APPENDIX A

Different in temperature gradients for welding current 130 and 160 Amp are shown in Table A1 and A2, respectively.

Table A1 Peak Temperature at Position 1 to 5. Welding Current 130 Amp

Ratio N_2:Ar	**Temperature (^oC)**							
	P1	**P2**	**P3**	**P_{3mm}Avg**	**P4**	**P5**	**P_{6mm}Avg**	**ΔT**
0:100								
AISI 304	810	735	711	752 ± 52	573	581	577 ± 6	175
AISI 304L	885	844	965	898 ± 62	646	675	660 ± 20	238
201-2M	838	861	821	840 ± 20	639	606	623 ± 24	218
AISI 202	746	712	720	726 ± 18	521	525	523 ± 3	203
5:95								
AISI 304	808	905	887	897 ± 9	629	606	618 ± 16	279
AISI 304L	864	815	838	839 ± 24	583	643	614 ± 43	226
201-2M	813	859	839	837 ± 23	574	616	595 ± 30	242
AISI 202	849	870	836	852 ± 18	672	650	661 ± 15	191
10:90								
AISI 304	1008	931	935	958 ± 43	685	684	684 ± 1	274
AISI 304L	831	875	846	851 ± 22	639	651	645 ± 9	206
201-2M	889	936	864	896 ± 36	634	689	661 ± 39	235
AISI 202	966	997	873	945 ± 65	708	709	709 ± 0	237

Remarks: Room temperature at welding current of 130 Amp was 29.0 ± 1.1 ℃

ΔT is the temperature difference between points at distance 3 and 6 mm from the weld-center line (WCL).

P3mm Avg = average peak temperature at 3 mm from WCL

P6mm Avg = average peak temperature at 6 mm from WCL

Table A2 Peak Temperature at Position 1 to 5. Welding Current 160 Amp

Ratio N$_2$:Ar	**Temperature (°C)**							
	P1	**P2**	**P3**	**P$_{3mm}$Avg**	**P4**	**P5**	**P$_{6mm}$Avg**	**ΔT**
0:100								
AISI 304	921	928	931	927 ± 5	672	640	656 ± 22	271
AISI 304L	1016	1055	972	1014 ± 42	706	740	723 ± 25	292
201-2M	935	1029	928	964 ± 57	713	688	700 ± 18	263
AISI 202	912	946	913	924 ± 20	725	677	701 ± 34	223
5:95								
AISI 304	1157	1036	1030	1074 ± 72	779	793	786 ± 10	288
AISI 304L	1011	973	935	923 ± 38	750	779	765 ± 21	208
201-2M	1038	1037	1029	1035 ± 5	769	778	773 ± 7	261
AISI 202	980	933	1020	978 ± 43	808	725	766 ± 59	212
10:90								
AISI 304	1098	1079	988	1055 ± 59	767	813	790 ± 32	265
AISI 304L	1061	1044	1026	1044 ± 18	804	778	791 ± 18	253
201-2M	1038	740	1050	943 ± 175	778	1033	906 ± 180	37
AISI 202	1083	1077	1049	1070 ± 18	801	850	826 ± 35	244

Remarks: Room temperature at welding current of 130 Amp was 29.0 ± 1.1 ℃

ΔT is the temperature difference between points at distance 3 and 6 mm from the weld-center line (WCL).

P3mm Avg = average peak temperature at 3 mm from WCL

P6mm Avg = average peak temperature at 6 mm from WCL

APPENDIX B

Weld pool inspection performed on PCGTAW samples were summarized in Table B1 to B4.

