

# Comparison of s-N curves in seawater with cathodic protection between standards DNV RP-C203:2019 and BS 7608:2014+A1:2015

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## Revision history

May 28, 2021 First release.

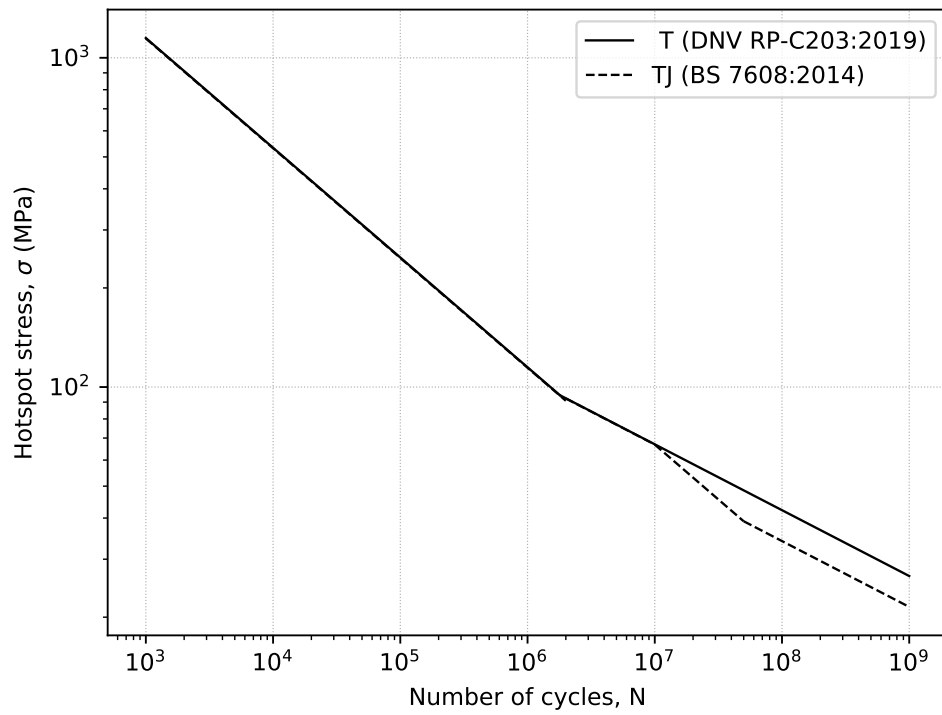


Figure 1: *T* curves

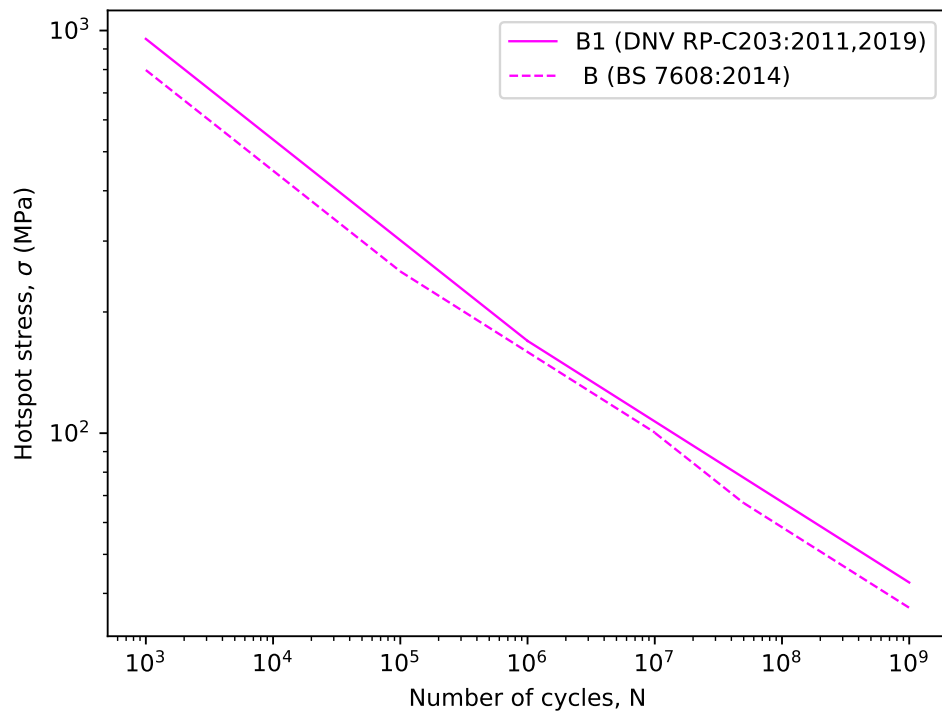


Figure 2: *B* curves

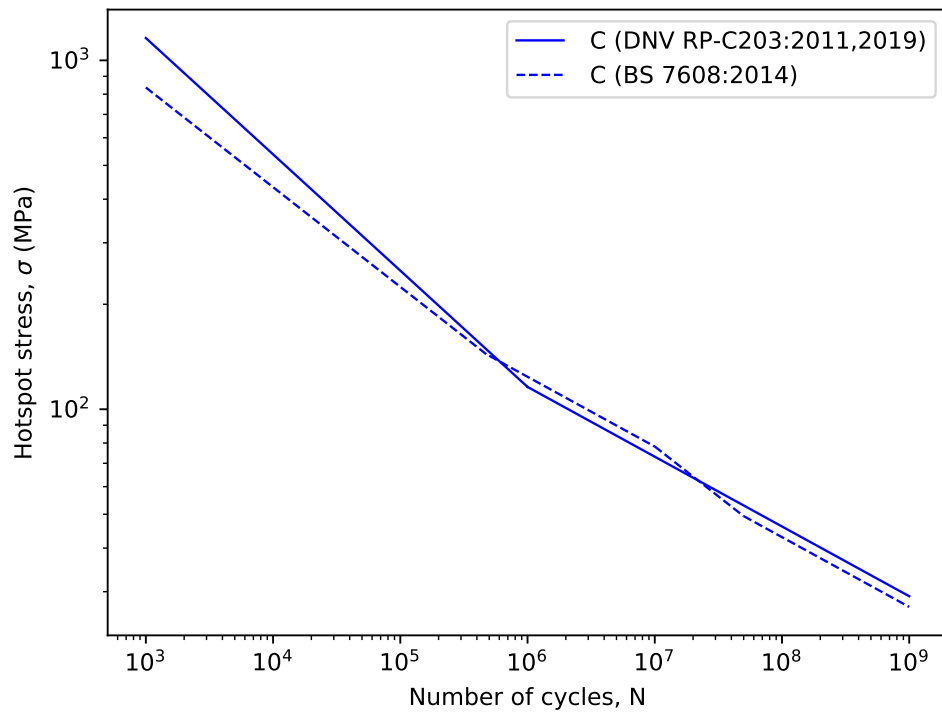


Figure 3: C curves

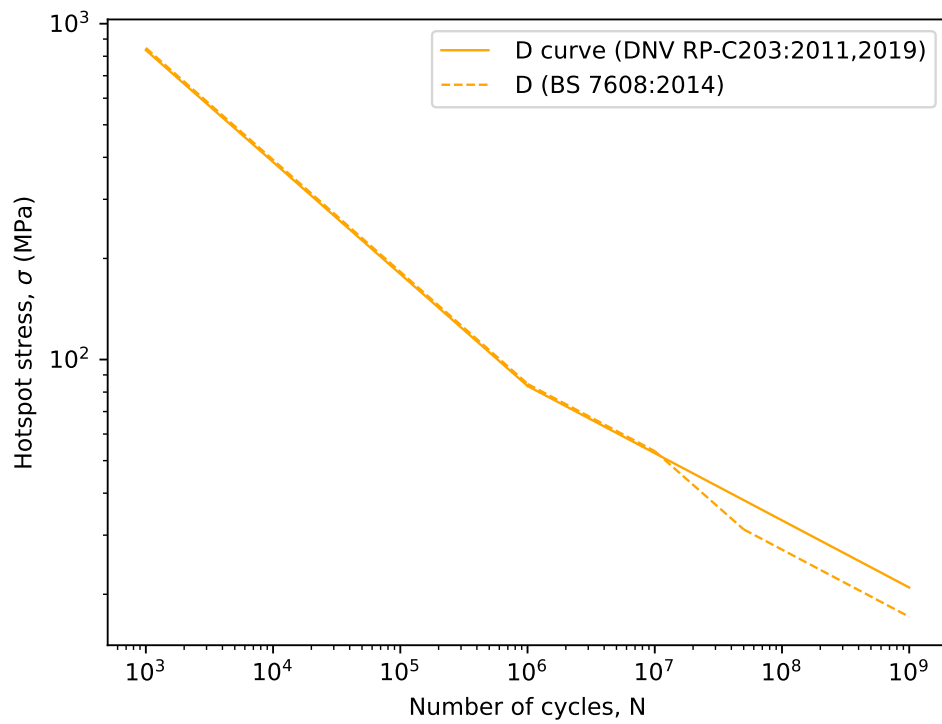


Figure 4: D curves

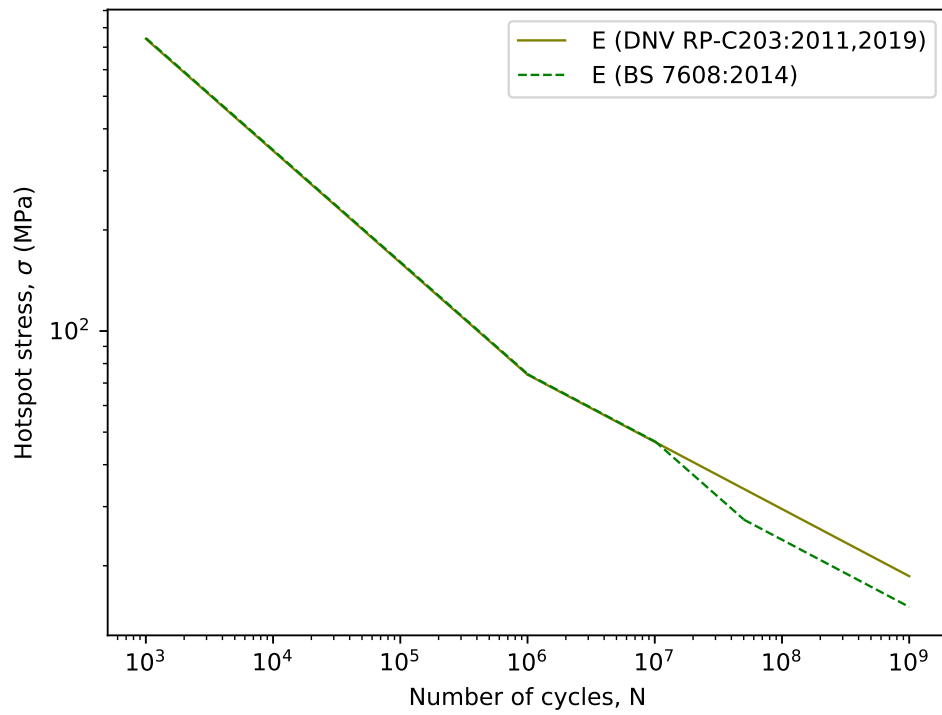


Figure 5: *E* curves

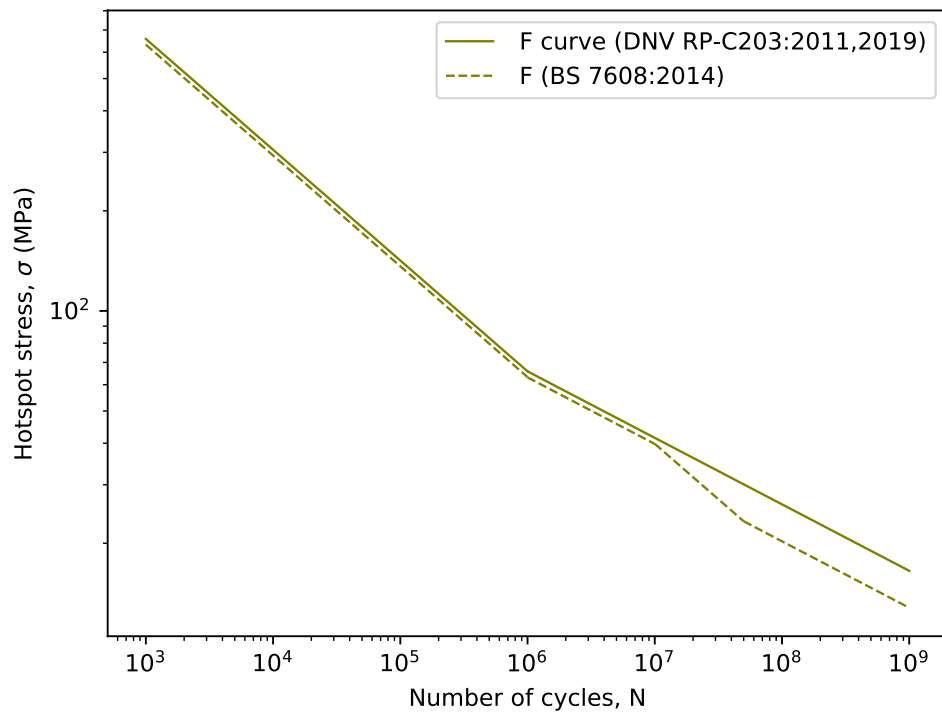


Figure 6: *F* curves

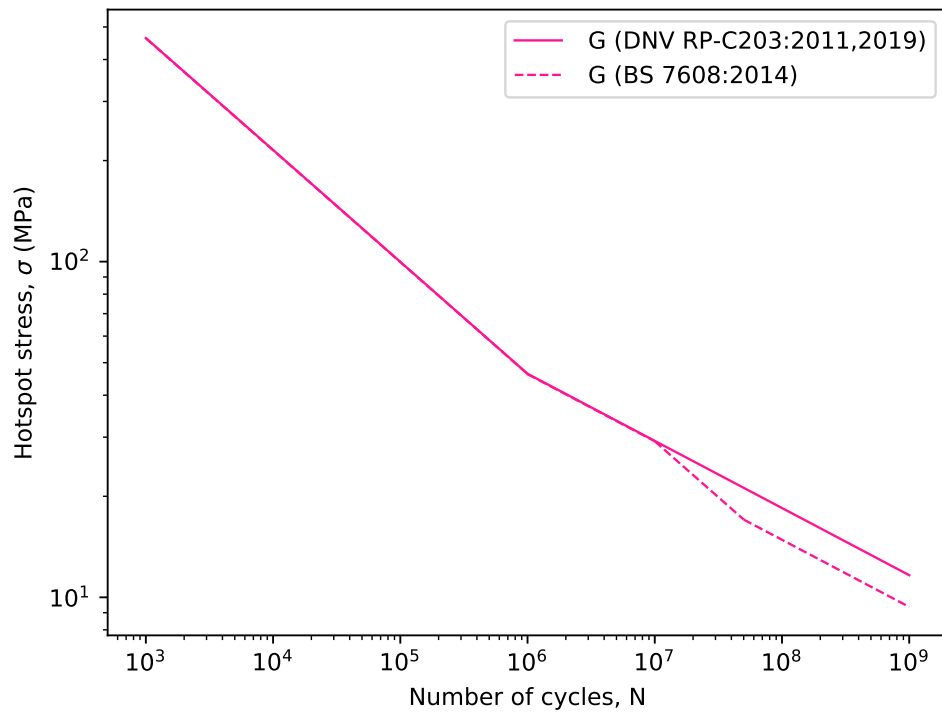


Figure 7:  $G$  curves

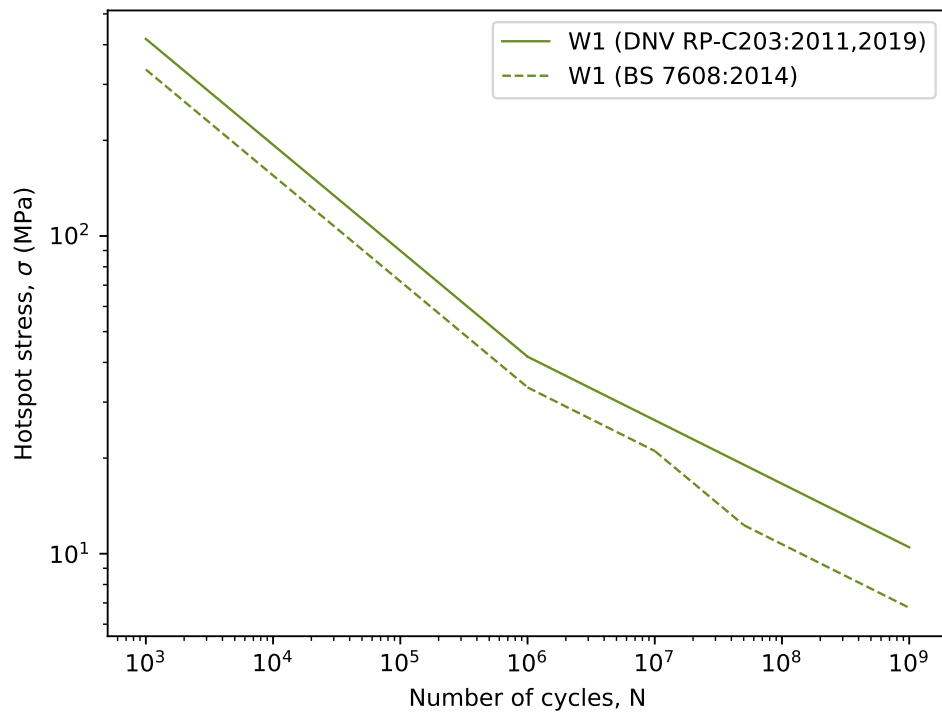


Figure 8:  $W$  curves

# Appendix

## A Plot code

```
1  #!/usr/bin/env python
