In July, 2006 the NRC issued draft Regulatory Guide 1144 on how to apply environmental correction factors for fatigue.
The regulatory guide said to use the equations in draft NUREG-6909, which was also issued for review about this time.
This sheet compares the calculations per RG-6906 and the previous guidance in Reg Guides 6583 and 5704.

The result is a slightly higher Fen for CS, a slightly lower Fen for LAS, and a much lower Fen for SS.

6909 (A.2)
6583 (6.5a)

6909 (A.4)

6909 (A.5)

6909 (A.6)

6909 (A.7)

6909 (A.8)

6583 (5.5a)

6583 (5.5b)

6583 (5.5c)

6583 (5.5d)

6909
6583

Note the new reg guide uses formula similar (but different) to NUREG-6717 without a term for ambient temperature.

CARBON STEEL	Condition	Reference	LOW ALLOY STEEL
Fen = exp(0.632-0.101S* T* O* ε̇*)		6909 (A.3)	Fen = exp(0.702-0.101S* T* O* ε̇*)
Fen = exp(0.585-0.00124T-0.101 S* T* O* ε̇*)		6583 (6.5b)	Fen = exp(0.929-0.00124T-0.101 S* T* O* ε̇*)
S* = S	≤ S ≤ 0.015 wt%	6909 (A.4)	S* = S
S* = 0.015	0.015 < S wt%		S* = 0.015
T* = 0	T < 150 °C	6909 (A.5)	T* = 0
T* = T-150	150 ≤ T ≤ 350 °C		T* = T-150
O* = 0	DO ≤ 0.04 ppm	6909 (A.6)	O* = 0
O* = ln(DO/0.04)	0.04 < DO ≤ 0.5 ppm		O* = ln(DO/0.04)
O* = ln (12.5)	0.5 < DO ppm		O* = ln (12.5)
ε̇=0	1 < ε̇ %/s	6909 (A.7)	ε̇=0
ε̇=ln(e)	0.001 ≤ ε̇ ≤ 1 %/s		ε̇=ln(e)
ε̇=ln(0.001)	ε̇ < 0.001 %/s		ε̇=ln(0.001)
If strain amplitude is less than 0.07% then Fen = 1		6909 (A.8)	If strain amplitude is less than 0.07% then Fen = 1
S* = S	0 < S ≤ 0.015 wt%	6583 (5.5a)	S* = S
S* = 0.015	0.015 < S wt%		S* = 0.015
T* = 0	T < 150 °C	6583 (5.5b)	T* = 0
T* = T-150	150 ≤ T ≤ 350 °C		T* = T-150
O* = 0	DO < 0.05 ppm	6583 (5.5c)	O* = 0
O* = ln(DO/0.04)	0.05 ≤ DO ≤ 0.5 ppm		O* = ln(DO/0.04)
O* = ln (12.5)	0.5 < DO ppm		O* = ln (12.5)
ε̇*=0	1 < ε̇ %/s	6583 (5.5d)	ε̇*=0
ε̇*=ln(ε̇)	0.001 ≤ ε̇ ≤ 1 %/s		ε̇*=ln(ε̇)
ε̇*=ln(0.001)	ε̇ < 0.001 %/s		ε̇*=ln(0.001)

Example:			Example:
S	0.015		S
T	185		T
O	0.1		O
ε̇	0.001		ε̇
S*	0.015		S*
T*	35		T*
O*	0.916290732		O*
ε̇*	-6.907755279		ε̇*
Fen	2.631679883	6909	Fen
Fen	2.434210274	6583	Fen

