

Datasheet  
Maraging steel

# Osprey® 18Ni300

Osprey® 18Ni300 is a high-hardness maraging steel alloyed with cobalt, nickel and molybdenum. It is typically used for conformal-cooled mould tooling and rubber-tyre mould (sipes) applications.

UNS  
K93120

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ASTM, AISI  
18Ni300

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EN Number  
1.2709

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DIN  
1.2709

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Powder designed for  
Additive Manufacturing (AM)



## Product description

Osprey® 18Ni300 is a high-hardness maraging steel alloyed with cobalt, nickel and molybdenum. The alloy is typically used for conformal-cooled mould tooling and rubber-tyre mould (sipes) applications.

In both as-built, directly age-hardened and solution annealed (homogenized) and aged conditions, the parts can be machined, spark-eroded, welded, micro shot-peened, polished, and coated if required.

This metal powder is manufactured by either induction melting under Vacuum Inert Gas Atomization (VIGA) or melting under argon prior to Inert Gas Atomization (IGA), producing a powder with a spherical morphology which provides good flow characteristics and high packing density. In addition, the powder has a low oxygen content and low impurity levels, resulting in a metallurgically clean product with enhanced mechanical performance.

## Chemical composition (nominal), %

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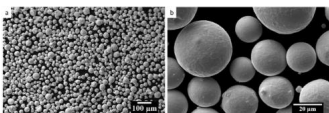
|    |       |
|----|-------|
| Fe | Bal.  |
| C  | ≤0.03 |
| Cr | ≤0.3  |
| Ni | 18    |
| Mo | 4.8   |
| Co | 9.0   |
| Ti | 0.7   |
| Al | 0.1   |
| Mn |       |
| Si | ≤0.1  |
| P  | ≤0.01 |
| S  | ≤0.01 |
| O  |       |
| N  |       |

## Powder characteristics and morphology

### Powder for Additive Manufacturing

Osprey® metal powder for Additive Manufacturing is characterized by a spherical morphology and high packing density, which confer good flow properties. For powder bed processes these are essential when applying fresh powder layers to the bed to ensure uniform and consistent part build.

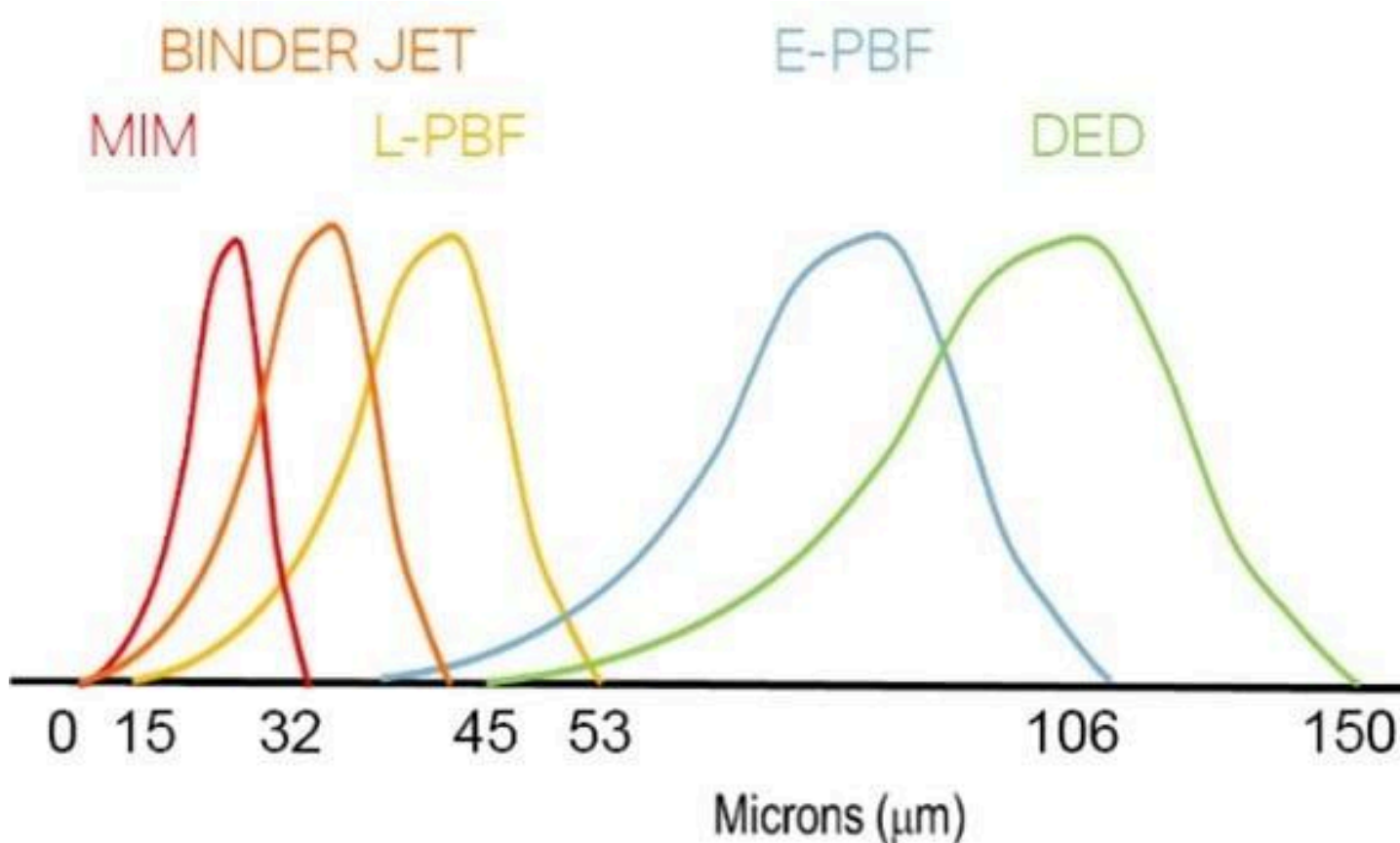
For blown powder processes, such as Direct Energy Deposition (DED), good flow ensures uniform build rates. Tight control of the particle size distribution also helps ensure good flowability. Low oxygen powders result in clean microstructures and low inclusion levels in the finished parts.