Table B1 Weld Pool Inspection for PCGTAW AISI 304 Austenitic Stainless Steels

AISI 304	Front width, T(mm)	Penetration depth, P(mm)	Ratio of completed penetration
I=130 Amp			
$0N_2$:100Ar	4.0509 ± 0.0228	1.1184 ± 0.0532	0.5592
$5N_2$:95Ar	4.8586 ± 0.0228	1.4247 ± 0.0092	0.7124
$10N_2$:90Ar	4.0881 ± 0.0225	1.4387 ± 0.0001	0.7194
I=160 Amp			
$0N_2$:100Ar	5.3971 ± 0.0229	2.2297 ± 0.0053	1.1148
$5N_2$:95Ar	6.0390 ± 0.0176	2.6063 ± 0.0000	1.3032
$10N_2$:90Ar	6.1735 ± 0.0371	2.5371 ± 0.0116	1.2686

Table B2 Weld Pool Inspection for PCGTAW AISI 304L Austenitic Stainless Steels

AISI 304L	**Front width, T(mm)**	**Penetration Depth, P(mm)**	**Ratio of completed penetration**
I=130 Amp			
$0N_2$:100Ar	4.7561 ± 0.0318	1.0800 ± 0.0091	0.5400
$5N_2$:95Ar	5.2550 ± 0.0182	1.4279 ± 0.0053	0.7140
$10N_2$:90Ar	5.8699 ± 0.0305	1.3992 ± 0.0290	0.6996
I=160 Amp			
$0N_2$:100Ar	6.4349 ± 0.0231	2.4295 ± 0.0066	1.2148
$5N_2$:95Ar	6.9077 ± 0.0305	2.4487 ± 0.0176	1.2246
$10N_2$:90Ar	6.6810 ± 0.0176	2.6178 ± 0.0115	1.3089

Table B3 Weld Pool Inspection for PCGTAW 201-2M Austenitic Stainless Steels

201-2M	**Front width, T(mm)**	**Penetration Depth, P(mm)**	**Ratio of completed penetration**
I=130 Amp			
$0N_2$:100Ar	4.9312 ± 0.419	2.3090 ± 0.0137	1.1545
$5N_2$:95Ar	4.7497 ± 0.466	2.2630 ± 0.0139	1.1315
$10N_2$:90Ar	5.0069 ± 0.0180	2.2599 ± 0.0091	1.1300
I=160 Amp			
$0N_2$:100Ar	6.0236 ± 0.0333	2.3679 ± 0.0133	1.1840
$5N_2$:95Ar	5.8622 ± 0.0067	2.2911 ± 0.0066	1.1456
$10N_2$:90Ar	6.1003 ± 0.0111	2.2872 ± 0.0176	1.1436

Table B4 Weld Pool Inspection for PCGTAW AISI 202 Austenitic Stainless Steels

AISI 202	**Front width, T(mm)**	**Penetration Depth, P(mm)**	**Ratio of completed penetration**
I=130 Amp			
$0N_2$:100Ar	4.9312 ± 0.0277	2.4051 ± 0.0182	1.2026
$5N_2$:95Ar	4.9615 ± 0.0138	2.2750 ± 0.0105	1.1375
$10N_2$:90Ar	5.1884 ± 0.0053	2.3446 ± 0.0138	1.1723
I=160 Amp			
$0N_2$:100Ar	5.8276 ± 0.0266	2.3641 ± 0.0115	1.1821
$5N_2$:95Ar	6.2696 ± 0.0176	2.4909 ± 0.0416	1.2455
$10N_2$:90Ar	6.4926 ± 0.0305	2.4948 ± 0.0067	1.2474

APPENDIX C

Difference in tensile properties and % elongation for welding current 130 and 160 Amp were summarized in Table C1 and C2.