2  # encoding: utf-8
3  """
4  Comparing S-N curves BS 7608:2014+A:2015 versus DNV RP-C203:2019
5  In seawater with cathodic protection
6
7  References:
8  - Table 20, BS 7608:2014+A1:2015
9  - Tables 2-2, 2-3, DNV RP-C203:2019
10
11 bsdnv.py -- 2021 ckunte
12
13 May 28: Initial commit.
14 """
15 import numpy as np
16 import matplotlib.pyplot as plt
17
18
19 def style():
20     plt.rcParams["grid.linestyle"] = ":"
21     plt.rcParams["grid.linewidth"] = 0.5
22     plt.grid(True)
23
24
25 def lbls():
26     plt.legend(loc=0)
27     plt.xlabel("Number of cycles, N")
28     plt.ylabel("Hotspot stress,  $\sigma$  (MPa)")
29     pass
30
31
32 def sncurve(
33     curve, r_start, r_mid, r_end, a1, m1, a2, m2, graphcolor, lsty
34 ):
35     # For slope 1 (m1)
36     n = np.arange(r_start, r_mid, 1.0e3)
37     s = (n / 10 ** a1) ** (-1 / m1)
38     plt.loglog(
39         n,
40         s,
41         base=10,
42         color=graphcolor,
43         ls=lsty,
44         linewidth=1.0,
45         label=curve,
46     )
47     # For slope 2 (m2)
48     n = np.arange(r_mid, r_end, 1.0e3)
49     s = (n / 10 ** a2) ** (-1 / m2)
50     plt.loglog(n, s, base=10, color=graphcolor, ls=lsty, linewidth=1.0)
51     pass
52
53
54 def bs_snc(
55     curve,
56     r_start,
57     r_mid1,
58     r_mid2,
```

```

59     r_mid3,
60     r_end,
61     a1,
62     m1,
63     a2,
64     m2,
65     a3,
66     m3,
67     a4,
68     m4,
69     graphcolor,
70     lsty,
71 ):
72     # For slope 1 (m1)
73     n = np.arange(r_start, r_mid1, 1.0e2)
74     s = (n / 10 ** a1) ** (-1 / m1)
75     plt.loglog(
76         n,
77         s,
