

Quiz Answer Key - The Inspector's Calc's

1. Most math mistakes are the result of: ***b. the inspector's failure to write the formula.***
2. When completing a calculation, always: ***c. add the appropriate units. (ipy, yrs, etc.)***
3. A "mil" is: ***a. one-thousandth of an inch.***

4. Write the formula for calculating the *Short-Term* corrosion rate.

$$\mathbf{CR_{short} = (t_{prev} - t_{last}) / time}$$

5. Write the formula for calculating the *Long-Term* corrosion rate.

$$\mathbf{CR_{long} = (t_{first} - t_{last}) / time}$$

6. Write the formula for calculating the *Remaining Life*.

$$\mathbf{Life = (t_{last} - t_{min}) / CR}$$

7. Convert the date, May 2013 to a number.

$$\mathbf{2013.42 \text{ (May is 5}^{\text{th}} \text{ month. } 5/12 = 0.42)}$$

8. Convert the number 2022.75 to a date (*year and month*).

$$\mathbf{September 2029 \text{ (} 0.75 \times 12 = 9, 9^{\text{th}} \text{ month is September)}}$$

9. In March 2013, a CML was measured at 0.289". In March 2020 the same CML was measured at 0.268". Calculate the *Corrosion Rate*.

$$\mathbf{CR = (0.289 - 0.268) / (2020.25 - 2013.25) = 0.021 / 7 = 0.003 \text{ ipy}}$$

10. In October 2011, a CML was measured at 0.435". In February 2019 the same CML was 0.384". Calculate the *Corrosion Rate*.

$$\mathbf{CR = (0.435 - 0.384) / (2019.17 - 2011.83) = 0.051 / 7.34 = 0.0069 \text{ ipy}}$$

11. Calculate the controlling *Corrosion Rate* for the following CML.

$$\mathbf{CR_{long} = (0.600 - 0.560) / (2020.08 - 2010.08) = 0.040 / 10 = 0.004 \text{ ipy}}$$

$$\mathbf{CR_{short} = (0.565 - 0.560) / (2020.08 - 2015.08) = 0.005 / 5 = 0.001 \text{ ipy}}$$

Choose highest CR 0.004 ipy

12. The controlling *corrosion rate* at a CML is 0.004 ipy. The *current thickness* is 0.332” and the *retirement thickness* is 0.268”. Calculate the *Remaining Life* at this CML.

$$\text{Life} = (0.332 - 0.268) / 0.004 = 16 \text{ yrs}$$

13. Calculate the *Remaining Life* for this CML.

$$CR_{long} = (0.320 - 0.282) / (2020.5 - 2003.5) = 0.038 / 17 = 0.0022 \text{ ipy}$$

$$CR_{short} = (0.308 - 0.282) / (2020.5 - 2015.5) = 0.026 / 5 = 0.0052 \text{ ipy}$$

Choose highest CR 0.0052 ipy

$$\text{Life} = (0.282 - 0.228) / 0.0052 = 10.4 \text{ yrs}$$

14. **API 510 students:** For a vessel, the controlling *Corrosion Rate* is 0.006 ipy and the *Remaining Corrosion Allowance* is 0.096”. Determine the *Intervals* for the *Internal* and *External Inspections*.

$$\text{Life} = 0.096 / 0.006 = 16 \text{ yrs}$$

$$\text{Internal Interval} = \text{Lesser of } \frac{1}{2} \text{ life } (0.5 \times 16 = 8 \text{ yrs}), \text{ or } 10 \text{ yrs} = 8 \text{ yrs}$$

$$\text{External Interval} = \text{Lesser of Internal Interval } (8 \text{ yrs}), \text{ or } 5 \text{ yrs} = 5 \text{ yrs}$$

15. **API 570 students:** For a *Class 2* pipe circuit, the controlling *Corrosion Rate* is 0.006 ipy and the *Remaining Corrosion Allowance* is 0.096”. Determine the *Intervals* for the *Thickness Measurement* and *External Inspections*.