Stainless Steel

	6909 (A.3)	Fen = exp(0.734 - T' O' ἑ')	
	5704 (13)	Fen = exp(0.935 - T' O' ἑ')	
≤ S ≤ 0.015 wt%			
0.015 < S wt%			
T < 150 °C	6909 (A.10)	T' = 0	T < 150 °C
150 ≤ T ≤ 350 °C		T' = (T-150)/175	150 ≤ T ≤ 325 °C
		T' = 1	325 < T
DO ≤ 0.04 ppm	6909 (A.12)	O' = 0.281	all DO all ppm
0.04 < DO ≤ 0.5 ppm			
0.5 < DO ppm			
1 < ἑ %/s	6909 (A.11)	ἑ'=0	0.4 < ἑ %/s
0.001 ≤ ἑ ≤ 1 %/s		ἑ'=ln(e/0.4)	0.0004 ≤ ἑ ≤ 0.4 %/s
ἑ < 0.001 %/s		ἑ'=ln(0.0004/0.4)	ἑ < 0.0004 %/s
	6909 (A.13)	If strain amplitude is less than 0.10% then Fen = 1	
0 < S ≤ 0.015 wt%			
0.015 < S wt%			
T < 150 °C	5704 (8a)	T' = 0	T < 200 °C
150 ≤ T ≤ 350 °C		T' = 1	200 ≤ T °C
DO < 0.05 ppm	5704 (8c)	O' = 0.260	DO < 0.05 ppm
0.05 ≤ DO ≤ 0.5 ppm		O' = 0.172	0.05 ≤ DO ppm
0.5 < DO ppm			
1 < ἑ %/s	5704 (8b)	ἑ*=0	0.4 < ἑ %/s
0.001 ≤ ἑ ≤ 1 %/s		ἑ*=ln(ἑ/0.04)	0.0004 ≤ ἑ ≤ 0.4 %/s
ἑ < 0.001 %/s		ἑ*=ln(0.004/0.4)	ἑ < 0.0004 %/s

Example:

0.015		T	280
185		O	0.005
0.1		ἑ	0.001
0.001	6909	T'	0.742857143
	6909	O'	0.281
0.015	6909	ἑ'	-6.91
35	6583	T'	1
0.916290732	6583	O'	0.26
-6.907755279	6583	ἑ'	-6.91
2.822498205	6909	Fen	8.81
3.433645007	6583	Fen	15.34847887

NUREG-6260 locations for which IPEC has CUFs.

Location	Unit 2
Bottom head to shell	0.004
Primary nozzles - inlet	0.05
Primary nozzles - outlet	0.281
Surge Line	
Charging system nozzle	
Safety Injection nozzle	
RHR piping	

Per NUREG/CR-6583
Low Alloy Steel (Bottom head to shell, Inlet Nozzle, Outlet Nozzle)

	Parameter	INPUTs
All	Ambient Temp	25
Bottom Head	Sulfur Content	0.025
Inlet Nozzle	Sulfur Content	0.020
Outlet Nozzle	Sulfur Content	0.020
Bottom Head	Outlet Temp	538.2
		281
Inlet Nozzle	Inlet Temp	538.2
		281
Outlet Nozzle	Vessel Temp	609
		321
All	Diss. Oxygen	0.005
All	Strain Rate	0.001

Environmental Correction Factor (Fen) for Low Alloy Steel:

Bottom Head	**Fen =**	**2.45**
Inlet Nozzle	**Fen =**	**2.45**
Outlet Nozzle	**Fen =**	**2.45**

Per NUREG/CR-5704
Austinitic Stainless Steel (Surge Line, Charging system nozzle, SI nozzle, RHR piping)

	Parameter	INPUTs
Surge line	Temperature	653
		345
Charging system nozzle	Temperature	538.2
		281
Safety Injection nozzle	Temperature	538.2
		281
RHR piping	Temperature	605.8
		319
All	Diss. Oxygen	0.005
All	Strain Rate	0.0004

Environmental Correction Factor (Fen) for Stainless Steel:

Surge line	**Fen =**	**15.35**
Charging system nozzle	**Fen =**	**15.35**
Safety Injection nozzle	**Fen =**	**15.35**
RHR piping	**Fen =**	**15.35**

Unit 3		
0.02	BH	LAS
0.049	PIN	LAS
0.259	PON	LAS
		SS
		SS
		SS
		SS

units	Factor	Value	Basis
deg C			
wt %		0.015	Highest sulphur for Lower Shell, don't have lower head sulphur (RVID2)
wt %	S* =	0.015	Highest sulphur for Intermediate Shell, Need Inlet Nozzle Sulphur (RVID2)
wt %		0.015	Highest sulphur for Intermediate Shell, Need Outlet Nozzle Sulphur (RVID2)
deg F	T* =	131.2	FSAR Table 3.2-6, vessel inlet
deg C			
deg F	T* =	131.2	FSAR Table 3.2-6, vessel inlet
deg C			
deg F	T* =	170.6	FSAR Table 3.2-6, vessel inlet
deg C			
ppm	O* =	0.0	≤5 ppb per CH-SQ-13.017, Rev 2
%/w	e* =	-6.91	assume bounding value of 0.001

