addresses and economically solves with a unique cutting geometry. The single-lip full drill tools, Type 110, with special geometry for diameters up to 12.0mm, as well as the single-lip deep drilling tools, Type 01, with interchangeable cutting inserts and guide bars in a special configuration starting from a diameter of 12.0mm, have proven to be excellent solutions.

| Toolox® 33 | drill-Ø | 3 | 4 | 5 | 6 | 7-8 | 9-10 | 11-12 | >12 | factory specs. Botek |
|------------------------------|-----------------------|--------|-------|--------|--------|------|-------|-------|-------|----------------------|
| | cutting speed [m/min] | | 50 | 50 | 50 | 50 | 40-50 | 40-50 | 40-50 | |
| feed [mm/U] | | 0.005 | 0.01 | 0.015 | 0.0175 | 0.02 | 0.03 | 0.04 | 0.1 | |
| coolant pressure [bar] | | 100 | 100 | 100 | 90 | 80 | 70 | 60 | 40 | |
| pilot drilling distance [mm] | | 40 | 40 | 50 | 60 | 60 | 70 | 70 | 70 | |
| pilot drilling feed [mm/U] | | 0.0025 | 0.005 | 0.0075 | 0.009 | 0.01 | 0.015 | 0.02 | 0.05 | |

Attainable tool life with oil: approximately 10 – 12 meters under optimal process conditions.

For further information, please contact Botek (www.botek.de) and feel free to refer to us.

| Toolox® 44 | drill-Ø | 3 | 4 | 5 | 6 | 7 | 8 | 9-10 | 11-12 | >12 | factory specs. Botek |
|------------------------------|-----------------------|--------|-------|-------|--------|--------|--------|-------|-------|-------|----------------------|
| | cutting speed [m/min] | | 50 | 50 | 50 | 50 | 40-50 | 40-50 | 40-50 | 40-50 | |
| feed [mm/U] | | 0.005 | 0.01 | 0.012 | 0.015 | 0.015 | 0.0175 | 0.02 | 0.03 | 0.07 | |
| coolant pressure [bar] | | 100 | 100 | 100 | 90 | 80 | 70 | 60 | 40 | 40 | |
| pilot drilling distance [mm] | | 40 | 40 | 50 | 50 | 60 | 60 | 70 | 70 | 70 | |
| pilot drilling feed [mm/U] | | 0.0025 | 0.005 | 0.006 | 0.0075 | 0.0075 | 0.009 | 0.01 | 0.015 | 0.035 | |

Attainable tool life with oil: approximately 2 – 3 meters under optimal process conditions.

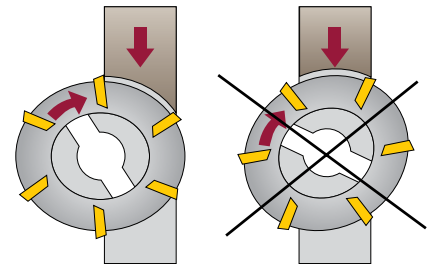
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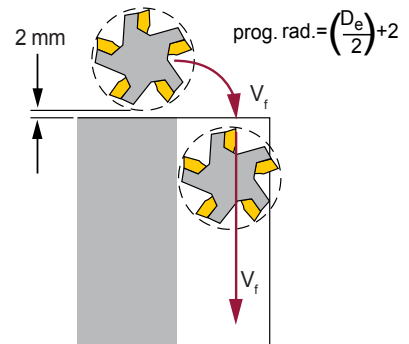


Milling

Toolox® is exceptionally resistant to deformation due to extremely low residual stresses when machined with optimal parameters and when unnecessary heat is not introduced into the workpiece. Prolonged tool life is achieved through smart milling strategies, stable workpiece fixation, and maintaining adequate chip thickness. Toolox® possesses a unique microstructure that facilitates machining despite its high hardness. Carbides are very hard and wear-resistant structural components. Their microscopically fine, spherical shape in the Toolox® microstructure prevents the typical edge damage found in other tool steels. Maintaining a sufficient tooth feed ensures the removal of carbides along with the chips, while insufficient feed would lead to excessive abrasive wear on the cutting edge. Sharp cutting edges with a positive geometry are ideal for Toolox®. Choose tools designed for processing high-alloyed steels. Tools for hard machining (up to 60 HRC) are unsuitable, as their cutting edges often have negative rake angles.



The introduction to the cutting process using the "roll-in" method.



Entry via the "roll-in" method Wear after 800 machining passes.



Straight entry into the workpiece Wear after 390 machining passes.



Face Milling

Interrupted cuts are milled more effectively using round inserts. Particularly high productivity is achieved with HPC (High-Performance Cutting) tools. Corner radius cutters are also suitable for Toolox®.