$$\text{Life} = 0.096 / 0.006 = 16 \text{ yrs}$$

$$\text{Class 2: Thick Interval} = \text{Lesser of } \frac{1}{2} \text{ life } (0.5 \times 16 = 8 \text{ yrs}), \text{ or } 10 \text{ yrs} = 8 \text{ yrs}$$

$$\text{Class 2: External Interval} = 5 \text{ yrs (no calculation)}$$

16. **API 653 students:** For a tank shell, the controlling *Corrosion Rate* is 0.006 ipy and the *Remaining Corrosion Allowance* is 0.096”. Determine the *Intervals* for the *Shell Thickness Measurements* and the *External Inspections*.

$$\text{Life} = 0.096 / 0.006 = 16 \text{ yrs}$$

$$\text{Shell Thickness Interval} = \text{Lesser of } \frac{1}{2} \text{ life } (0.5 \times 16 = 8 \text{ yrs}), \text{ or } 15 \text{ yrs} = 8 \text{ yrs}$$

$$\text{External Interval} = \text{Lesser of } \frac{1}{4} \text{ life } (0.25 \times 16 = 4 \text{ yrs}), \text{ or } 5 \text{ yrs} = 4 \text{ yrs}$$

17. **API 510 students:** The *Remaining Life* of a vessel is 3 years. Determine the *Intervals* for the *Internal* and *External Inspections*.

$$\text{Internal Interval (when life} < 4 \text{ yrs)} = \text{Lesser full life } (3 \text{ yrs}) \text{ or } 2 \text{ years} = 2 \text{ yrs}$$

$$\text{External Interval} = \text{Lesser of Internal Interval } (2 \text{ yrs}), \text{ or } 5 \text{ yrs} = 2 \text{ yrs}$$

18. If there are multiple CMLs on an equipment item, which CML controls the *Remaining Life* calculation? ***e. The CML with the shortest remaining life.***
19. ***API 510 students:*** Use the above thickness data for a vessel. Determine the *Interval* and *Next Inspection Date* for the *Internal* and *External Inspections*.

Step 1: Calc Remaining Life for CML #1

$$CR_{long} = (0.480 - 0.422) / (2020.33 - 2005.08) = 0.058 / 15.25 = 0.0038 \text{ ipy}$$

$$CR_{short} = (0.428 - 0.422) / (2020.33 - 2018.67) = 0.006 / 1.66 = 0.0036 \text{ ipy}$$

Choose highest CR: 0.0038 ipy

$$\text{Life} = (0.422 - 0.380) / 0.0038 = 11.05 \text{ yrs}$$

Step 2: Calc Remaining Life for CML #2

$$CR_{long} = (0.478 - 0.433) / (2020.33 - 2005.08) = 0.045 / 15.25 = 0.003 \text{ ipy}$$

$$CR_{short} = (0.442 - 0.433) / (2020.33 - 2018.67) = 0.009 / 1.66 = 0.0054 \text{ ipy}$$

Choose highest CR: 0.0054 ipy

$$\text{Life} = (0.433 - 0.380) / 0.0054 = 9.8 \text{ yrs}$$

Step 3: Pick shortest Life of the CMLs (9.8 years)

Step 4: Calc Internal Inspection Interval

$$\text{Interval} = \text{Lesser of } \frac{1}{2} \text{ Life } (0.5 \times 9.8 = 4.9 \text{ yr}), \text{ or } 10 \text{ yr} = 4.9 \text{ yr}$$

Step 5: Calc Next Inspection Date for Internal

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 4.9 = 2025.23$$

$$\text{Convert Partial Yrs to months: } 0.23 \times 12 = 2.76 \text{ months} = \text{March}$$

$$\text{NID} = \text{March 2025}$$

Step 6: Calc External Inspection Interval

$$\text{Interval} = \text{Lesser of Internal Interval } (4.9 \text{ yr}), \text{ or } 5 \text{ yr} = 4.9 \text{ yr}$$

Step 7: Calc Next Inspection Date for External

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 4.9 = 2025.23$$

$$\text{Convert Partial Yrs to months: } 0.23 \times 12 = 2.76 \text{ months} = \text{March}$$

$$\text{NID} = \text{March 2025}$$

20. **API 570 students:** Use the above thickness data for a Class 3 piping circuit. Determine the *Interval* and *Next Inspection Date* for the *Thickness Measurement* and *External Inspections*.