	CUFs	Fen	EAF CUF
Bottom Head to shell	0.004	2.45	0.01
Inlet Nozzle	0.050	2.45	0.12
Outlet Nozzle	0.281	2.45	0.69

units	Factor	Value	Basis
deg F	T' =	1	FSAR Table 4.1-3
deg C			
deg F	T' =	1	FSAR Table 3.2-6, cold leg temp
deg C			
deg F	T' =	1	FSAR Table 3.2-6, cold leg temp
deg C			
deg F	T' =	1	FSAR Table 3.2-6, hot leg temp
deg C			
ppm	O* =	0.260	≤5 ppb per CH-SQ-13.017, Rev 2
%/w	e' =	-6.91	assume bounding value of 0.0004

	CUF	Fen	EAF CUF
Surge line		15.35	0.00
Charging system nozzle		15.35	0.00
Safety Injection nozzle		15.35	0.00
RHR piping		15.35	0.00

Per NUREG/CR-6909
Low Alloy Steel (Bottom head to shell, Inlet Nozzle, Outlet Nozzle)

	Parameter	**INPUTs**	**units**	**Factor**	**Value**
All					
Bottom Head	Sulfur Content	0.025	wt %		0.015
Inlet Nozzle	Sulfur Content	0.020	wt %	S* =	0.015
Outlet Nozzle	Sulfur Content	0.020	wt %		0.015
Bottom Head	Outlet Temp	538.2	deg F	T* =	131
		281	deg C		
Inlet Nozzle	Inlet Temp	538.2	deg F	T* =	131
		281	deg C		
Outlet Nozzle	Vessel Temp	538.2	deg F	T* =	131
		281	deg C		
All	Diss. Oxygen	0.005	ppm	O* =	0.0
All	Strain Rate	0.001	%/w	e* =	-6.9
	Environmental Correction Factor (Fen) for Low Alloy Steel:				
Bottom Head		**Fen = 2.02**	Bottom Head to shell		
Inlet Nozzle		**Fen = 2.02**	Inlet Nozzle		
Outlet Nozzle		**Fen = 2.02**	Outlet Nozzle		

Per NUREG/CR-6909
Austinitic Stainless Steel (Surge Line, Charging system nozzle, SI nozzle, RHR piping)

	Parameter	**INPUTs**	**units**	**Factor**	**Value**
Surge line	Temperature	653	deg F	T' =	1.00
		345	deg C		
Charging system nozzle	Temperature	538.2	deg F	T' =	0.75
		281	deg C		
Safety Injection nozzle	Temperature	538.2	deg F	T' =	0.75
		281	deg C		
RHR piping	Temperature	605.8	deg F	T' =	0.96
		319	deg C		
All	Diss. Oxygen	NA	ppm	O* =	0.281
All	Strain Rate	0.0004	%/w	e' =	-6.91
	Environmental Correction Factor (Fen) for Stainless Steel:				
Surge line		**Fen = 14.51**	Surge line		
Charging system nozzle		**Fen = 8.93**	Charging system nozzle		
Safety Injection nozzle		**Fen = 8.93**	Safety Injection nozzle		
RHR piping		**Fen = 13.55**	RHR piping		

Basis

Highest sulphur for Lower Shell, don't have lower head sulphur (RVID2)
Highest sulphur for Intermediate Shell, Need Nozzle Sulphur (RVID2)
Highest sulphur for Intermediate Shell, Need Nozzle Sulphur (RVID2)

FSAR Table 3.2-6, vessel inlet

FSAR Table 3.2-6, vessel inlet

FSAR Table 3.2-6, vessel inlet

≤5 ppb per CH-SQ-13.017, Rev 2

assume bounding value of 0.001

CUFs	Fen	EAF CUF
0.004	2.02	0.01
0.050	2.02	0.10
0.281	2.02	0.57

Basis

FSAR Table 4.1-3

FSAR Table 3.2-6, cold leg temp

FSAR Table 3.2-6, cold leg temp

FSAR Table 3.2-6, hot leg temp

6906 uses 0.281 for all oxygen levels.

assume bounding value of 0.0004

CUF	Fen	EAF CUF
	14.51	0.00
	8.93	0.00
	8.93	0.00
	13.55	0.00

NUREG-6260 locations for which IPEC has CUFs.