Recommendation for 45° milling cutters

| cutting speed: v [m/min] | Toolox® 33 | | Toolox® 44 | |
|--------------------------------|------------|-------------|------------|-------------|
| | min.–max. | start value | min.–max. | start value |
| 180–220 | | | | |
| feed: f _z [mm/Zahn] | min.–max. | start value | min.–max. | start value |
| Insert grade P30 | 0.15–0.35 | 0.25 | 0.15–0.35 | 0.25 |

Recommendation for face milling cutters with round inserts.

| cutting speed: v [m/min] | Toolox® 33 | | Toolox® 44 | |
|--------------------------------|------------|-------------|------------|-------------|
| | min.–max. | start value | min.–max. | start value |
| 180–220 | | | | |
| feed: f _z [mm/Zahn] | min.–max. | start value | min.–max. | start value |
| Insert grade P30 | 0.10–0.25 | 0.15 | 0.10–0.25 | 0.15 |

Recommendation for end mills / corner radius cutters.

| cutting speed: v [m/min] | Toolox® 33 | | Toolox® 44 | |
|--------------------------------|------------|-------------|------------|-------------|
| | min.–max. | start value | min.–max. | start value |
| 180–220 | | | | |
| feed: f _z [mm/Zahn] | min.–max. | start value | min.–max. | start value |
| Insert grade P30 | 0.12–0.25 | 0.17 | 0.12–0.25 | 0.17 |

Cutting values for HPC (High-Performance Cutting) copy and face milling cutters.

| material group | material designation | Festigkeit N/mm ² | copy milling | | | | | | Plunge/circular milling. | | | | | | | | | |
|----------------|-----------------------------|------------------------------|-----------------------------|------------|-----|-----------------------------|------------|-----|-----------------------------|------------|------|-----------------------------|------------|-----|------|----|----|-----|
| | | | dry machining | | | wet machining | | | dry machining | | | wet machining | | | | | | |
| | | | cutting material 1st choice | Vc [m/min] | | cutting material 1st choice | Vc [m/min] | | cutting material 1st choice | Vc [m/min] | | cutting material 1st choice | Vc [m/min] | | | | | |
| 8.2 | Toolox® 33 Werkzeugstähle | 900–1100 | F25M | 120 | 140 | 160 | F25M | 110 | 130 | 150 | F25M | 80 | 90 | 100 | F25M | 70 | 85 | 100 |
| 10.0 | Toolox® 44 gehärtete Stähle | 41–47HRC | F15M | 120 | 160 | 200 | – | – | – | – | F15M | 80 | 105 | 130 | – | – | – | – |

Werkangaben Hoffmann

End Milling

In slot milling, a depth of cut (ap) of 0.5 x D (where D is the diameter of the end mill) has proven to be effective, and sufficient chip space should be available. End milling, including trochoidal milling, is very productive with an ap equal to the full cutting length and an ae of approximately 0.1 x D. Dry milling with compressed air cooling for chip removal helps avoid thermal shock and overloading due to chip recutting.

Threads

Both Toolox® materials can be machined with **machine tap drills**. Experienced machinists drill the core hole slightly larger. Cutting paste, cutting oil, or a richer emulsion have proven to be particularly effective.

Thread milling is a productive process that offers high manufacturing reliability, even for very small diameters and especially in cases where thread cutting is challenging.

Counterboring and countersinking with indexable insert tools are easily achievable on machining centers. For less stable machines, countersinks with integral guide pins have proven to be effective.

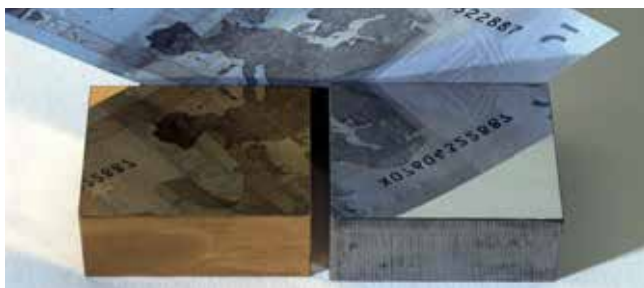
| | Toolox® 33 | Toolox® 44 |
|-----------------------------|--------------------------|------------|
| cutting speed: v [m/min] | 7–10 | 3–5 |
| thread size | Rotational speed [1/min] | |
| M5 | 445–635 | 190–320 |
| M6 | 370–530 | 160–265 |
| M8 | 270–400 | 120–200 |
| M10 | 220–320 | 95–160 |
| M12 | 185–265 | 80–130 |
| M16 | 140–200 | 60–100 |
| M20 | 110–160 | 45–80 |

| | Toolox® 33 | Toolox® 44 |
|------------------------------------|------------|------------|
| cutting speed: v [m/min] | 80–110 | 50–70 |
| feed: f _z [mm/tooth] | 0.03–0.06 | 0.02–0.05 |

| | Toolox® 33 | Toolox® 44 |
|-----------------------------|--------------------------|------------|
| cutting speed: v [m/min] | 0.10–0.20 | 0.10–0.20 |
| diameter [mm] | Rotational speed [1/min] | |
| 19 | 670–1340 | 335–840 |
| 24 | 530–1060 | 265–665 |
| 34 | 375–750 | 185–470 |
| 42 | 300–600 | 150–380 |
| 57 | 225–440 | 110–280 |



