

## **VARIABLES- ESSENTIAL, NON-ESSENTIAL & SUPPLEMENTARY ESSENTIAL**

'Welding Variables' are qualities of a WPS that can change, for example: Parent material, welding process, consumable types and grade, backing gas, flux, root gap, metal transfer etc.

Some Variables such as filler wire or gas composition when TIG and MIG welding are more important than others as changing them will change the mechanical properties of the weld and therefore deem the WPQR invalid- These variables are termed '**Essential Variables**'.

Other variables such as tungsten diameter or gas cup size when TIG welding or the method of cleaning the slag off when MMA welding do not alter mechanical properties and are termed '**Non-Essential Variables**'

The ASME IX standard also has '**Supplementary Essential Variables**' which become relevant when the design code deems notch toughness a factor.

Put simply if a change to the variable is likely to cause a change to the mechanical properties of the joint it will deem the WPQR invalid and requalification of the WPS is required. If the change does not affect the mechanical properties of the joint you can make the change and the WPS is still considered qualified by the WPQR.

ASME IX and BS EN ISO 15614 both give clear and concise details of what which variables are deemed Essential and which are deemed Non-Essential.

This guide attempts to demystify these terms and is educational only. Not all Variables are listed, furthermore it based on ASME IX which differs slightly to BS EN ISO 15614 therefore it is strongly recommended that anybody wishing to qualify welds should purchase and fully understand the relevant standard or employ a suitably qualified consultant to guide them through the process.

<b>Process &amp; Variable</b>	<b>Typical Designation</b>		
	Essential	Supplementary Essential	Non-Essential
<b>THIS LIST IS NOT DEFINITIVE</b>			
<b>TIG (GTAW)</b>			
Root Gap			<b>X</b>
Base Metal P No	<b>X</b>		
Base Metal Group No		<b>X</b>	
Filler Metal Diameter			<b>X</b>
Filler Metal F No	<b>X</b>		
Change to PWHT	<b>X</b>		
Gas Composition (%)	<b>X</b>		
Gas Flow Rate			<b>X</b>
Removal of Backing Gas	<b>X</b>		
Increase in Heat Input		<b>X</b>	
Tungsten Diameter			<b>X</b>
Method of cleaning			<b>X</b>

<b>MIG (GMAW)</b>			
Groove Design (Weld Prep)			<b>X</b>
Base Metal P No	<b>X</b>		
Single Pass >1/2" Thick		<b>X</b>	
Decrease in Pre-Heat >55°C	<b>X</b>		
Increase in Pre-Heat >55°C		<b>X</b>	
Gas Flow Rate			<b>X</b>
Change in Transfer Mode	<b>X</b>		
<b>MMA (SMAW)</b>			
Removal of Backing			<b>X</b>
Base Metal P No	<b>X</b>		
Change beyond Thickness Qualified	<b>X</b>		
Base Metal Group No		<b>X</b>	
String or Weave Technique			<b>X</b>
Manual or Automatic			<b>X</b>
Method of Back Gouge			<b>X</b>

When looking at the table above the notion of Variables being Essential or Non-Essential makes perfect sense- Changing the Tungsten Diameter when TIG welding or the Gas Flow Rate when MIG welding will not affect the mechanical properties of a weld and is allowable without the need for costly requalification. Changing the Base Material P No will make a difference regardless of what process is being used to weld the joint and therefore constitutes a change to an Essential Variable and requalification of the WPS is required.

Care must be taken when working with multiple standards as what constitutes an Essential Variable in one standard might not necessarily constitute an Essential Variable in another. A good example of this taken from the table above would be 'Groove Design' or edge preparation- this is deemed a Non-Essential Variable in ASME IX which means a Butt weld qualifies a Branch Intersection. In BS EN ISO 15614 this is not the case- A Butt weld WPQR can only be used to qualify a Branch Intersection with an angle >60°. There are a number of other intricacies particularly around coupon diameters- In effect ASME qualifies the thickness of weld regardless if that weld is in plate or pipe, BS EN ISO 15614 deems product form an Essential Variable meaning a WPQR qualified on plate will only cover you to weld pipe >500mm (150mm when rotated).