NUREG-6260 Location	IP3 Specific Location
	Primary nozzles - inlet
	outlet
	Bottom head to shell
	Pressurizer Surge Line
	RCS Piping Charging Nozzle
	RCS Piping SIS nozzle
	RHR Class 1 Piping

Per NUREG/CR-6583
Low Alloy Steel (Bottom head to shell, Inlet Nozzle, Outlet Nozzle)

	Parameter
All	Ambient Temperature
Bottom Head	Sulfur Content
Inlet Nozzle	Sulfur Content
Outlet Nozzle	Sulfur Content
Bottom Head	Vessel Temp
Inlet Nozzle	Inlet Temp
Outlet Nozzle	Outlet Temp
All	Diss. Oxygen
All	Strain Rate

Environmental Correction Factor (Fen) for Low Alloy Steel:
Fen =
Fen =
Fen =

Per NUREG/CR-5704
Austinitic Stainless Steel (Surge Line, Charging system nozzle, SI nozzle, RHR piping)

	Parameter
Pressurizer Surge Line	Temperature
RCS piping charging system nozzle	Temperature
RCS piping safety injection nozzle	Temperature
RHR Class 1 piping	Temperature
	Diss. Oxygen
	Strain Rate

Environmental Correction Factor (Fen) for Stainless Steel:

Pressurizer Surge Line	**Fen =**
RCS piping charging system nozzle	**Fen =**
RCS piping safety injection nozzle	**Fen =**
RHR Class 1 piping	**Fen =**

Carbon Steel

Material Type	Unit 3	
0.05	0.049	LAS
0.281	0.259	LAS
0.004	0.02	LAS
		SS
		SS
		SS
		SS

INPUTs	units	Factor	Value	Basis
25	deg C			
0.026	wt %		0.015	Highest sulphur for Lower Shell, don't have lower head sulphur (RVID2)
0.025	wt %	S* =	0.015	Highest sulphur for Intermediate Shell, Need Inlet Nozzle Sulphur (RVID2)
0.025	wt %		0.015	Highest sulphur for Intermediate Shell, Need Outlet Nozzle Sulphur (RVID2)
540.7	deg F	T* =	133	FSAR Table 4.1-4, cold leg temp
283	deg C			
540.7	deg F	T* =	133	FSAR Table 4.1-4, cold leg temp
283	deg C			
603	deg F	T* =	167	FSAR Table 4.1-4, hot leg temp
317	deg C			
0.005	ppm	O* =	0.0	≤5 ppb per CH-SQ-13.017, Rev 2
0.001	%/w	e* =	-6.9	assume bounding value of 0.001

		CUFs	Fen	EAF CUF
2.45	Bottom Head to Shell	0.020	2.45	0.05
2.45	Inlet Nozzle	0.049	2.45	0.12
2.45	Outlet Nozzle	0.259	2.45	0.64

INPUTs	units	Factor	Value	Basis
653	deg F	T' =	1	FSAR Table 4.1-3, Pzr design temp
345	deg C			
540.7	deg F	T' =	1	FSAR Table 4.1-4, cold leg temp
283	deg C			
540.7	deg F	T' =	1	FSAR Table 4.1-4, cold leg temp
283	deg C			
602.5	deg F	T' =	1	FSAR Table 4.1-4, hot leg temp
317	deg C			
0.005	ppm	O* =	0.260	≤5 ppb per CH-SQ-13.017, Rev 2
0.0004	%/w	e' =	-6.9078	assume bounding value of 0.0004

	CUF	Fen	EAF CUF
15.35		15.35	0.00
15.35		15.35	0.00
15.35		15.35	0.00
15.35		15.35	0.00

Per NUREG/CR-6909
Low Alloy Steel (Bottom head to shell, Inlet Nozzle, Outlet Nozzle)

	Parameter	INPUTs	units
Bottom Head	Sulfur Content	0.026	wt %
Inlet Nozzle	Sulfur Content	0.025	wt %
Outlet Nozzle	Sulfur Content	0.025	wt %
Bottom Head	Vessel Temp	540.7	deg F
		283	deg C
Inlet Nozzle	Inlet Temp	540.7	deg F
		283	deg C
Outlet Nozzle	Outlet Temp	540.7	deg F
		283	deg C
All	Diss. Oxygen	0.005	ppm
All	Strain Rate	0.001	%/w