Polieren von Toolox®



1. Fine grinding using a coarse abrasive (e.g., grit size 120). All traces of processing or erosion are completely removed in this step. It is advisable to use the flat side of the abrasive. Vary the grinding direction in a crisscross pattern to achieve an absolutely flat surface, make your work more efficient, and save time.
2. Fine grinding as in step 1, but with a finer grit size, such as 320. All remaining traces from the previous grinding are completely eliminated.
3. Coarse polishing with diamond paste on a piece of brass. Grit size 45µm. This coarse polishing is performed until all remaining traces and scratches from the previous step (step 2) are completely eliminated.
4. Proceed as in step 3, but use 15µm diamond paste until all traces remaining from step 3 are gone.
5. In this step, follow the same procedure as in step 4, but now use 7µm diamond paste. Continue until all remaining traces from step 4 are removed.
6. Polish with 7µm diamond paste on a fiber or plastic element. Continue until the last remaining imperfections from step 5 are eliminated.
7. Follow the same process as in step 6, but use 3µm diamond paste instead of 7µm paste. Continue until the last nuances of imperfections from step 6 are removed. (We use the word "nuance" here because, by this point, the surface is already so smooth and fine that there are essentially no visible scratches to the naked eye.)
8. Polish with 3µm diamond paste on a piece of felt until all remaining nuances from the previous step are gone.
9. As a final step, polish with 3µm diamond paste and cotton. This is done by hand and achieves the ultimate shine. Continue until the entire surface has a uniform luster.



Welding of Toolox®

Toolox® welds well when the following guidelines are observed. The carbon equivalent for Toolox® is as follows:

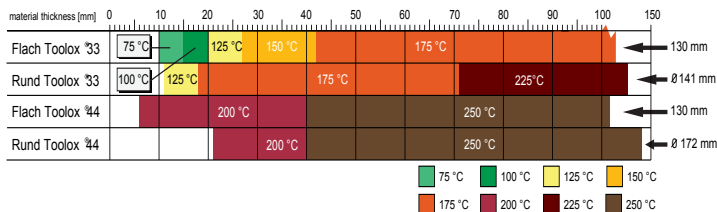
For Toolox® 33: CEIIV 0.62–0.71 / CET 0.4–0.44

For Toolox® 44: CEIIV 0.92–0.96 / CET 0.55–0.57

Austenitic welding fillers such as AWS 307 or AWS 309 are suitable for welding without preheating. This results in a strength of approximately Rp0.2 = 500 MPa in the weld. Non-alloyed or low-alloy welding fillers yield strengths up to Rp0.2 = 930 MPa and good toughness. For the selection of welding fillers, also refer to page 84.

- 1 Preheat both sides of the weld joint to approximately 100–150mm on each side. The preheat temperature should be reached in the middle of the plate. Maintain the preheat temperature throughout the entire welding process, especially during tack welding.

Minimum preheating temperature for non-alloyed and low-alloy welding additives



Preheating temperature for austenitic welding material 125 °C starting from 20 mm sheet thickness.

- 2 Use soft or stainless electrodes if possible. The electrodes must be dry. The maximum allowable hydrogen content is

5ml/100g of weld metal. To achieve optimal grain structure quality, welding should be carried out using the TIG process with a filler wire having the same chemical composition as the base material. The simplest method is to cut a rod from a leftover part of the base material.

- 3 Weld with a heat input resulting in a t8/5 value between 10 and 20 seconds.
- 4 When welding, an interpass temperature should not exceed:
 - 170°C for Toolox® 33
 - 225°C for Toolox® 44
 before proceeding to the next pass.
- 5 Perform a post-weld heat treatment in the area approximately 100-150mm on each side of the weld joint. The soaking time should be 5 minutes per millimeter of plate thickness or at least 60 minutes. Typically, a soaking time of 2 hours is sufficient. The start of the soaking time is the moment when the temperature is achieved throughout the entire annealing volume.

* Post-weld heat treatment should be performed at a temperature of 150–200°C if only low requirements regarding dimensional stability are needed.

* The post-weld heat treatment should be carried out at a temperature of 560–580°C if high requirements for dimensional stability are necessary, and the influence of the weld on the texture formation result needs to be minimized.

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Toolox 33
Toolox 44

TOOLOX® 33 / TOOLOX® 44

Examples of Applications

Toolox 33
Toolox 44



Toolox was originally developed as a plastic mold steel, but it soon proved to be highly suitable for a wide range of other applications.