78         base=10,
79         color=graphcolor,
80         ls=lsty,
81         linewidth=1.0,
82         label=curve,
83     )
84     # For slope 2 (m2)
85     n = np.arange(r_mid1, r_mid2, 1.0e2)
86     s = (n / 10 ** a2) ** (-1 / m2)
87     plt.loglog(n, s, base=10, color=graphcolor, ls=lsty, linewidth=1.0)
88     # For slope 3 (m3)
89     n = np.arange(r_mid2, r_mid3, 1.0e3)
90     s = (n / 10 ** a3) ** (-1 / m3)
91     plt.loglog(n, s, base=10, color=graphcolor, ls=lsty, linewidth=1.0)
92     # For slope 4 (m4)
93     n = np.arange(r_mid3, r_end, 1.0e3)
94     s = (n / 10 ** a4) ** (-1 / m4)
95     plt.loglog(n, s, base=10, color=graphcolor, ls=lsty, linewidth=1.0)
96     pass
97
98
99 def main():
100     # Plot all
101     style()
102     # TJ curve(s)
103     sncurve(
104         " T (DNV RP-C203:2019)",
105         1.00e3,
106         1.80e6,
107         1.00e9,
108         12.18,
109         3.0,
110         16.13,
111         5.0,
112         "black",
113         "-",
114     )
115     bs_snc(
116         "TJ (BS 7608:2014)",
117         1.0e3,
118         2.0e6,
119         1.0e7,
120         5.0e7,
121         1.0e9,

```

```

122         12.1761,
123         3.0,
124         16.1271,
125         5.0,
126         12.4757,
127         3.0,
128         15.6609,
129         5.0,
130         "black",
131         "--",
132     )
133     lbls()
134     plt.savefig("sncurves-tj.pdf")
135     plt.close()
136     # # B curve(s)
137     sncurve(
138         "B1 (DNV RP-C203:2011,2019)",
139         1.00e3,
140         1.00e6,
141         1.00e9,
142         14.917,
143         4.0,
144         17.146,
145         5.0,
146         "magenta",
147         "-",
148     )
149     bs_snc(
150         " B (BS 7608:2014)",
151         1.0e3,
152         1.0e5,
153         1.0e7,
154         5.0e7,
155         1.0e9,
156         14.6075,
157         4.0,
158         17.0086,
159         5.0,
160         15.0043,
161         4.0,
162         16.8319,
163         5.0,
164         "magenta",
165         "--",
166     )
167     lbls()
168     plt.savefig("sncurves-b.pdf")
169     plt.close()
170     # # C curve(s)
171     sncurve(
172         " C (DNV RP-C203:2011,2019)",
173         1.00e3,
174         1.00e6,
175         1.00e9,
176         12.192,
177         3.0,
178         16.320,
179         5.0,
180         "blue",
181         "-",
182     )
183     bs_snc(
184         " C (BS 7608:2014)",

