A Study Guide for Pressure Equipment Inspectors

The Inspector's Calc's

Corrosion Rates
Equipment Remaining Life
Inspection Intervals
Next Inspection Date

How are these calculations related?

An important role for Authorized Inspectors is setting appropriate inspection intervals. Intervals are often based on the *Remaining Life* of the equipment. The *Remaining Life* of the equipment is most often determined using the *Corrosion Rate* of the equipment. Thus to set the interval, the inspector must know how to determine the *Corrosion Rate* and *Remaining Life*.

Why are these calculations important?

During the API certification exam, you will perform many calculations. e.g. retirement thickness, hydrotest pressure, etc. At the job-site, engineers usually perform most calculations. But … the calcs that every inspector must successfully perform are the corrosion rate, remaining life and interval calculations. These calcs *"belong"* to the inspector.

Sure, most inspection records programs perform these calculations. But don't be a wimp inspector who just relies on the computer! Remember, autopilot computers can fly and land an airplane, but we still want a live pilot in the seat! Let's look at the following situations. If you were this inspector, imagine how silly you could look!

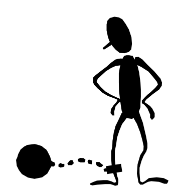
Situation 1: During the turnaround the plant spends $250,000 to clean, isolate and open a large vessel. You were the one that had last inspected the vessel and had set the internal interval at 3 years. During the current inspection, the vessel is found to be in better shape than expected. Another inspector reviews the old thickness data and determines that you blew the calculations! The internal inspection could have been set at 10 years. The Process Manager is extremely upset about wasting the money required to prepare this vessel for this unnecessary inspection.

The result: *You're embarrassed!*

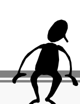
Situation 2: You are assigned as the bundle inspector during a chemical plant turnaround. You are organized, have copies of all the old inspection data, and are basically having a great time inspecting remote from all the normal turnaround hub-bub. But … one of the last bundles inspected has unexpected deep corrosion and is made of an exotic alloy. The word quickly gets out and suddenly the key Operations & Maintenance Leads show up at the bundle cleaning area. Their first question is not, "How's the weather?", or, "How's the bundle cleaners doing?", but ... "Will the bundle make the next operational run???" You sheepishly look at the past records and tell them you will not know until after you have plugged the data into the computer. They walk away disgusted, muttering something about your lack of ability.

The result: *You're embarrassed!*

Situation 3: A vessel fails and results in a tremendous fire. Two contract craftsmen are injured and will have permanent disabilities. During the post-fire investigation, it is determined that you made a mistake when calculating the corrosion rate. The actual corrosion rate was 0.020 ipy, but … you missed a decimal and used 0.002 ipy! The primary cause of the fire was your mistake.



The result: *You're embarrassed! You sorrow for those hurt, you're depressed, you may be fired, you may have your API certs pulled, and you'll probably have to admit your mistakes in a lawsuit. All because of a silly little decimal point!*



These Calculations are Important!!

What's a Subscript?

Before proceeding further, lets understand subscripts! In math, *"subscripts"* are used to differentiate between values that use a similar symbol. For example, ***"t"*** often represents ***"thickness"***. However, many thicknesses are important to us, *e.g. nominal thickness, minimum thickness, etc*. Subscripts clearly communicate which thickness you are using in a calculation. Always use subscripts in Corrosion Rate calculations. *YES THAT MEANS YOU!*

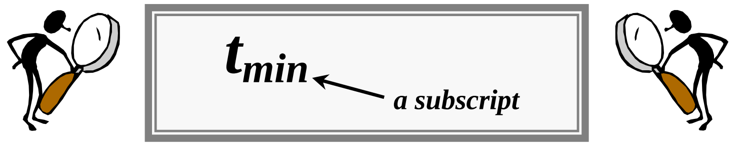


Table 1 lists the most common thicknesses and the common math symbol.