## Particle size distribution

### Powder for Additive Manufacturing

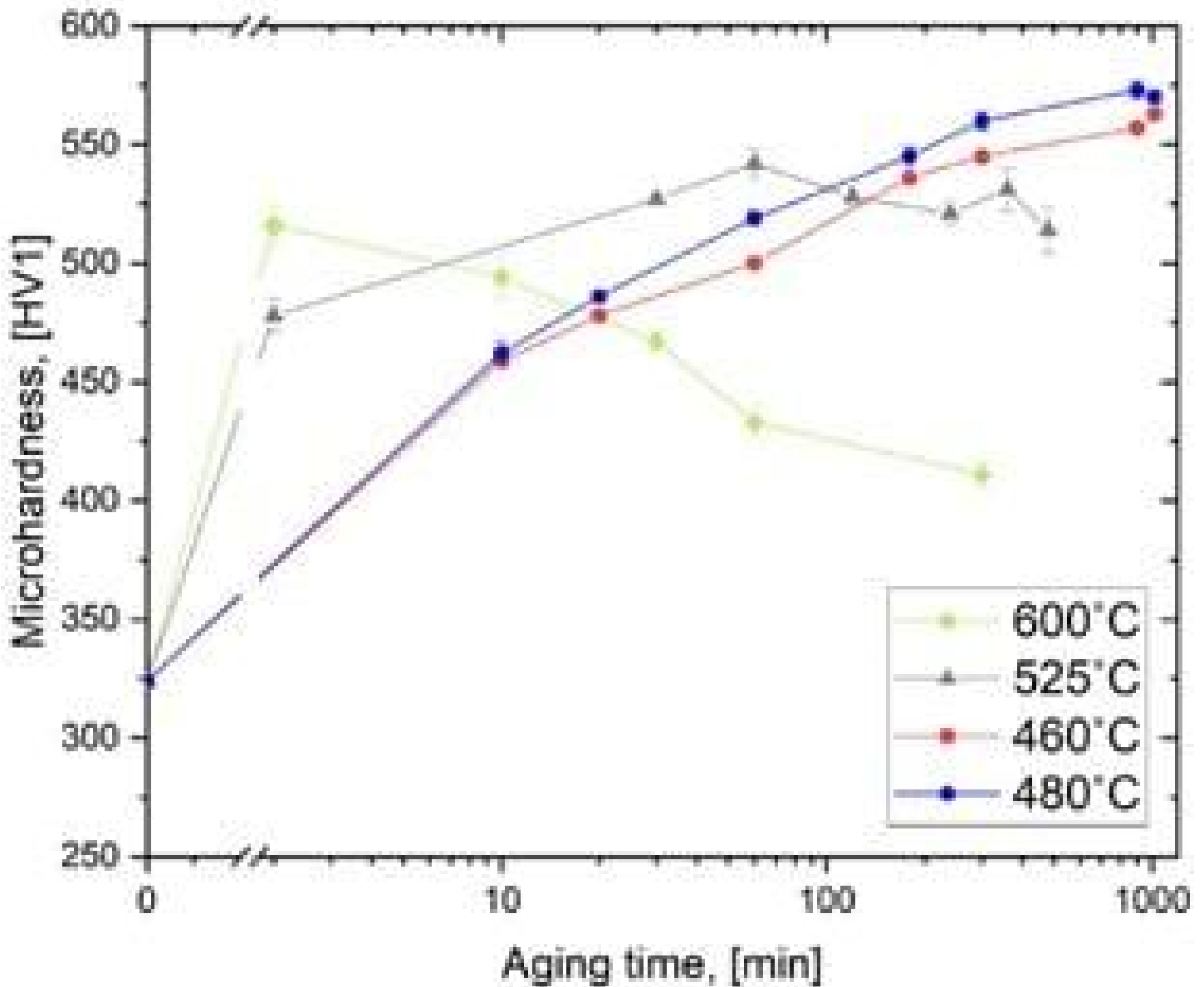
Osprey® metal powder for Additive Manufacturing is available in a wide range of particle size distributions that are tailored to the individual Additive Manufacturing systems. They can also be tailored to the particular requirements of the end application, both in terms of mechanical performance and surface finish.