Environmental Correction Factor (Fen) for Low Alloy Steel:

Fen =	**2.02**	Bottom Head to Shell
Fen =	**2.02**	Inlet Nozzle
Fen =	**2.02**	Outlet Nozzle

Per NUREG/CR-6909
Austinitic Stainless Steel (Surge Line, Charging system nozzle, SI nozzle, RHR piping)

	Parameter	INPUTs	units
Pressurizer Surge Line	Temperature	653	deg F
		345	deg C
RCS piping charging system nozzle	Temperature	540.7	deg F
		283	deg C
RCS piping safety injection nozzle	Temperature	540.7	deg F
		283	deg C
RHR Class 1 piping	Temperature	602.5	deg F
		317	deg C
	Diss. Oxygen	0.005	ppm
	Strain Rate	0.0004	%/w

Environmental Correction Factor (Fen) for Stainless Steel:

Pressurizer Surge Line	**Fen =**	**14.51**
RCS piping charging system nozzle	**Fen =**	**9.07**
RCS piping safety injection nozzle	**Fen =**	**9.07**
RHR Class 1 piping	**Fen =**	**13.27**

Factor	Value	Basis
	0.015	Highest sulphur for Lower Shell, don't have lower head sulphur (RVID2)
S* =	0.015	Highest sulphur for Intermediate Shell, Need Nozzle Sulphur (RVID2)
	0.015	Highest sulphur for Intermediate Shell, Need Nozzle Sulphur (RVID2)
T* =	133	FSAR Table 4.1-4, cold leg temp
T* =	133	FSAR Table 4.1-4, cold leg temp
T* =	133	FSAR Table 4.1-4, cold leg temp
O* =	0.0	≤5 ppb per CH-SQ-13.017, Rev 2
e* =	-6.9	assume bounding value of 0.001

CUFs	Fen	EAF CUF
0.020	2.02	0.04
0.049	2.02	0.10
0.259	2.02	0.52

Factor	Value	Basis
T' =	1.00	FSAR Table 4.1-3, Pzr design temp
	0.76	FSAR Table 4.1-4, cold leg temp
	0.76	FSAR Table 4.1-4, cold leg temp
	0.95	FSAR Table 4.1-4, hot leg temp
O* =	0.281	
e' =	-6.91	assume bounding value of 0.0004

CUF	Fen	EAF CUF
	14.51	0.00
	9.07	0.00
	9.07	0.00
	13.27	0.00

INPUTs	units	Factor	Value	Basis

Dissolved Oxygen

CARBON STEEL
NUREG/CR-6717
O*=0 DO<0.04 ppm
O*=ln(DO/0.04) 0.04<=DO<=0.5 ppm
O*=ln(12.5) DO >0.5 ppm

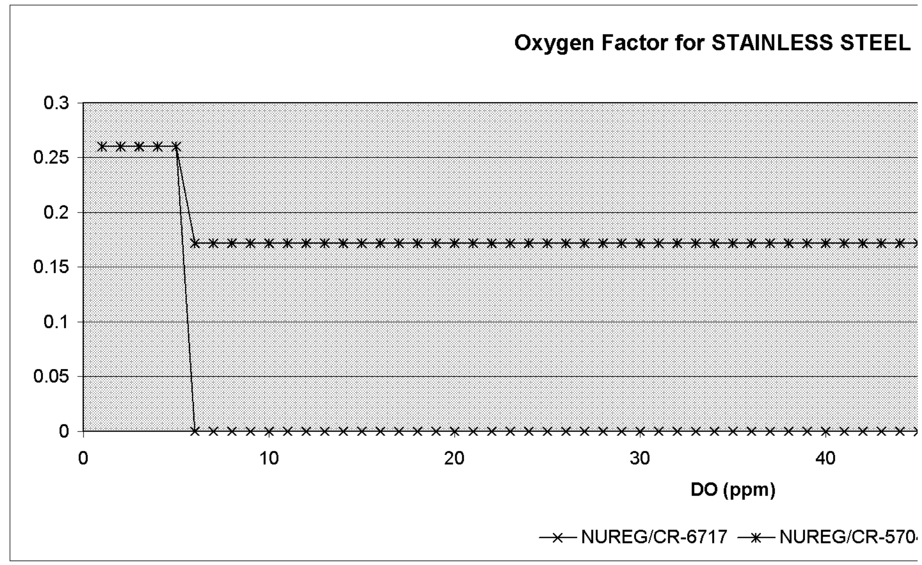
NUREG/CR-6583
O* = 0 DO<0.05 ppm
O* = ln(DO/0.04) 0.05 ppm <= DO <+ 0.5 ppm
O* = ln(12.5) DO > 0.5 ppm