Table 1: Types of Thicknesses

Thickness	*Math Symbol*	*Notes*
Nominal thickness	t_{nom} or $t_{nominal}$	*Based on std pipe or plate thickness*
Initial thickness	t_{ini} or $t_{initial}$ or t_{base}	*At a TML - First thickness reading. Also called base or first reading.*
Previous thickness	t_{pre} or $t_{previous}$	*At a TML - The previous(prior) thickness reading*
Last thickness	t_{last} or $t_{current}$ or t_{actual}	*At a TML - The most recent thickness reading. Also called current or actual*
Retirement thickness	$t_{retirement}$ or t_{min} or $t_{minimum}$	*Minimum allowed thickness. Also called minimum thickness*

What is a Speed?

A *Speed* is how fast something moves. Speed always has units of ***a distance per time.*** Speeds are expressed different ways depending on what units are most convenient. For example, traveling in a car, speed is measured in miles-per-hour (mph). It would be ridiculous to say we're traveling 3,801,600 inches-per-hour, but that's exactly the same as 60 mph. Typical speed units are illustrated in ***Table 2***.

Table 2: Speed Units

Speed Types	*US Speed Units*	*US Symbols*
Automobiles	*miles per hour*	*mph*
Bullets	*feet per second*	*fps*
Light	*miles per second*	*mps*
Corrosion	*inches per year, or mils per year*	*ipy or mpy*

A Corrosion Rate is a Speed!

A Corrosion Rate is a Speed! The Corrosion Rate is the speed of *"Corrosion BUG"* eating through the metal! The units commonly used to measure the speed of the corrosion bug are inches-per-year or mils-per-year. *(A Corrosion Rate in metric measurements would be mm/yr)*

Current Speed vs. Average Speed

If we're on a trip and want to estimate our arrival time we need to know our average speed. Our current speed is not that useful. At one moment, we may be driving at 70 mph, and then a few minutes later we get stuck in traffic and are only going 15 mph. Or, we may be on a long trip and will have to stop for gas and meals. This reduces our average speed and lengthens the duration of the trip.

Likewise, when we calculate the *Remaining Life* of equipment, we need to know the *Average Speed* of the *"Corrosion Bug",* not an instantaneous speed. Some days the bug may be *"eating"* faster, and other days slower. The arrival time to the retirement thickness will be based on the average speed of the *"Bug"*.

How is Average Speed Calculated?

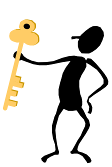
Current speeds are measured by various devices. For example, the speedometer measures the current speed of a car, and a radar gun measures the current speed of a baseball. But these devises do not measure the average speed of an object. An average speed must always be calculated. The formula for average speed is always:

$$\textit{Average Speed} = \frac{\textit{Distance Traveled}}{\textit{Travel Time}}$$

Illustration: An Average Car Speed

You're on a trip and have traveled 340 miles in 6 hrs. Your high speed was 73 mph, but you stopped once for lunch and were slowed by some construction work. What is your average speed?

$$\textit{Speed} = \frac{\textit{340 miles}}{\textit{6 hours}} = \textit{56.7 mph}$$



Key! All speeds always use the term *"per",* as in *miles-per-hour*, or *inches-per-year*. In mathematical terms, what is the meaning of *"per"*? ***"PER" means "DIVIDED BY".*** Remember this and you will always be able to write the formula for a corrosion rate or any other speed. ***So miles-per-hour is just miles-divided by-hours.***