| Process technology                        | Size (µm)                    |
|---|------------------------------|
| Binder jetting                            | ≤ 16, ≤ 22, ≤ 32, ≤ 38, ≤ 45 |
| Laser - Powder Bed Fusion (L-PBF)         | 15 to 53 and 10 to 45        |
| Electron beam - Powder Bed Fusion (E-PBF) | 45 to 106                    |
| Direct Energy Deposition (DED)            | 53 to 150                    |

## Heat treatment

Osprey® 18Ni300 maraging steel is characterized by high hardness and toughness and is easily heat-treatable using a simple thermal age-hardening process to obtain excellent hardness and strength. Otherwise, depending on the application, the steel can be solution annealed prior to aging treatment.



Maximum hardness, approximately 550 HV (53 HRC), is typically reached after a heat treatment at 480°C/896°F for 6–10 hours, depending on the part size. Lower hardness can be achieved by aging at higher temperatures. The use of maraging steels in applications such as die casting tooling might require an aging temperature of approx. 525°C/977°F to achieve an overaged structure to ensure the thermal stability in service.

Higher temperatures and longer holding times should be avoided as softening will occur due to excessive over-aging and austenite reversion. If a specific yield strength is required, it is recommended to use a maraging steel in which the required strength is achieved by conventional aging instead of over-aging a higher strength grade.

## Mechanical properties

Comparison of material, based on Osprey® 18Ni300 Vacuum Inert Gas Atomized (VIGA) and Inert Gas Atomized (IGA) powder, produced by Laser - Powder Bed Fusion (L-PBF) and typical wrought material properties. The material was processed using 40 µm layer thickness.

| Condition          | Yield strength (Rp0.2), MPa | Tensile strength (Rm), MPa | Elongation (A), % | Area reduction | Hardness, HV (HRC) | Impact toughness (CVN*), J |
|--------------------|-----------------------------|----------------------------|-------------------|----------------|--------------------|----------------------------|
| VIGA               |                             |                            |                   |                |                    |                            |
| As built           | 1,181 +/-4                  | 1,242 +/-2                 | 17.9 +/-0.1       | 68 +/-2        | 385 +/-6 (39)      | 108.0                      |
| DA1)               | 1,974 +/-5                  | 2,031 +/-4                 | 9.2 +/-0.2        | 45 +/-1        | 580 +/-4 (54)      | 17.0                       |
| HSA2)              | 1,970 +/-40                 | 2,071 +/-30                | 8.3 +/-0.8        | 37 +/-3        | 594 +/-7 (54)      | 14.0                       |
| IGA                |                             |                            |                   |                |                    |                            |
| As built           | 1,172 +/-4                  | 1,244 +/-5                 | 17.1 +/-0.5       | 63 +/-1        | 385 +/-10 (39)     | 63.0                       |
| DA1)               | 1,961 +/-10                 | 2,029 +/-9                 | 7.2 +/-1.2        | 34 +/-5        | 575 +/-5 (53)      | 12.0                       |
| HSA2)              | 2,008 +/-16                 | 2,111 +/-15                | 9.0 +/-0.3        | 42 +/-2        | 585 +/-5 (54)      | 13.5                       |
| Wrought properties |                             |                            |                   |                |                    |                            |
| VIM3)/VAR4)        | 1,800                       | 1,900–2,100                | 9.0               | 40.0           | -                  | -                          |
| Vacuum melted      | 2,000                       | 2,050                      | 7.0               | 40.0           | -                  | -                          |