Step 1: Calc Remaining Life for CML #1

$$CR_{long} = (0.480 - 0.422) / (2020.33 - 2005.08) = 0.058 / 15.25 = 0.0038 \text{ ipy}$$

$$CR_{short} = (0.428 - 0.422) / (2020.33 - 2018.67) = 0.006 / 1.66 = 0.0036 \text{ ipy}$$

Choose highest CR: 0.0038 ipy

$$\text{Life} = (0.422 - 0.380) / 0.0038 = 11.05 \text{ yrs}$$

Step 2: Calc Remaining Life for CML #2

$$CR_{long} = (0.478 - 0.433) / (2020.33 - 2005.08) = 0.045 / 15.25 = 0.003 \text{ ipy}$$

$$CR_{short} = (0.442 - 0.433) / (2020.33 - 2018.67) = 0.009 / 1.66 = 0.0054 \text{ ipy}$$

Choose highest CR: 0.0054 ipy

$$\text{Life} = (0.433 - 0.380) / 0.0054 = 9.8 \text{ yrs}$$

Step 3: Pick shortest Life of the CMLs (9.8 years)

Step 4: Calc Thickness Measurement Inspection Interval (Class 3)

$$\text{Interval} = \text{Lesser of } \frac{1}{2} \text{ Life } (0.5 \times 9.8 = 4.9 \text{ yr}), \text{ or } 10 \text{ yr} = 4.9 \text{ yr}$$

Step 5: Calc Next Inspection Date for Thickness Measurements

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 4.9 = 2025.23$$

$$\text{Convert Partial Yrs to months: } 0.23 \times 12 = 2.76 \text{ months} = \text{March}$$

NID = March 2025

Step 6: Calc External Inspection Interval

$$\text{Interval} = 10 \text{ yr (from API 570 Table 6)}$$

Step 7: Calc Next Inspection Date for External

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 10 = 2030.33$$

$$\text{Convert Partial Yrs to months: } 0.33 \times 12 = 4 \text{ months} = \text{April}$$

NID = April 2030

Note: It doesn't make sense to have an interval extend beyond the life of the equipment, but that's an omission in this Code. Good practice is to limit this interval to the equipment life.

21. **API 653 students:** Use the above thickness data for a tank. Determine the *Interval* and *Next Inspection Date* for the *Shell Thickness Measurement* and *External Inspections*.

Step 1: Calc Remaining Life for CML #1

$$CR_{long} = (0.480 - 0.422) / (2020.33 - 2005.08) = 0.058 / 15.25 = 0.0038 \text{ ipy}$$

$$CR_{short} = (0.428 - 0.422) / (2020.33 - 2018.67) = 0.006 / 1.66 = 0.0036 \text{ ipy}$$

Choose highest CR: 0.0038 ipy

$$\text{Life} = (0.422 - 0.380) / 0.0038 = 11.05 \text{ yrs}$$

Step 2: Calc Remaining Life for CML #2

$$CR_{long} = (0.478 - 0.433) / (2020.33 - 2005.08) = 0.045 / 15.25 = 0.003 \text{ ipy}$$

$$CR_{short} = (0.442 - 0.433) / (2020.33 - 2018.67) = 0.009 / 1.66 = 0.0054 \text{ ipy}$$

Choose highest CR: 0.0054 ipy

$$\text{Life} = (0.433 - 0.380) / 0.0054 = 9.8 \text{ yrs}$$

Step 3: Pick shortest Life of the CMLs (9.8 years)

Step 4: Calc Thickness Measurement Inspection Interval

$$\text{Interval} = \text{Lesser of } \frac{1}{2} \text{ Life } (0.5 \times 9.8 = 4.9 \text{ yr}), \text{ or } 15 \text{ yr} = 4.9 \text{ yr}$$

Step 5: Calc Next Inspection Date for Thickness Measurements

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 4.9 = 2025.23$$

Convert Partial Yrs to months: $0.23 \times 12 = 2.76 \text{ months} = \text{March}$

NID = March 2025

Step 6: Calc External Inspection Interval

$$\text{Interval} = \text{Lesser of } \frac{1}{4} \text{ Life } (0.25 \times 9.8 = 2.45 \text{ yr}), \text{ or } 5 \text{ yr} = 2.45 \text{ yr}$$

Step 7: Calc Next Inspection Date for External

$$\text{NID} = \text{Last Insp Date} + \text{Interval} = 2020.33 + 2.45 = 2022.78$$

Convert Partial Yrs to months: $0.78 \times 12 = 9 \text{ months} = \text{September}$

NID = September 2022