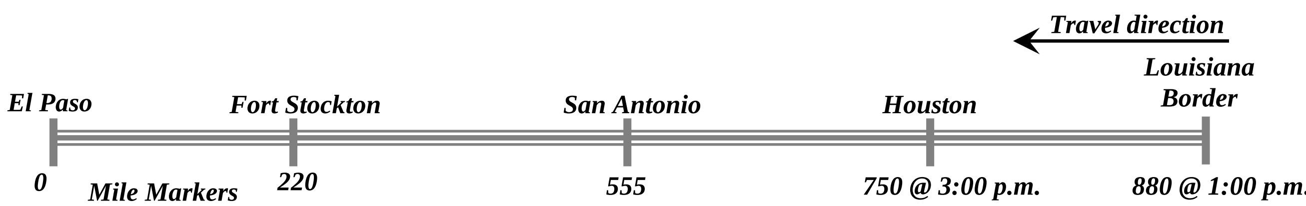
Determining a Speed

Automobile Speed (mph):	***Miles Traveled "DIVIDED BY" Hours Traveled***
Corrosion Speed (ipy):	***Inches Traveled "DIVIDED BY" Years Traveled***

Illustration: Taking a Vacation

Determining the *Corrosion Rate* and *Remaining Life* is a major role for an authorized inspector. The best way to learn these calculations is by *"Taking a Vacation"*. Let's roll! Alamo here we come!

We are heading west from Louisiana and want to see the Alamo in San Antonio. At 1:00 p.m. we cross the Texas/Louisiana border, *highway mile marker 880*. At 3:00 p.m. we pass downtown Houston, *mile marker 750*. If we maintain the same average speed, when will we reach San Antonio, *mile marker 555?* Let's calculate!



Step 1: Calculate Average Speed

First we must calculate our Average Speed

$$\text{Speed} = \frac{\text{Distance Traveled}}{\text{Time Traveled}}$$

$$\text{Speed} = \frac{880 - 750}{3{:}00 - 1{:}00} = \frac{130 \text{ miles}}{2 \text{ hours}} = 65 \text{ mph}$$

Step 2: Calculate Remaining Trip Time

Next, we must determine the Remaining Life of our trip

$$\text{Time Remaining} = \frac{\text{Distance To Go}}{\text{Speed}}$$

$$\text{Time Remaining} = \frac{750 - 555}{65} = \frac{195 \text{ miles}}{65 \text{ mph}} = 3 \text{ hrs}$$

Step 3: Determine Arrival Time

Now, let's determine our Arrival Time

Arrival Time = Current Time + Remaining Time

Arrival Time = 3:00 p.m. + 3 hours = 6:00 p.m.

The Key!!! Understand these simple steps! When calculating the equipment's Next Inspection Date, we use the same basic steps!

How do I calculate the Corrosion Rate?

The introduction is complete. Time to direct our attention to real problems. Let's first learn how to calculate a *Corrosion Rate*. Later we'll learn how to calculate *Remaining Life* and the *Next Inspection Date*. Remember a *Corrosion Rate is a Speed!* It's how fast the *"Corrosion BUG"* is eating through the metal! And speeds are always distance traveled divided by the time traveled. In corrosion, the ***DISTANCE TRAVELED is the METAL LOSS***. Here is the formula.

Formula #1:
Corrosion Rate

$$\textit{Corrosion Rate} = \frac{\textit{metal loss}}{\textit{time period}} = \frac{t_{previous} - t_{last}}{\textit{time period}}$$

<u>Illustration</u>: Calculate the Corrosion Rate

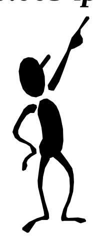
Here is the thickness data for a specific TML. Calculate the *Corrosion Rate*.

Thickness Data

TML #	*Jan. 2014*	*Jan. 2004*
01	*0.450"*	*0.500"*

$$CR = \frac{t_{previous} - t_{last}}{time}$$

$$CR = \frac{0.500 - 0.450}{2014 - 2004} = \frac{0.050}{10} = 0.005 \text{ ipy}$$



Always add units to your answer!
Don't say the corrosion rate is 0.005.
Is that 0.005 mm/yr or 0.005 ft/second?

Time to Practice: Calculate the *Corrosion Rate* in the following exercises. An *Answer Key* is provided in the website as another "pdf" file to download.