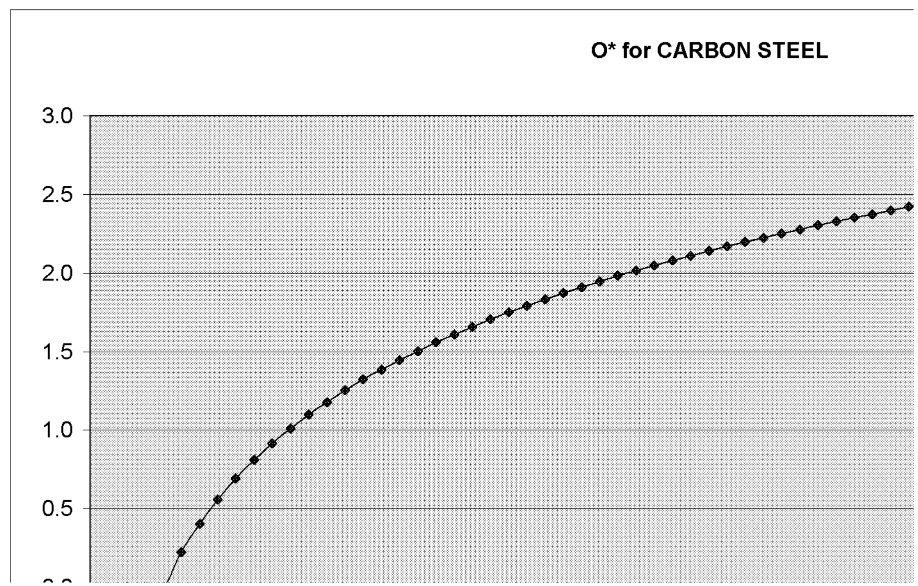
STAINLESS STEEL
NUREG/CR-6717
O' = 0.260 DO < 0.05 ppm
O' = 0 DO >= 0.05 ppm

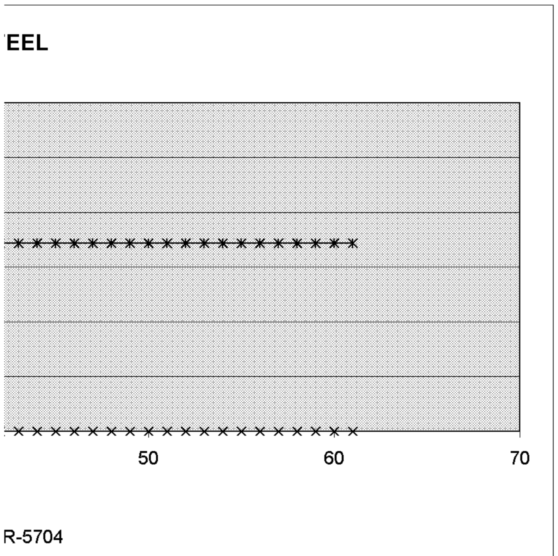
NUREG/CR-5704
O* = 0.260 DO < 0.05 ppm
O* = 00.172 DO >= 0.05 ppm

NOTE:
Higher Oxygen is bad for Carbon Steel but good for Stainless Steel.
Assuming DO < 0.05 ppm is conservative for Stainless Steel
Assuming DO > 0.5 ppm is conservative for Carbon Steel