Table C1 Tensile Stress Results of PCGTAW Austenitic Stainless Steels

PCGTAW	**Tensile stress (MPa)**			
	Base/Parent	N_2:Ar = 0:100	N_2:Ar = 5:95	N_2:Ar = 10:90
I = 130 A				
AISI 304	*712.90* ± *2.21*	715.15 ± 2.19	715.57 ± 3.16	615.79 ± 3.06
AISI 304L	*684.04* ± *3.96*	686.68 ± 1.64	694.52 ± 1.60	694.99 ± 3.06
201-2M	*796.32* ± *1.63*	806.18 ± 2.67	**809.81 ± 3.16**	804.72 ± 1.88
AISI 202	*739.96* ± *2.46*	750.62 ± 3.60	730.19 ± 4.25	717.37 ± 5.38
I = 160 A				
AISI 304	*712.90* ± *2.21*	688.11 ± 9.82	692.63 ± 3.70	675.34 ± 2.36
AISI 304L	*684.04* ± *3.96*	699.60 ± 9.82	647.42 ± 4.23	643.69 ± 9.07
201-2M	*796.32* ± *1.63*	**794.86 ± 2.22**	785.33 ± 4.41	783.97 ± 2.05
AISI 202	*739.96* ± *2.46*	739.11 ± 3.15	690.60 ± 4.41	692.35 ± 5.38

Table C2 % Elongation of PCGTAW Austenitic Stainless Steels

PCGTAW	% Elongation			
	Base/ Parent	N_2:Ar = 0:100	N_2:Ar = 5:95	N_2:Ar = 10:90
I = 130 A				
AISI 304	*57.13 ± 0.29*	54.60 ± 0.95	56.05 ± 58.59	36.87 ± 0.49
AISI 304L	*59.47 ± 0.14*	58.21 ± 1.57	58.59 ± 0.73	60.51 ± 1.36
201-2M	*50.30 ± 0.23*	52.35 ± 1.04	50.66 ± 1.86	48.30 ± 1.27
AISI 202	*55.91 ± 0.33*	53.49 ± 0.54	50.50 ± 1.29	47.19 ± 1.08
I = 160 A				
AISI 304	*57.13 ± 0.29*	44.71 ± 2.23	44.62 ± 0.70	41.68 ± 0.76
AISI 304L	*59.47 ± 0.14*	60.00 ± 0.84	45.17 ± 0.65	42.61 ± 1.87
201-2M	*50.30 ± 0.23*	44.43 ± 1.18	37.97 ± 0.86	37.33 ± 1.04
AISI 202	*55.91 ± 0.33*	52.52 ± 1.08	40.22 ± 0.66	40.40 ± 0.55

APPENDIX D

Autolab GPES Version 4.9: Corrosion rate calculation

[After Autolab GPES Ver. 4.9 Manual page 71-73]

This option allows the determination of the corrosion rate and the polarisation resistance.

If the current versus the potential curve passes the zero current line more than once, the user is asked to define a window of interest around the point where the anodic current balances the cathodic current. Before doing this, it might be useful to draw the horizontal axis through the origin of the vertical axis. This can be done by double-clicking the horizontal axis and subsequently selecting the "Origin" in the Intercept position panel.

If the curve passes the zero current line only once, the whole curve is used for the analysis.

Subsequently the graph is transformed in a logarithmic scaled current versus potential plot and the Corrosion rate window appears. This window shows the corrosion potential and the polarisation resistance at the corrosion potential.

In this window the surface area (SA), equivalent weight (EW), and the density (D) of the electrode material can be specified. These data are used to calculate the corrosion rate in terms of current density (Icorrosion) and millimetres/year (CR):

Icorrosion = icorrosion /SA A/cm^2

and

CR = 3272*icorr*EW/(SA *D)

The polarisation resistance Rp is determined by taking the reciprocal value of the derivative di/dE. The derivative is obtained from a 2nd order polynomial fit through the corrosion potential and its neighbours. From this Rp value the corrosion rate can be obtained:

icorrosion = B/Rp

where B is normally an empirical constant.

B can also be obtained from the Tafel slopes (M. Stern and A.L. Geary, J. electrochem. Soc., 104, 56(1957).