<u>Exercise 1</u>: Calculate the Corrosion Rate

Thickness Data

TML #	*Jan. 2015*	*Jan. 1995*
08	*0.260"*	*0.400"*

$$CR = \frac{t_{previous} - t_{last}}{time}$$

CR = ____________ = ________ = ________ ***ipy***

<u>Exercise 2</u>: Another Corrosion Rate Calculation

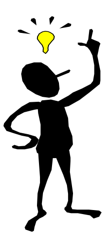
Thickness Data

TML #	*Nov. 2014*	*Nov. 1999*
C-5	*0.675"*	*0.750"*

CR = ____________

Remember! Always write the formula!

CR = ____________ = ________ = ________ ***ipy***



Always write the formula! Failure to write the formula is the Number 1 cause of calculation mistakes!

<u>Illustration</u>: Calculate a Corrosion Rate using Mils

You can also work corrosion rate problems in *mil*s. A *"mil"* is equal to a thousandth of an inch *(1 mil = 0.001")*. I like to work these problems in mils since there are fewer decimals and … it is much easier to say *"mils per year"* vs. *"thousandth of an inch per year"!*

Here is the thickness data for a specific TML. Calculate the *Corrosion Rate*.

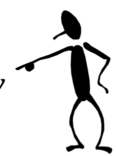
Thickness Data

TML #	***March 2015***	***March 2008***
TH-3	***0.280"***	***0.350"***

Convert thickness readings to mils; 280 mils & 350 mils

$$CR = \frac{t_{previous} - t_{last}}{time}$$

$$CR = \frac{350 - 280}{2015 - 2008} = \frac{70}{7} = 10 \text{ mpy}$$



Since we used mils, the units on the answer are in mils-per-year

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<u>Exercise 3</u>: Calculate the Corrosion Rate with Mils

Calculate this *Corrosion Rate* using mils.

Thickness Data

TML #	***Nov. 2014***	***Nov. 1992***
32	***0.410"***	***0.480"***

CR = ________________ ***Remember! Always write the formula!***

CR = ________________ = ________ = ________ ***mpy***

What is this Corrosion Rate in "ipy"? __________ ***ipy***

Calculating a Corrosion Rate when readings were taken on different Months

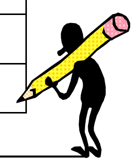
In our previous examples, the thicknesses readings were taken exactly on the same month. Therefore, the length of time between the thickness readings was in whole years. In *"real life"*, the readings are often taken at different months. This makes the calculation a bit trickier. Let's illustrate!

The Key to this Problem! We have to convert the Month into a fraction of a Year. For example, suppose a reading was taken in May 2003. May is the 5th month. Since there are 12 months in a year, *May is 5/12ths of a year*. *(and 5/12 = 0.42)*. Therefore, May 2003 can be represent as *2003.42*.

<u>Exercise 4</u>: Convert Months to Years

Complete this Table. Row #1 is completed as an example.

	Date	***Month #***	***Fractional Year***	***Decimal Year***	***Total Years***
1	***April 1998***	***4th***	***4/12***	***0.33***	***1998.33***
2	***Feb. 1995***				
3	***June 2011***				
4	***Nov. 2007***				

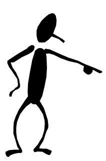


<u>Illustration</u>: Calculate a Corrosion Rate with "Odd" Months

Here's the data. Let's do it!

Thickness Data

TML #	***March 2015***	***Oct 2012***
N-2	***0.275"***	***0.288"***



Step 1 - Convert the months to years.

March 2015 = 2015.25 (March is 3rd month, so 3/12 of a year, which = 0.25 yrs)

Oct 2012 = 2012.83 (Oct is 10th month, so 10/12 of a year, which = 0.83 yrs)

Step 2 - Calc Corrosion Rate

$$CR = \frac{t_{previous} - t_{last}}{time}$$

$$CR = \frac{0.288 - 0.275}{2015.25 - 2012.83} = \frac{0.013}{2.42} = 0.0054 \text{ ipy}$$

Note! The dates have been converted to numbers!!!