\*CVN = Charpy V-Notched impact toughness test

- 1) DA = Direct aged
- 2) HSA = Homogenized solution annealed
- 3) VIM = Vacuum-induction melted
- 4) VAR = Vacuum-arc melted

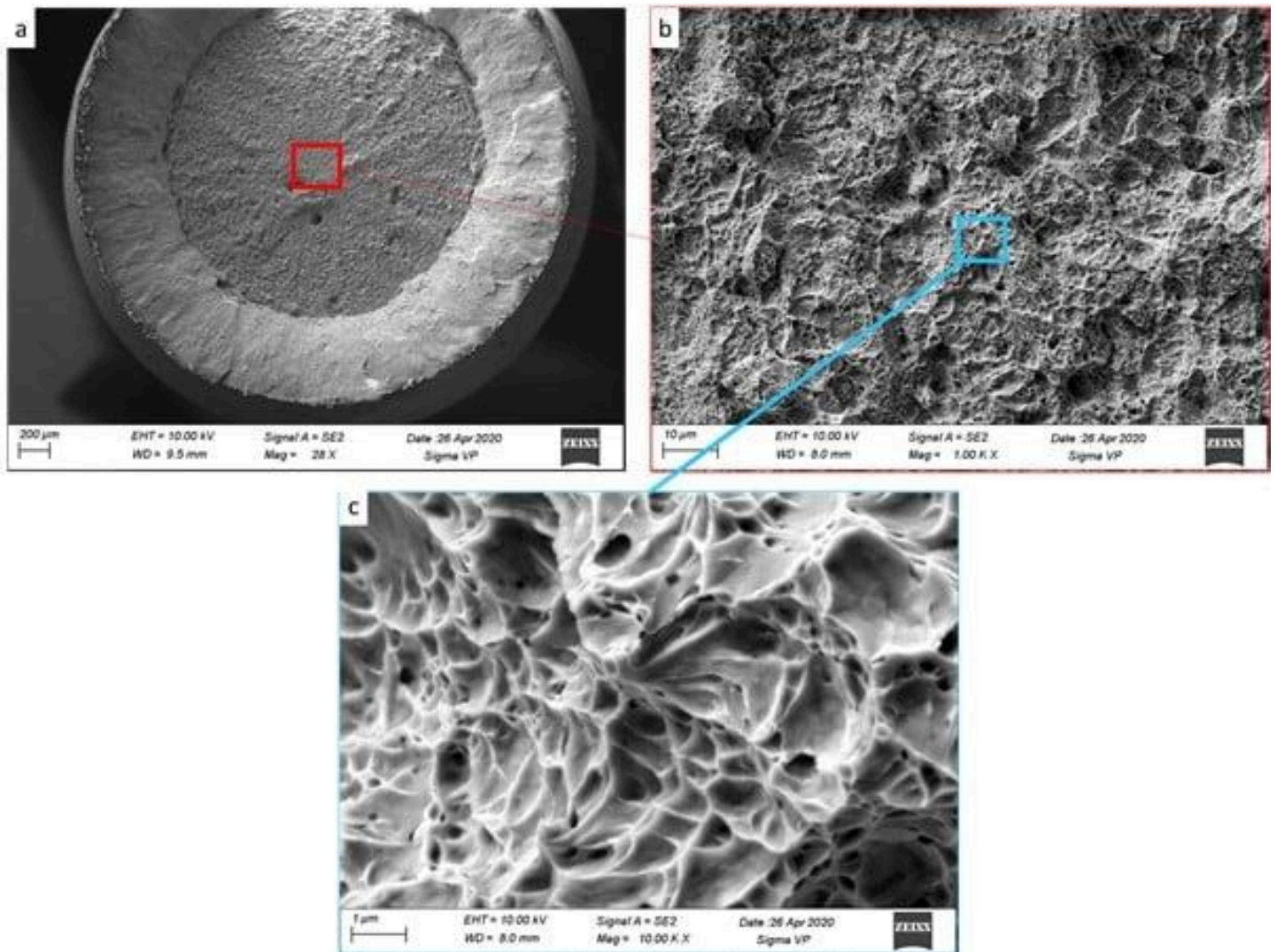
## Surface roughness

Typical surface roughness, Ra ( $\mu\text{m}$ ) of Laser - Powder Bed Fusion (L-PBF) material:

