

<p>Process:</p>	<p>HYPROTECT is a proprietary laser cladding/hardfacing process developed by Laser Welding Solutions.</p> <p>HYPROTECT w/ buffer layer is designed for austenitic base materials</p>
<p>Characteristics:</p>	<p>Compared to “conventional” laser cladding processes HYPROTECT ensures:</p> <ul style="list-style-type: none"> ➤ Less heat input into the part ➤ Less dilution with the base material (subsequently higher hardness of the clad layer) ➤ Homogeneous clad layer & consistent quality over the entire part
<p>Base Materials:</p>	<p>All austenitic stainless steel drill collar materials</p>
<p>Clad Materials:</p>	<p><i>Buffer:</i> SUPER BOND – Nickel based alloy developed to:</p> <ul style="list-style-type: none"> ➤ Enhance adhesion of coating ➤ Increase impact resistance of clad layer ➤ Compensate thermal stresses during welding process <p><i>Hardfacing:</i> SUPER M-1 - Nickel alloy matrix material w/ spherical tungsten carbide particles designed for:</p> <ul style="list-style-type: none"> ➤ Non-magnetic permeability ➤ Maximized abrasive wear behavior <p>Mechanical Properties for Super M-1:</p> <ul style="list-style-type: none"> ➤ Hardness of Matrix: 50 HRC ➤ Hardness of spherical carbides: 3000 HV ➤ Magnetic permeability: <1.010 Mμ ➤ Machinability: Grinding ➤ Carbide content: >60%
<p>Clad Layer Specs:</p>	<p><i>Buffer:</i> SUPER BOND can be applied in a thickness range of .004” – 0.06” (TYP .045”).</p> <p><i>Hardfacing:</i> SUPER M-1 is applicable in a single layer thickness range of .008” - .09” (TYP .05”).</p>

Recommendation:	<p>For best grain structure in the clad layer and maximized wear resistance LWS recommends two laser hardfacing layers (TYP 2 x .05" thickness) for any laser cladding process.</p> <p>A single layer build up of more than .06" will significantly increase the heat input into the base material and increase the risk of distortion.</p>
Bond Strength:	<p>> 70 MPa (>10 KSI)</p>
Part Dimensions:	<p>To ensure process repeatability and optimal overlay properties the following recommendations apply:</p> <ul style="list-style-type: none"> ➤ OD tolerance before cladding: $\pm .006"$ (0.15 mm) ➤ Overlay tolerance for OD: $\pm .02"$ (0.5 mm) (single layer) ➤ Overlay tolerance for OD $\pm .03"$ (0.76 mm) (multiple layers) ➤ Overlay to be applied to an edge needs a 45° angle machined for good bond. ➤ Overlay shall not be applied within .06" (1.5 mm) of an internal corner (especially the corner of a machined pocket) without a 45° angle. ➤ Attempting to apply overlay in a pocket with surrounding walls at a 90° angle to the pocket floor will result in poor bonding and the overlay will not follow the substrate shape.
Part Preparation:	<p>Parts should be clean and free of any surface contamination. Degrease the weld area thoroughly! Brush w/ stainless brush.</p>
HYPROTECT	<p>Set-up and parameters of the HYPROTECT process are confidential and proprietary to Laser Welding Solutions.</p> <p>Processing parameters will be tailored according to customer specifications and part requirements.</p> <p>At the option of the customer, Laser Welding Solutions will issue a set-up & parameter code (Format CUSTOMER NAME LWS XXX) under which all parameter information are secured.</p>

<p>Quality</p>	<p>Inspection & Quality Assurance Acceptance:</p> <ul style="list-style-type: none"> ➤ All parts are visually inspected and measured for dimensional acceptance. ➤ Limited cracking may occur and is considered normal depending upon the part geometry. ➤ Cracks are permitted only in a direction perpendicular to the laser passes. The maximum number of cracks is 8 in any interval of 1" (25.4 mm). The interval is measured parallel to the laser passes. ➤ Additionally parts are struck a medium hard blow with a 1 kg hammer. Chipping or loss of adhesion causes automatic rejection of the part.
<p>Certification</p>	<p>HYPROTECT is a fully certifiable process. Laser Welding Solutions is in the process of obtaining ISO 9000 certification.</p> <p>At the option of the customer certifications can include:</p> <ul style="list-style-type: none"> ➤ Purchase Order number ➤ Applicable part specifications ➤ Part number ➤ Revision level & work order quantity ➤ Individual serial numbers ➤ CNC program number and revision ➤ Set-up & parameter code ➤ Date of application / machine used ➤ Thickness & composition of buffer layer ➤ Thickness & composition of hardfacing layer