<u>Exercise 5</u>: Calculate a Corrosion Rate with "Odd" Months

Calculate this *Corrosion Rate*. *(either in ipy or mpy)*

Thickness Data

TML #	Sept 2014	April 2010
HD-2	0.521"	0.565"

Step 1 - Convert the months to years.

September 2014 = ______________________

April 2010 = ______________________

Step 2 - Calc Corrosion Rate

CR **=** ____________ ***Remember! Always write the formula!***

CR **=** ____________ **=** ________ **=** ________ ***ipy***

How do I calculate the Remaining Life?

The *Remaining Life* at a specific TML is the length of time remaining until this point corrodes to the retirement thickness. The ***Remaining Life is the life from date of the last thickness reading.*** It is not the remaining time from today's date (unless the last reading was taken today). The *Remaining Life* is basically how long until the *"Corrosion Bug"* eats through the *Remaining Corrosion Allowance.*

Retirement thickness is also called *minimum thickness* (t_{min}). The retirement thickness (minimum thickness) is calculated using appropriate formulas from the construction code.

Here is the formula for *Remaining Life*:

Formula #2: Remaining Life

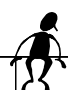
$$\textit{Remaining Life} = \frac{\text{Remaining Corrosion Allowance (RCA)}}{\text{Corrosion Rate (CR)}} = \frac{t_{last} - t_{min}}{CR}$$

Note! The Remaining Life for an Equipment Item is based on the TML with the lowest Remaining Life!

<u>Illustration</u>: Calculate Remaining Life

Here is the thickness data for TML #6. The corrosion rate at this TML is 0.005 ipy. Calculate the *Remaining Life.*

Thickness Data

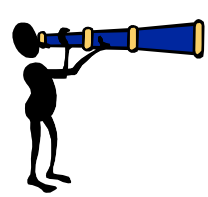


TML #	$t_{minimum}$	*Jan. 2015*	*Jan. 2005*
6	*0.270"*	*0.300"*	*0.350"*

$$\textit{Life} = \frac{t_{last} - t_{min}}{CR}$$

No need to calculate the Corrosion Rate. It was given in the problem.

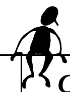
$$\textit{Life} = \frac{0.300 - 0.270}{0.005} = \frac{0.030}{0.005} = 6 \text{ yrs}$$



The Equipment Life at this TML is 6 years from the last inspection date (January 2015).

<u>Exercise 6</u>: Calculate the Remaining Life

Calculate this *Remaining Life* for the following TML.



TML Data

TML #	*Corrosion Rate*	$t_{minimum}$	*March 2015*
D-7	*0.007 ipy*	*0.150"*	*0.198"*

Life = ______________ ***Remember! Always write the formula!***

Life = ______________ = ________ = ________ ***yrs***

<u>Exercise 7</u>: Another Remaining Life

Calculate this *Remaining Life* for the following TML.

TML Data

TML #	*Corrosion Rate*	$t_{minimum}$	*March 2015*
D-8	*0.003 ipy*	*0.150"*	*0.211"*

Life = ______________ ***Remember! Always write the formula!***

Life = ______________ = ________ = ________ ***yrs***

How do I determine the Inspection Interval?

Inspection Intervals are determined based on the applicable requirements from the *Inspection Code*. *Table-3* summarizes the current rules for setting the Inspection Intervals.

Note! When establishing the interval for most inspection types, the *Remaining Life* must be calculated first. Without knowing the *Remaining Life*, the *Interval* cannot be set!