Tafel plot analysis and results:

1. The corrosion current, corrosion current density and the corrosion rate.
2. The Tafel slopes ba and bc.
3. The corrosion potential at zero current and the corrosion potential as calculatedfrom cross-point of the two Tafel lines.
4. The Polarisation resistance Rp obtained from the equation:

$$Rp = B/i_{corrosion} \text{ where } B = \frac{1}{S} \quad \text{and } S = 2.303 * \left(\frac{1}{b_a} + \frac{1}{b_c} \right)$$

The corrosion rate is determined on the basis of the equation:

$$i = i_{corrosion} \left\{ \exp\left[s1(E - E_{corr}) \right] - \exp\left[-s2(E - E_{corr}) \right] \right\}$$

where s1 = slope of the anodic branch = 2.303/ba

s2 = slope of the cathodic branch = 2.303/bc

Eeq = the equivalence or corrosion potential

icorrosion = the corrosion rate or exchange current in Ampere

The comparison between the observed and the calculated curve is shown.

The Tafel slope parameter α can be obtained from the slopes:

b = 2.303 RT/3αnF F = Faraday constant R = Gas constant

T = temperature

= 96484.6 C/mol = 8.31441 J/mol/K = 298.15 at 25°C

n = no. of transferred electrons 2.303 = ln (10)

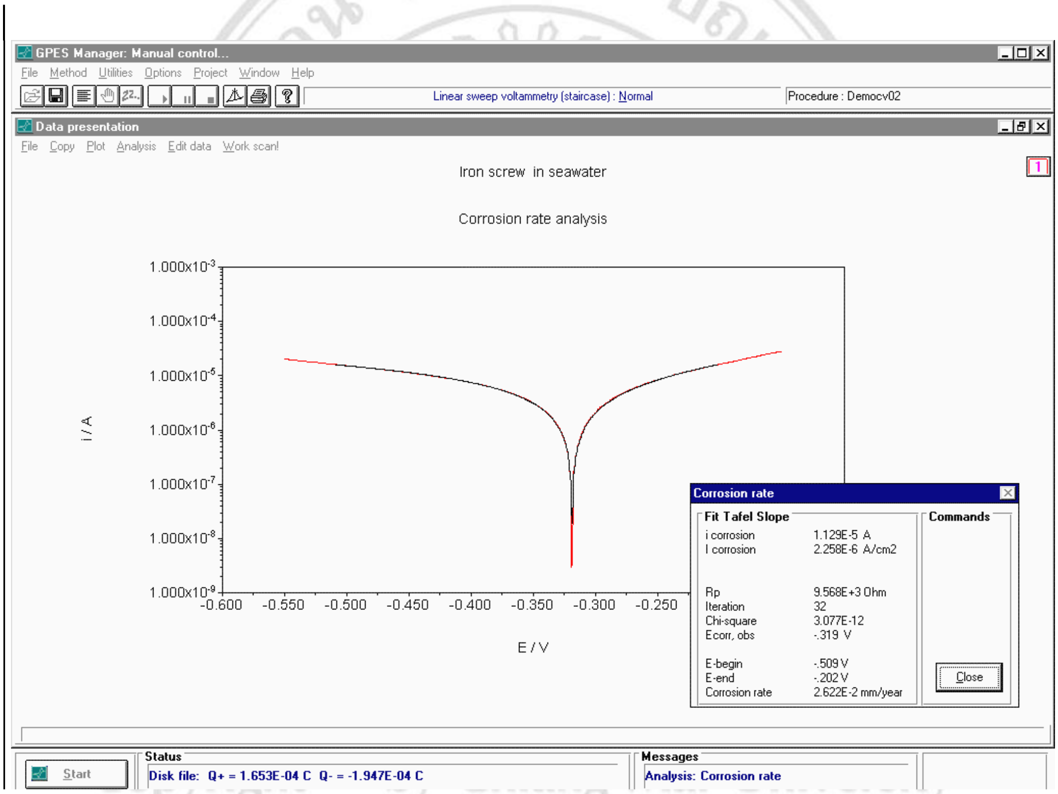

Figure Annex D.1

Tafel plot generated in corrosion rate analysis windows by Autolab GPES Ver. 4.9

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