Reg Guide DO (ppm)	CS 6717 O*	CS 6583 O*	SS 6717 O'	SS 5704 O*
0.00	0.0	0.0	0.26	0.26
0.01	0.0	0.0	0.26	0.26
0.02	0.0	0.0	0.26	0.26
0.03	0.00	0.00	0.26	0.26
0.04	0.00	0.00	0.26	0.26
0.05	0.22	0.22	0	0.17
0.06	0.41	0.41	0	0.17
0.07	0.6	0.6	0	0.17
0.08	0.7	0.7	0	0.17
0.09	0.8	0.8	0	0.17
0.10	0.9	0.9	0	0.17
0.11	1.0	1.0	0	0.17
0.12	1.1	1.1	0	0.17
0.13	1.2	1.2	0	0.17
0.14	1.3	1.3	0	0.17
0.15	1.3	1.3	0	0.17
0.16	1.4	1.4	0	0.17
0.17	1.4	1.4	0	0.17
0.18	1.5	1.5	0	0.17
0.19	1.6	1.6	0	0.17
0.20	1.6	1.6	0	0.17
0.21	1.7	1.7	0	0.17
0.22	1.7	1.7	0	0.17
0.23	1.7	1.7	0	0.17
0.24	1.8	1.8	0	0.17
0.25	1.8	1.8	0	0.17
0.26	1.9	1.9	0	0.17
0.27	1.9	1.9	0	0.17
0.28	1.9	1.9	0	0.17
0.29	2.0	2.0	0	0.17
0.30	2.0	2.0	0	0.17
0.31	2.0	2.0	0	0.17
0.32	2.1	2.1	0	0.17
0.33	2.1	2.1	0	0.17
0.34	2.1	2.1	0	0.17
0.35	2.2	2.2	0	0.17
0.36	2.2	2.2	0	0.17
0.37	2.2	2.2	0	0.17
0.38	2.3	2.3	0	0.17
0.39	2.3	2.3	0	0.17
0.40	2.3	2.3	0	0.17
0.41	2.3	2.3	0	0.17
0.42	2.4	2.4	0	0.17
0.43	2.4	2.4	0	0.17
0.44	2.4	2.4	0	0.17
0.45	2.4	2.4	0	0.17
0.46	2.4	2.4	0	0.17
0.47	2.5	2.5	0	0.17
0.48	2.5	2.5	0	0.17
0.49	2.5	2.5	0	0.17



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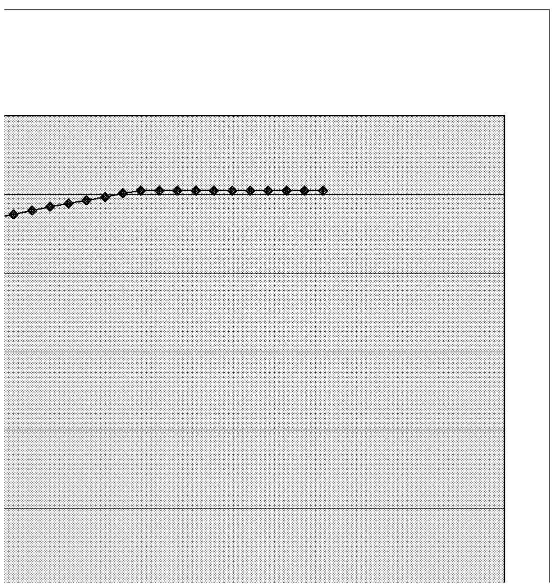
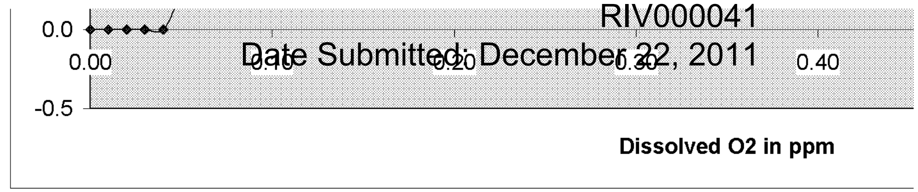
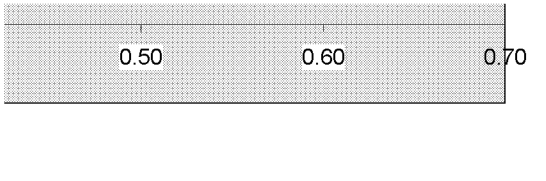


0.50	2.5	2.5	0	0.17
0.51	2.5	2.5	0	0.17
0.52	2.5	2.5	0	0.17
0.53	2.5	2.5	0	0.17
0.54	2.5	2.5	0	0.17
0.55	2.5	2.5	0	0.17
0.56	2.5	2.5	0	0.17
0.57	2.5	2.5	0	0.17
0.58	2.5	2.5	0	0.17
0.59	2.5	2.5	0	0.17
0.60	2.5	2.5	0	0.17




0.50
0.60
0.70