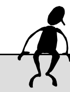


Table 3:
Interval Rules

Inspection Code	*Inspection Type*	*Inspection Interval Rule*
API 510 - Vessels	***Internal***	***a) Normally, lesser of: 10 yrs or ½ Life, or*** ***b) 2 yrs - if Life is from 2-4 yrs, or*** ***c) Full Life - if Life is < 2 yrs***
	External	***Lesser of: 5 yrs or the Inspection Interval***
API 570 - Piping	***Thickness Readings***	***Lesser of: ½ Life or maximum interval specified in API 570 Table 6-1. (Max interval is either 5 or 10 yrs based on Piping Class)***
	External	***No relationship to Life. (Seems a bit weird, but that's the way the Code is written)***
API 653 - Tanks	***External***	***Lesser of: ¼ Life of Shell or 5 yrs***
	Internal	***Lesser of: Full Life of Bottom or 20 yrs***
	UT of Shell	***Lesser of: ½ Life of Shell or 15 yrs***

How do I determine the Next Inspection Date?

How do you determine when to change the oil in your car? The *"interval"* for an oil change is usually 3000 miles. So when is the next oil change due? Its the ***Last Oil Change plus the Interval***.

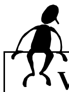
For inspection schedules, the *Next Inspection Date* works exactly the same. When is an equipment inspection due? It's just the ***Last Inspection Date plus the Interval***. Here is the formula.

Formula #3:
Next Inspect Date

Next Inspection Date = Last Inspection Date + Interval

<u>Illustration</u>: Calculate the Next Inspection Date

Here is the data for a vessel. Determine the *Interval* and *Next Inspection Date* for the *Internal Inspection*.



Vessel Data

Vessel	Remaining Life	Last Inspection
V-100	12 yrs	January 2015

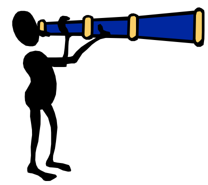
Step 1 - Calculate the Interval

Interval = Lesser of: ½ life or 10 yrs *(Per API 510 Code)*

= Lesser of: 12 x ½ = 6 yr, or 10 yrs

= 6 yrs

Step 2 - Calculate the Next Inspection Date (NID)



NID = Last Inspection Date + Interval

= January 2015 + 6 yrs

= January 2021

<u>Exercise 8</u>: Calculate the Next Inspection Date

Here is the data for a vessel. Determine the *Interval* and *Next Inspection Date* for the *Internal Inspection*.

Vessel Data

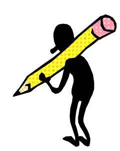
Vessel ID	Remaining Life	Last Inspection
V-200	*14 yrs*	*March 2015*

Step 1 - Calculate the Internal Interval

Interval = Lesser of: ______________________________

= Lesser of: ______________________________

= ____________



Remember!
Always write the formula!

Step 2 - Calculate the Next Inspection Date (NID)

NID = ______________________________

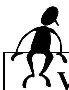
= ______________________________

= ______________

<u>Illustration</u>: Calculate the Next Inspection Date with Odd Months

Not all inspection intervals are in nice "round" years. Suppose a vessel has a *Remaining Life* of 9.5 yrs. Then the *Internal Inspection Interval* is 4.75 yrs. Determining this *Next Inspection Date* is a bit more difficult. Let's show you how it's done. Here is the data for this vessel. Determine the *Next Inspection Date* for the *Internal Inspection*.

Vessel Data



Vessel	**Remaining Life**	**Last Inspection**
V-300	**9.5 yrs**	**October 2014**

Step 1 - Calculate the Interval

Interval = Lesser of: ½ life or 10 yrs *(Per API 510 Code)*

= Lesser of: 9.5 x ½ = 4.75 yr, or 10 yrs

= 4.75 yrs

Step 2 - Convert the Last Inspection Date to a Number)

October 2014 = 2014-10/12 = 2014.83

Step 3 - Calculate Next Inspection Date (NID)

NID = Late Inspection Date + Interval

= 2014.83 + 4.75 yrs

= 2019.58

Step 4 - Convent the Partial Year to Months

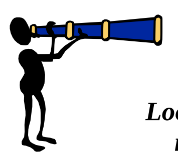
Partial Year is 0.58 yr *(there are 12 months in a year)*

# of Months = 0.58 yr x 12 months/yr = 6.96 months = 7 months

The 7th month is July

Step 5 - The Final Answer

July 2019



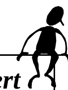
Looking ahead to the next Inspection.