```



```

185         1.0e3,
186         5.0e5,
187         1.0e7,
188         5.0e7,
189         1.0e9,
190         13.2279,
191         3.5,
192         16.4654,
193         5.0,
194         13.6263,
195         3.5,
196         16.1673,
197         5.0,
198         "blue",
199         "--",
200     )
201     lbls()
202     plt.savefig("sncurves-c.pdf")
203     plt.close()
204     # D curve(s)
205     sncurve(
206         " D curve (DNV RP-C203:2011,2019)",
207         1.00e3,
208         1.00e6,
209         1.00e9,
210         11.764,
211         3.0,
212         15.606,
213         5.0,
214         "orange",
215         "-",
216     )
217     bs_snc(
218         " D (BS 7608:2014)",
219         1.0e3,
220         1.0e6,
221         1.0e7,
222         5.0e7,
223         1.0e9,
224         11.7839,
225         3.0,
226         15.6365,
227         5.0,
228         12.1818,
229         3.0,
230         15.1703,
231         5.0,
232         "orange",
233         "--",
234     )
235     lbls()
236     plt.savefig("sncurves-d.pdf")
237     plt.close()
238     # E curve(s)
239     sncurve(
240         " E (DNV RP-C203:2011,2019)",
241         1.00e3,
242         1.00e6,
243         1.00e9,
244         11.610,
245         3.0,
246         15.350,
247         5.0,

```

```

248         "olive",
249         "--",
250     )
251     bs_snc(
252         " E (BS 7608:2014)",
253         1.0e3,
254         1.0e6,
255         1.0e7,
256         5.0e7,
257         1.0e9,
258         11.6170,
259         3.0,
260         15.3579,
261         5.0,
262         12.0170,
263         3.0,
264         14.8927,
265         5.0,
266         "green",
267         "--",
268     )
269     lbls()
270     plt.savefig("sncurves-e.pdf")
271     plt.close()
272     # F curve(s)
273     sncurve(
274         " F curve (DNV RP-C203:2011,2019)",
275         1.00e3,
276         1.00e6,
277         1.00e9,
278         11.455,
279         3.0,
280         15.091,
281         5.0,
282         "olive",
283         "--",
284     )
285     bs_snc(
286         " F (BS 7608:2014)",
287         1.0e3,
288         1.0e6,
289         1.0e7,
290         5.0e7,
291         1.0e9,
292         11.4031,
293         3.0,
294         15.0000,
295         5.0,
296         11.8007,
297         3.0,
298         14.5353,
299         5.0,
300         "olive",
301         "--",
302     )
303     lbls()
304     plt.savefig("sncurves-f.pdf")
305     plt.close()
306     # G curve(s)
307     sncurve(
308         " G (DNV RP-C203:2011,2019)",
309         1.00e3,
310         1.00e6,

```

```

311         1.00e9,
312         10.998,
313         3.0,
314         14.330,
315         5.0,
316         "deeppink",
317         "--",
318     )
319     bs_snc(
320         " G (BS 7608:2014)",
321         1.0e3,
322         1.0e6,
323         1.0e7,
324         5.0e7,
325         1.0e9,
326         10.9961,
327         3.0,
328         14.3243,
329         5.0,
330         11.3945,
331         3.0,
332         13.8573,
333         5.0,
334         "deeppink",
335         "--",
336     )
337     lbls()
338     plt.savefig("sncurves-g.pdf")
339     plt.close()
340     # W curve(s)
341     sncurve(
342         "W1 (DNV RP-C203:2011,2019)",
343         1.00e3,
344         1.00e6,
345         1.00e9,
346         10.861,
347         3.0,
348         14.101,
349         5.0,
350         "olivedrab",
351         "-",
352     )
353     bs_snc(
354         "W1 (BS 7608:2014)",
355         1.0e3,
356         1.0e6,
357         1.0e7,
358         5.0e7,
359         1.0e9,
360         10.5717,
361         3.0,
362         13.6170,
363         5.0,
364         10.9699,
365         3.0,
366         13.1492,
367         5.0,
368         "olivedrab",
369         "--",
370     )
371     lbls()
372     plt.savefig("sncurves-w.pdf")
373     plt.close()

```

```
374     pass
375
376
377 if __name__ == "__main__":
378     main()
```