

## Calibration Certificate

**PFE** [redacted]

*Low Stress Certified Reference Material*

Proto Manufacturing Limited standard **PFE** [redacted] low stress certified reference material (CRM), for use in residual stress measurements using x-ray diffraction techniques was measured to be:

**$0 \pm 14$  MPa**

Using the following parameters:

- Material: Iron 99.5%
- Chromium anode,  $\lambda = 2.291$  Angstroms
- Bragg Angle ( $2\theta$ ):  $156.4^\circ$
- Crystallographic plane: (211)
- X-ray Elastic Constant,  $\frac{1}{2} S_2 =$  [redacted]  $\text{MPa}^{-1}$
- Aperture: 1mm round
- Location: Center of standard
- Temperature of standard not to exceed  $100^\circ\text{C}$
- Measurement as per ASTM E2860/SAE HS784/EN15305-2008
- Test Date: December 2, [redacted]
- Equipment: Proto Model LXRD(serial #lab 003), Proto Model iXRD(serial # 006), Proto Model iXRD(serial # 008)

Laboratory Operator

Name: Eli Skaff

Date: June 15, [redacted]

Signature: [Signature]

Laboratory Quality Manager

Name: James Pineault

Date: June 15, [redacted]

Signature: [Signature]

This powder may be used for verification of the alignment of X-ray Diffraction Instrumentation for Residual Stress Measurement as per ASTM E915

**Warning:**

*This CRM should not be cold worked in any way either by purposefully or accidentally. Measuring using a smaller or larger aperture, not measuring in the center or indicated direction will invalidate the Use of the certified value of the property and the associated statement of uncertainty.*

*This laboratory is accredited for testing in accordance with the recognized International Standard ISO/IEC 17025:2005 by PJLA accreditation #71619. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality managements system (as outlined by the joint ISO-ILAC-IAF Communiqué date January 2009).*

2175 Solar Crescent, Oldcastle, Ontario Canada N0R 1L0  
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**PJLA**  
Calibration & Testing  
Accreditation# 71619

## Calibration Certificate

SFE [redacted]

*High Stress Certified Reference Material*

Proto Manufacturing Limited hereby certifies that this high stress certified reference material (CRM), for use in residual stress measurements using x-ray diffraction techniques number SFE [redacted] was measured to be:

**-497 ± 35 MPa**

Using the following parameters:

- Material: Steel
- Chromium anode,  $\lambda = 2.291$  Angstroms
- Bragg Angle ( $2\theta$ ): 156.4°
- Crystallographic plane: (211)
- X-ray Elastic Constant,  $\frac{1}{2} S_2 =$  [redacted] MPa<sup>-1</sup>
- Aperture: 1mm round
- Location: Center of standard
- Direction of measure is parallel to indicated line
- Temperature of standard not to exceed 100°C
- Measurement as per ASTM E2860/SAE HS784/EN15305-2008
- Test Date: June 8, [redacted]
- Equipment: Proto Model LXRD(serial #lab 003), Proto Model LXRD(serial # 004), Proto Model LXRD(serial # 006)

Laboratory Operator

Name: Eli Skaff

Date: June 14, [redacted]

Signature: [Signature]

Laboratory Quality Manager

Name: James Pineault

Date: June 14, [redacted]

Signature: [Signature]

**Warning:**

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# Calibration Certificate

PRA [redacted]

## Retained Austenite Certified Reference Material

Proto Manufacturing Limited hereby certifies that standard PRA [redacted] retained austenite certified reference material (CRM) was measured to be:

**$19.8 \pm 1.1 \%$**

Using the following parameters:

- Chromium anode,  $\lambda = 2.291$  Angstroms
- 4 Peak Method as per ASTM E975/SAE SP453
- Vanadium Filter
- Aperture: 2mm round
- Location: Center of standard
- Temperature of standard not to exceed 100°C
- Test Date: June 2, [redacted]
- Equipment: Lab 002

2 $\theta$	Beta Angle	hkl Plane	R Value
156°	12°	BCC(211)	[redacted]
128°	26°	FCC(220)	[redacted]
106°	37°	BCC(200)	[redacted]
79°	50.5°	FCC(200)	[redacted]

Laboratory Operator

Name: Eli Skaff

Date: June 14, [redacted]

Signature: [redacted]

Laboratory Quality Manager

Name: James Pineault

Date: June 14, [redacted]

Signature: [redacted]

### Warning:

This CRM should not be cold worked in any way either by purposefully or accidentally. Measuring using a smaller or larger aperture, not measuring in the center or indicated direction will invalidate the Use of the certified value of the property and the associated statement of uncertainty.

This laboratory is accredited for testing in accordance with the recognized International Standard ISO/IEC 17025:2005 by PJLA accreditation #71619. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality managements system refer joint ISO-ILAC-IAF Communiqué date January 2009.

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