To convert year & months

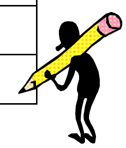
Partial Yr to Months: # of Months = Partial Year x 12
Months to Partial Yr: Partial Year = # of Months / 12

<u>Exercise 9</u>: Calculate the Next Inspection Date

Determine the *Next Inspection Date* for the *Internal Inspection* for each of the vessels in this Table. The first row is completed as an example.



	Last Insp Date	*Last Insp Date (number)*	*Remaining Life (yrs)*	*Inspection Interval (yrs)*	*Next Insp Date (number)*	*Convert Partial Yr to Months*	*Next Insp Date*
V-10	***April 2014***	***2014.33***	***18.7***	***9.35***	***2023.68***	***8.16***	***Aug 2023***
V-20	***Feb. 2015***		***9***				
V-30	***Sept 2014***		***5.5***				
V-40	***Nov. 2011***		***20***				
V-50	***May 2014***		***11.2***				



Short-Term vs. Long-Term Corrosion Rates

Most Codes suggest you calculate the *Long-Term* and *Short-Term* corrosion rates. The *Short-Term* corrosion rate is based on metal lost between the last two reading thickness at a TML. The *Long-Term* corrosion rate is based on metal lost between the first and last thickness readings at a TML.

Advantages: Since process conditions often change over the life of the equipment, the *Short-Term* corrosion rate is usually a better indicator of the current conditions. But this corrosion rate is subject to greater inaccuracy when there are inaccurate thickness readings. The *Long-Term* corrosion rate is less affected by inaccurate thickness readings.

The Corrosion Rate used in *Remaining Life* calculations is usually the greater of the *Long-Term* and *Short-Term* rates.

Formula #4:
Short-Term Rate

$$\textit{Short-Term Rate} = \frac{\textit{metal loss}}{\textit{time period}} = \frac{t_{previous} - t_{last}}{\textit{time period}}$$

Formula #5:
Long-Term Rate

$$\textit{Long-Term Rate} = \frac{\textit{metal loss}}{\textit{time period}} = \frac{t_{first} - t_{last}}{\textit{time period}}$$

<u>Illustration</u>: Short & Long-Term Corrosion Rates

For this TML, we have multiple thickness readings taken at different dates. Calculate the *Short-Term* and *Long-Term Corrosion Rates* and the *Remaining Life* for the TML.

Thickness Data

$t_{minimum}$	*Jan 2015*	*Jan 2010*	*Jan 2007*	*Jan 2005*
0.380"	*0.440"*	*0.465""*	*0.480"*	*0.500"*

Step 1 - Calculate Short-Term Corrosion Rate

$$\textit{ST Rate} = \frac{t_{previous} - t_{last}}{\text{time period}} = \frac{465 - 440}{5} = 5 \text{ mpy}$$

Step 2 - Calculate Long-Term Corrosion Rate

$$\textit{LT Rate} = \frac{t_{first} - t_{last}}{\text{time period}} = \frac{500 - 440}{10} = 6 \text{ mpy}$$

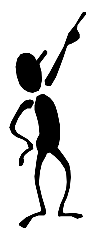
Step 3 - Pick the Controlling Corrosion Rate (the highest)

Highest between: 5 & 6 mpy = 6 mpy

Step 4 - Calculate Remaining Life

$$\textit{Life} = \frac{t_{last} - t_{min}}{\text{Corrosion Rate}} = \frac{440 - 380}{6} = 10 \text{ yrs}$$

This problem is worked in mils. If you work it in inches, the answer is the same!