Horizontal: 5.6

Vertical: 4.3

## Fracture surface



## Fatigue properties

Age-hardened samples were heat treated in the direct aged (DA) and homogenized solution annealed (HSA) and the fatigue strength is compared with typical wrought material properties. Results of fatigue strength are based on the rotating bending configuration in a staircase regime, with a maximum number of cycles ( $2 \times 10^6$ ) as the run-out level, 2,300 RPM rotation speed and an applied stress between 525 and 800 MPa.

| Age-hardened samples  | Test configuration                    | Fatigue strength, MPa | Tensile strength (Rm), MPa | Hardness, HV (HRC) |
|-----------------------|---------------------------------------|-----------------------|----------------------------|--------------------|
| VIGA1) L-PBF material |                                       |                       |                            |                    |
| DA3)                  | Rotating bending / $2 \times 10^6$    | 700                   | 2,031 +/-4                 | 610 (54)           |
| HSA4)                 | Rotating bending / $2 \times 10^6$    | 750                   | 2,071 +/-30                | 610 (54)           |
| IGA2) L-PBF material  |                                       |                       |                            |                    |
| DA3)                  | Rotating bending / $2 \times 10^6$    | 570                   | 2,029 +/-9                 | 590 (53)           |
| HSA4)                 | Rotating bending / $2 \times 10^6$    | 717                   | 2,111 +/-15                | 610 (54)           |
| Wrought properties    |                                       |                       |                            |                    |
| VIM5)/VAR6)           | Bending / $1 \times 10^7$             | >735                  | 1,900–2,100                | -                  |
| Vacuum melted         | Tension-compression / $2 \times 10^6$ | 700                   | 1,916                      | 556 (52)           |
| Vacuum melted         | Rotating bending / $2 \times 10^6$    | 600 +/-30             | 2,115                      | 634 (56)           |

- 1) VIGA = Vacuum Inert Gas Atomization
- 2) IGA = inert Gas Atomization
- 3) DA = Direct aged
- 4) HSA = Homogenized solution annealed
- 5) VIM = Vacuum-induction melted



6) VAR = Vacuum-arc melted

## Physical properties

|   |  |
|---|--|
| Density                                 | 8.1 g/cm <sup>3</sup> (0.29 lb/in <sup>3</sup> ) |
| Thermal conductivity, 20°C (68°F)       | 14.2 W/mK  |
| Thermal conductivity, 600°C (1,200°F)   | 21.0 W/mK  |
| Thermal conductivity, 1,300°C (2,600°F) | 28.6 W/mK  |
| Coefficient of thermal expansion        | 10.3 10 <sup>-6</sup> K <sup>-1</sup>            |
| Melting point                           | 1,413°C (2,575°F)                                |

## About maraging steels

Maraging steels are a class of ultra-high strength, high hardness and high toughness steels which can be welded without preheating either in annealed (easy to machine) or heat-treated condition. These properties make them ideal candidates for the Laser - Powder Bed Fusion (L-PBF) process to manufacture parts with complex geometries for demanding applications which require an excellent combination of strength, toughness, and thermal stability.

The strengthening mechanisms in this type of steel differ from those in classical carbon steels where martensitic, bainitic or pearlitic phases are formed on cooling and tempering is employed to control carbide precipitation. Less than 50% of the overall contribution to strengthening is provided by the extremely tough Fe-Ni martensite, while aging of this martensite, containing Mo, Al, Ti and Co in supersaturated solid solution, provides additional strengthening by precipitation of nanosized intermetallic particles in the martensitic matrix.

## Testing

All Osprey® metal powders are supplied with a certificate of analysis containing information on the chemical composition and particle size distribution. Information on other powder characteristics is available upon request.

## Packaging

A wide range of packaging options is available, from 5kgs plastic bottles to 250kg metal drums.

- 5 kg (11 lbs) Plastic bottles
- 6 kg (13 lbs) Plastic bottles
- 10 kg (22 lbs) Plastic bottles
- 20 kg (44 lbs) Metal cans
- 100 kg (220 lbs) Steel drums
- 150 kg (330 lbs) Steel drums
- 250 kg (551 lbs) Steel drums

All packaging materials are suitable for air, sea and road freight.

Contact us for more information and to discuss your packaging requirements.