Plastic molds made from Toolox are wear-resistant, and Toolox's fine microstructure makes it easy to polish and photo-etch. Additionally, Toolox is highly machinable due to its microstructure with spherical carbides. It doesn't require the addition of sulfur, which could otherwise compromise toughness and polishability.

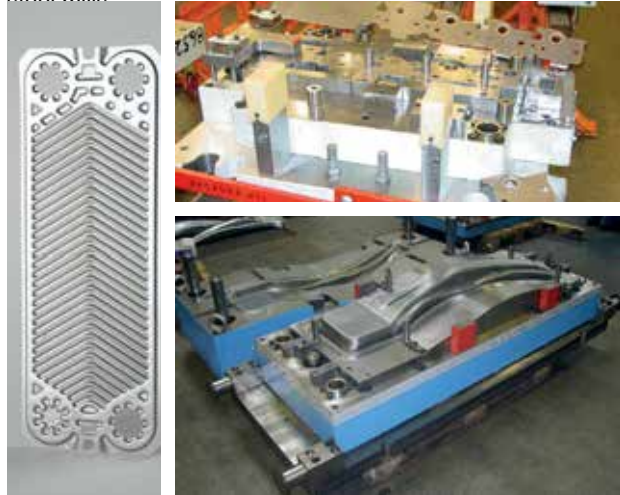


Stamping, bending, and forming tools benefit from the high base hardness of Toolox® 44. With a hardness of approximately 45 HRC, Toolox® 44 is particularly resistant to pressure and wear, making it a valuable material for bending tools. Its high toughness allows for load-bearing without fracturing, even in unfavorable constructions. In addition, Toolox® 44 is used in printing plates and slide guides. **Machine blades** made from Toolox® 44 cut high-strength sheets in steel mills.

Hydroforming tools require high strength, toughness, and workability. This is where Toolox® 44 fully leverages its advantages.



Toolox 33
Toolox 44



The high tempering temperature allows for various hot applications. Slide and molding components in **aluminum die-casting tools** are manufactured from Toolox® 44. Even in the harshest conditions when removing furnace slag in steel mills or aluminum smelting, Toolox® withstands longer than conventional wear-resistant steels. Its excellent weldability is of particular importance in this regard.



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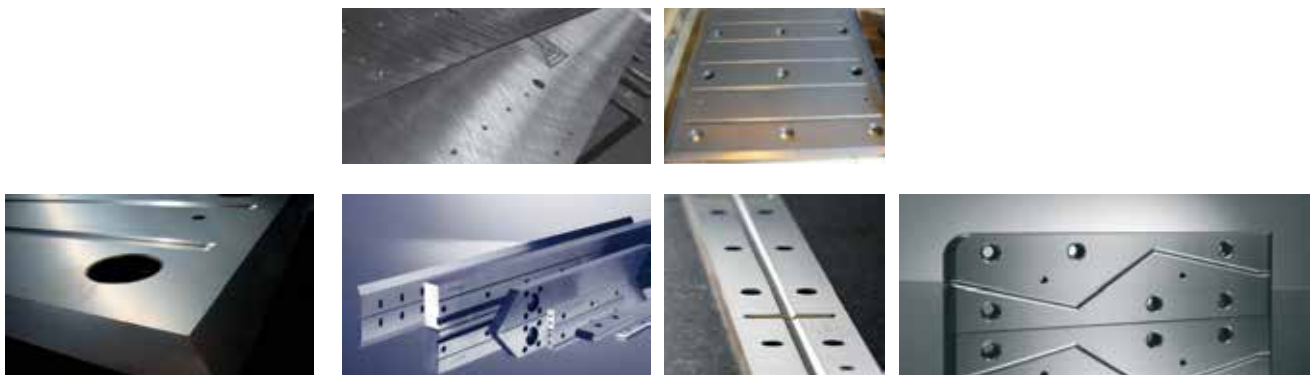
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High-strength and wear-resistant machine parts of all kinds are made from Toolox® when precision is of the utmost importance.

The high hardness already provides excellent wear resistance without the need for additional heat treatment. This is beneficial for **fixtures** that can be manufactured directly from the raw material and put to immediate use without heat treatment.

The extremely low internal stresses of the material are ensured by the high tempering temperature of at least 590° C, which acts like stress-relief annealing. Additionally, Toolox® is exclusively processed using cold methods in our facilities, eliminating heat-induced stresses and hardness loss from cutting processes such as flame or plasma cutting. The hassle-free maintenance of shape tolerances is why many manufacturers rely on Toolox®.

Achieving the highest demands for long-term precision is possible by **nitriding the surface**. Toolox® retains its core hardness during the nitriding process while gaining increased resistance to abrasion and corrosion.



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Toolox 33

Toolox 44