Which Corrosion Rate should you use? Long-Term or Short-Term? Select the larger rate!

What do we do with the Reading on January 2007?
For this TML, absolutely nothing!
It's not needed for either the short or long-term calculations.

<u>Exercise 10</u>: Short & Long-Term Corrosion Rates

For this TML, we have multiple thickness readings taken at different dates. Calculate the *Short-Term* and *Long-Term Corrosion Rates* and the *Remaining Life* for the TML. .

Thickness Data

$t_{minimum}$	*Jun 2015*	*Jun 2009*	*Jun 2006*	*Jun 2002*
0.640"	*0.718"*	*0.742"*	*0.745"*	*0.750"*

Step 1 - Calculate Short-Term Corrosion Rate

ST Rate = ______________ = ____________ =

Step 2 - Calculate Long-Term Corrosion Rate

LT Rate = ______________ = ____________ =

Step 3 - Pick the Controlling Corrosion Rate (the highest)

Step 4 - Calculate Remaining Life

Life = ______________ = ____________ =

Illustration: The Monster Calc

This calculation will be more detailed than anything you will have on the API exam. But this is real life! For this vessel, calculate the *Next Inspection Date* for the *Internal Inspection*.

Thickness Data

$t_{minimum}$	May 2015	Oct 2010	May 2007	Jan 2003
0.395"	0.454"	0.477""	0.492"	0.500"

Step 1 - Convert Dates to Numbers

May 2015 = 2015-5/12 = 2015.42
Oct 2010 = 2010-10/12 = 2010.83
Jan 2003 = 2003-1/12 = 2003.08

Step 2 - Calculate Short-Term Corrosion Rate

$$ST\ Rate = \frac{t_{previous} - t_{last}}{time\ period} = \frac{477 - 454}{2015.42 - 2010.83} = \frac{23}{4.59} = \mathbf{5\ mpy}$$

Step 3 - Calculate Long-Term Corrosion Rate

$$LT\ Rate = \frac{t_{first} - t_{last}}{time\ period} = \frac{500 - 454}{2015.42 - 2003.08} = \frac{46}{12.34} = \mathbf{3.7\ mpy}$$

Step 4 - Pick the Controlling Corrosion Rate (the highest)

Highest between: 5 & 3.7 mpy = 5 mpy

Step 5 - Calculate Remaining Life

$$Life = \frac{t_{last} - t_{min}}{Corrosion\ Rate} = \frac{454 - 395}{5} = \frac{59}{5} = \mathbf{11.8\ yrs}$$

Step 6 - Calculate Inspection Interval

*Per API 510: Lesser of: ½ Life (0.5 x 11.8 = 5.9 yr) or 10 yrs = **5.9 yrs***

Step 7 - Calculate the Next Inspection Date (NID)

NID = Last Insp Date + Interval

*NID = 2015.42 + 5.9 = **2021.32***

Step 8 - Convert Partial Year to Month

# of Months = 0.32 x 12 = 3.8 months, about 4th month (April)

Step 9 - Final Answer: April 2021

<u>Exercise 11</u>: The Monster Calc

Here's a *Monster Calc* for you to do. The steps are listed as an aid. For this vessel, calculate the *Next Inspection Date* for the *Internal Inspection*.

Thickness Data

$t_{minimum}$	*Feb 2015*	*May 2009*	*Jun 2004*	*Nov 1997*
0.212"	*0.288"*	*0.296"*	*0.305"*	*0.322"*

Step 1 - Convert Dates to Numbers

Step 2 - Calculate Short-Term Corrosion Rate

Step 3 - Calculate Long-Term Corrosion Rate

Step 4 - Pick the Controlling Corrosion Rate (the highest)

Step 5 - Calculate Remaining Life

Step 6 - Calculate Inspection Interval

Step 7 - Calculate the Next Inspection Date (NID)

Step 8 - Convert Partial Year to Month

Step 9 - Final Answer: