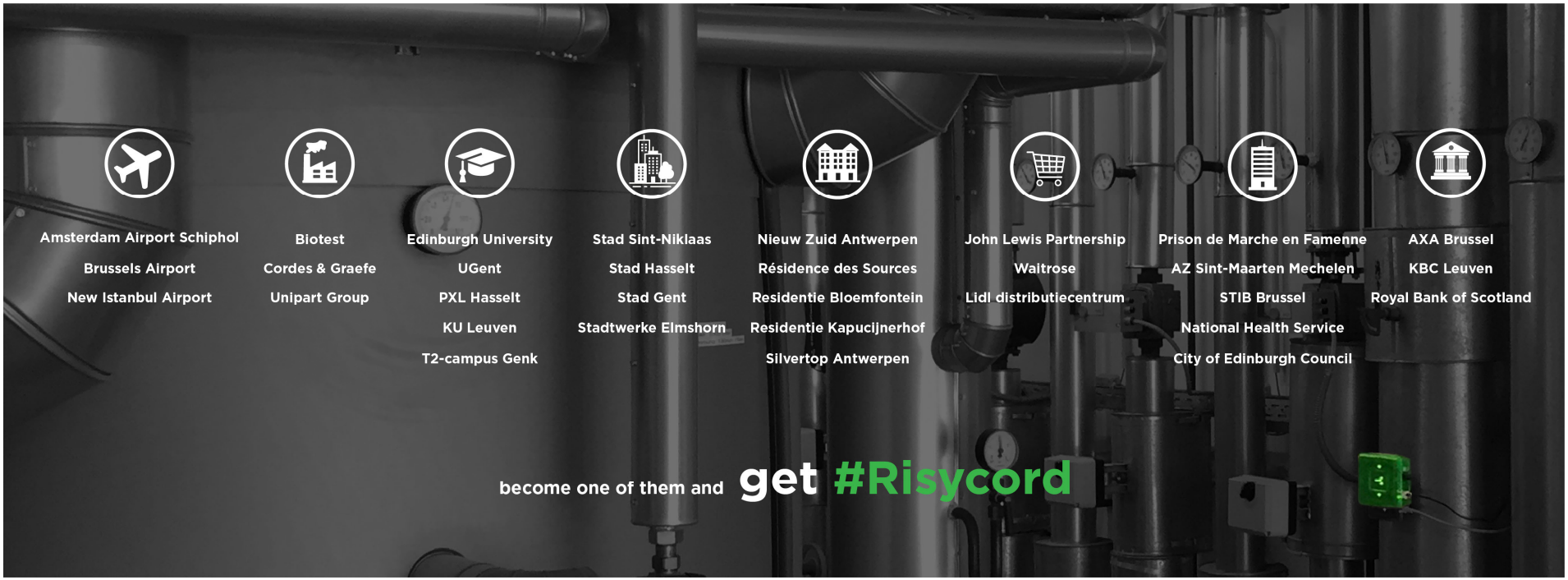
Welcome Everyone

CIBSE accredited Presentation by Gordon Pringle HASL – UK & Ireland Risycor Sole Distributors



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Preventing Corrosion by Continuous Monitoring

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BSRIA Member

CIBSE CPD

Monitoring for Longevity

Water monitoring should not be considered simply as a retrofit once a system has gone awry, but properly included as part of the initial design. **© Tim Dwyer, 2018.**

www.cibsejournal.com October 2018 21

Learning Objective

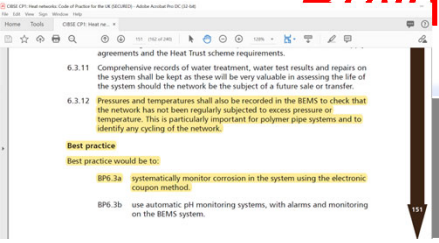
- This CPD module explains why, despite sound standards and guidelines many heating and cooling systems still suffer the often disastrous and costly effects of corrosion.
- The course explains what causes corrosion in closed systems and how it can be avoided.
- It goes on to show that continuous monitoring of system corrosion rates and other key factors can prevent the high costs associated with corrosion damage.

Contents

- Why do heating and cooling systems corrode
- The cost of corrosion
- What is corrosion and what causes it
- The role of oxygen and how it enters the system
- Methods for monitoring
- Why monitor for corrosion and pressure*
- Summary
- (Real life examples how monitoring can save systems)

Why do heating systems corrode?

- Sealed systems are designed to prevent corrosion
- In addition most systems in the UK are treated with corrosion inhibitors.
- There are many UK standards and guidelines all aimed at minimising corrosion.
  - BSRIA ,BG29/2020/2021 6th Edition April* (2021 Jan), BG50/2013 with new version in 2020 & 2021.
  - BS 8552:2012 Sampling CoP, BS2486:1997, BS7593:2019*
  - ICOM Commercial Htg Systems Guide
  - CIBSE AM14:2010, Commissioning Code W, Guide B & M
  - Other European Standards are relevant i.e. VDI2035
  - CIBSE Heat Networks: *Code of Practice for the UK (CP1)*
  - CIBSE Heat Pump Installation for Large Non Domestic Building_AM17_2022*


agreements and the Heat Trust scheme requirements.

6.3.11 Comprehensive records of water treatment, water test results and repairs on the system shall be kept as these will be very valuable in assessing the life of the system should the network be the subject of a future sale or transfer.

6.3.12 Pressures and temperatures shall also be recorded in the BEMS to check that the network has not been regularly subjected to excess pressure or temperature. This is particularly important for polymer pipe systems and to identify any cycling of the network.

Best practice

Best practice would be to:

BP6.3a systematically monitor corrosion in the system using the electronic coupon method.

BP6.3b use automatic pH monitoring systems, with alarms and monitoring on the BEMS system.

Despite these old standards EVERYONE in the business has come across this

…this..

Ensuring Heat Network performance

- Heat networks are a crucial aspect of the path towards decarbonising heat.
- 17000 Heat Networks in the UK
- 90% of all connections are Residential
- Currently 2% of UK Heat Demand
- Cost Effectively 14-20% by 2030 & 43% by 2050
- In 2015 CCC est. 18% needs to be met for UK CRP
- Ambient Temp Loops inc. Heat Pump also driving forward development of these networks
- Greaves[4] illustrated that 15% of the 185 UK heat networks studied had suffered failures as a result of issues around water quality.
- *Potentially 2573 Systems at risk now*!

CIBSE **Module 157: Ensuring heat network water quality for effective brazed plate heat exchangers 2020 January**

…and this

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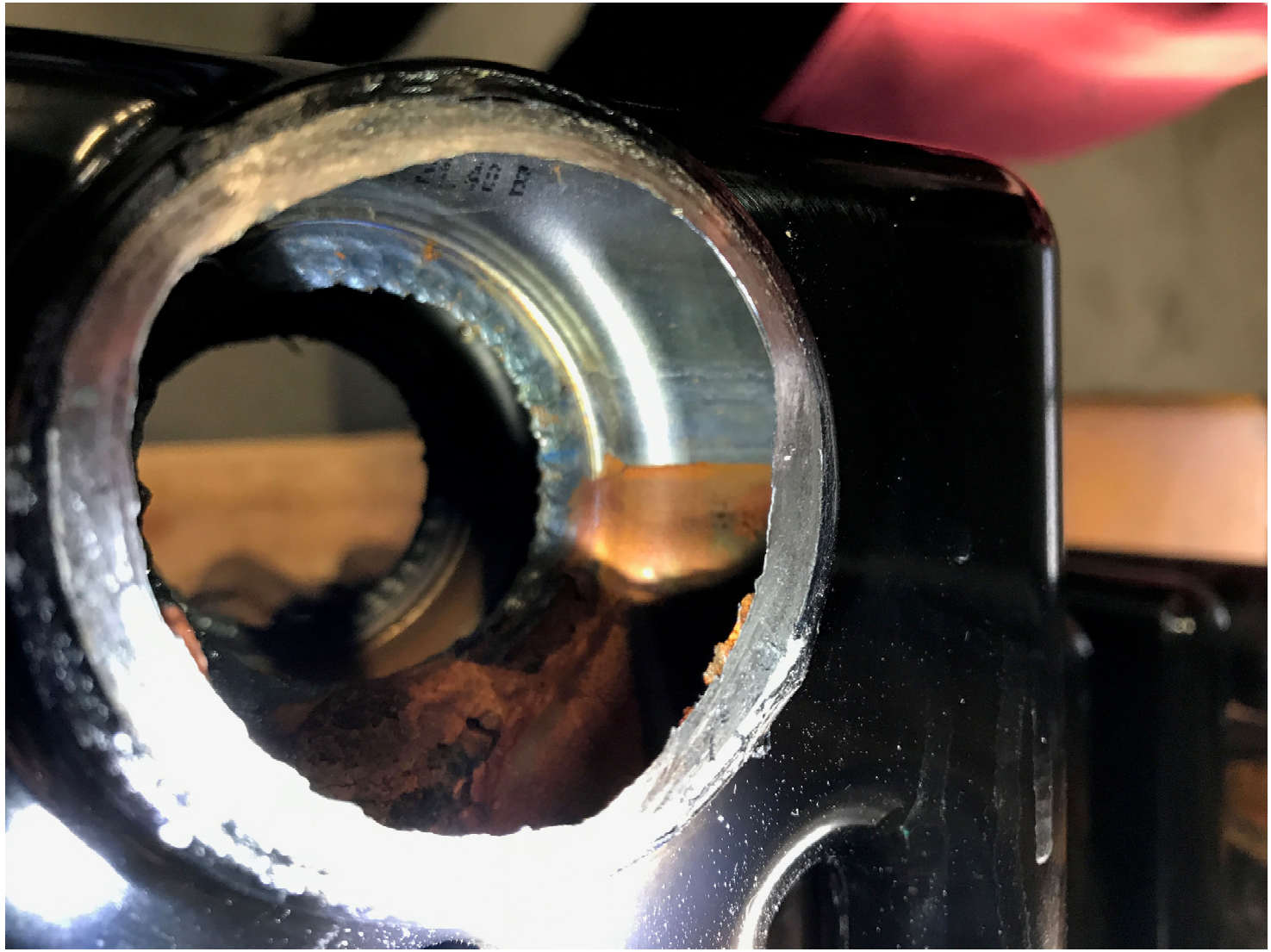
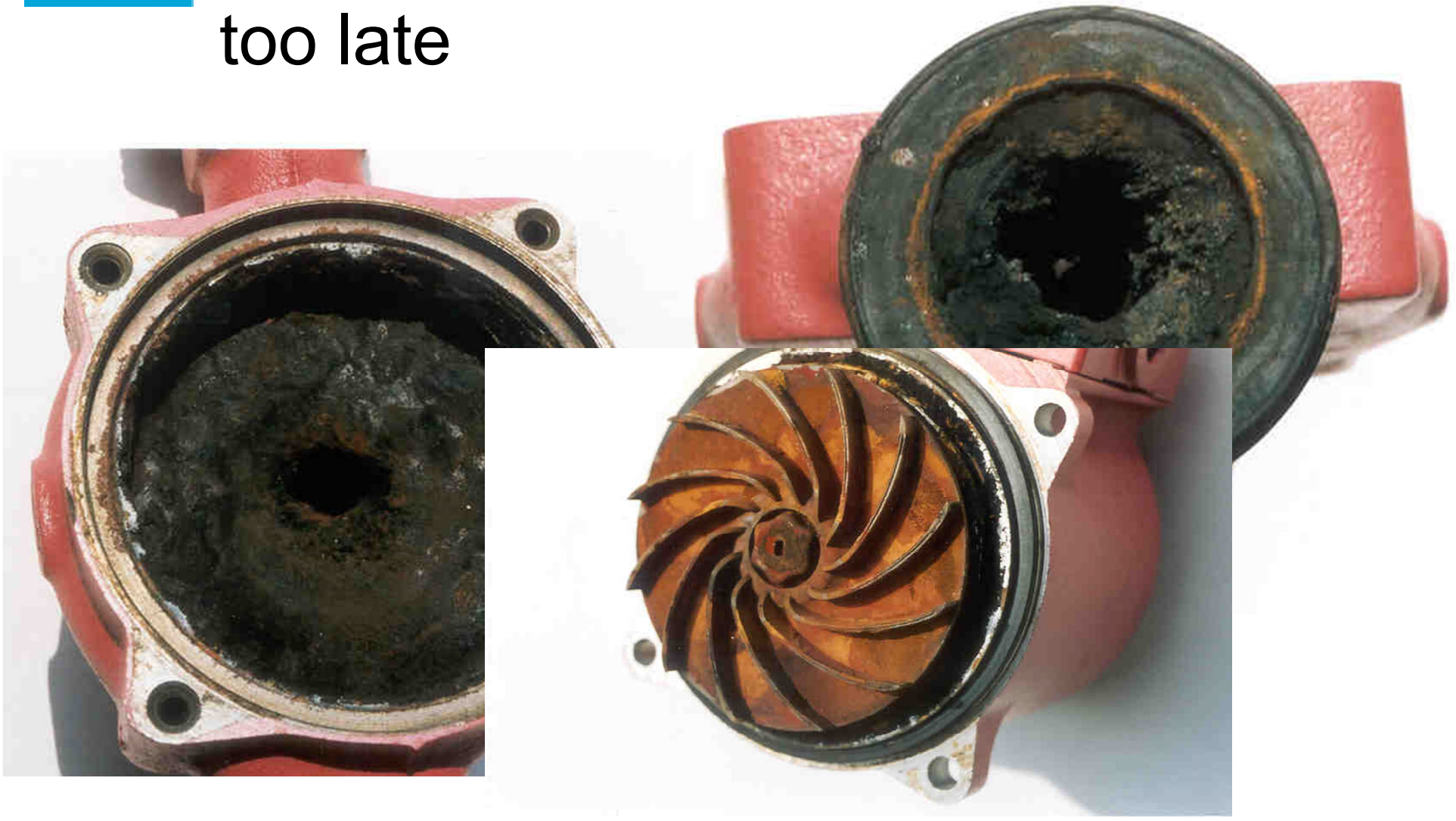
…or indeed this..



The real problem often remains invisible from the outside until it is far too late

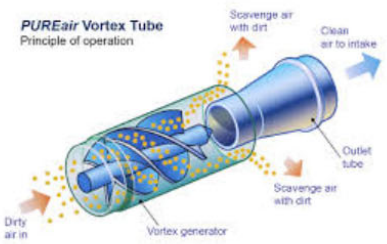


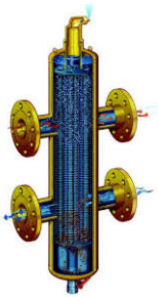
If systems are so well protected from corrosion, why has a whole industry developed around Power flushing and system cleaning?

41 600000 hits on Google Search for the term Power flushing

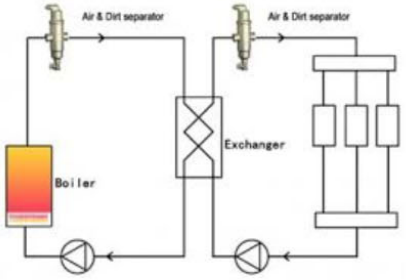
Sales and variety of filters / magnetic dirt separators have exploded.






480 × 480 - ambientfloorheat.com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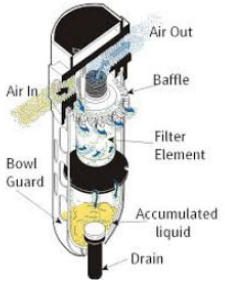


Which of the following may be contributing to corrosion problems?

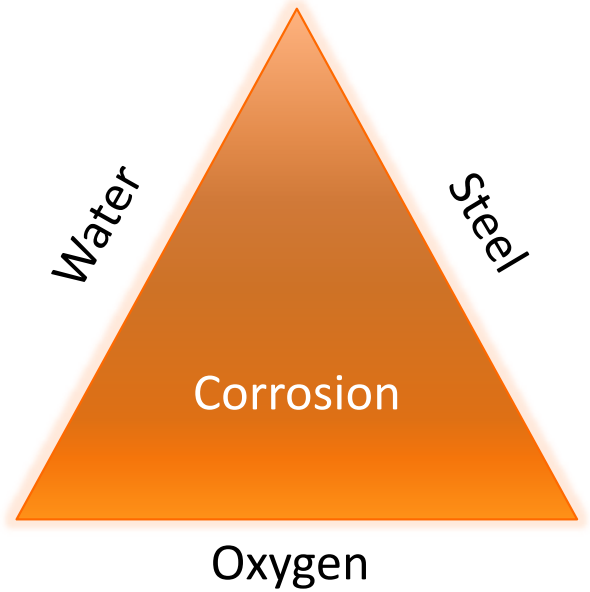
- System design?
- Choice of materials?
- Modern high efficiency components?
- Cost cutting?
- Poor training?
- Poor maintenance?
- Incorrect / Poor chemical treatment regime?
- Implication of Mixed Metals?

All of these can lead to corrosion problems

There are many types of corrosion

- **Uniform Corrosion**
- Galvanic Corrosion
- Crevice Corrosion
- Pitting Corrosion
- Under Deposit Corrosion
- Microbiological Induced Corrosion (MIC)
- Intergranular Corrosion
- Erosion Corrosion
- Stress Corrosion

What is corrosion?



Without one of these components (uniform) corrosion cannot take place

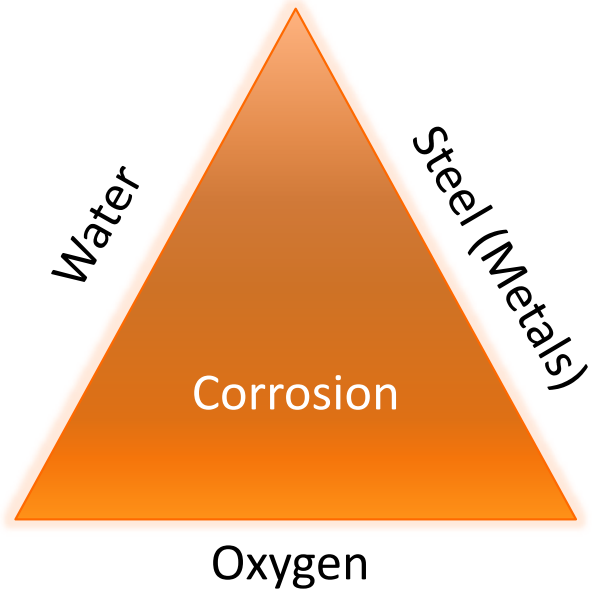
Corrosion is an electro-chemical process

- Iron Oxide (red rust) FE^2 O^3
- Magnetite (black sludge) FE^3 O^4
- Corrosion is not just limited to steel. It also effects, aluminium, stainless steel, brass and copper *i.e. electropotential of metal and pH*

In nearly all cases of excessive corrosion high levels of oxygen are to blame.

Eliminating one component (eliminates corrosion)

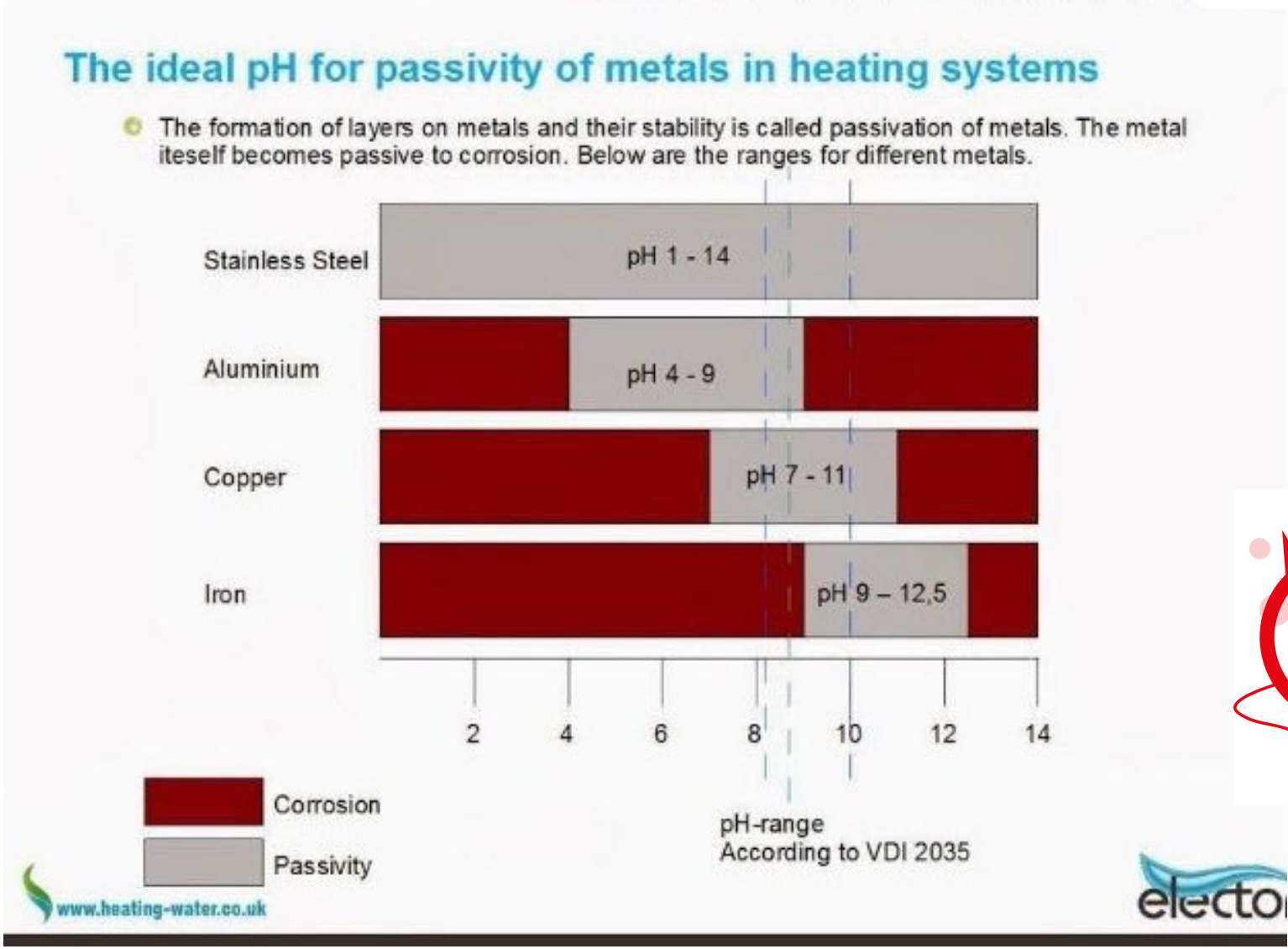
- Do not use water. E.g. Thermal oil



- Caution: Do not use st/steel or other metals e.g. plastics thinking issue is resolved!

- Eliminate oxygen from the system and keep it out

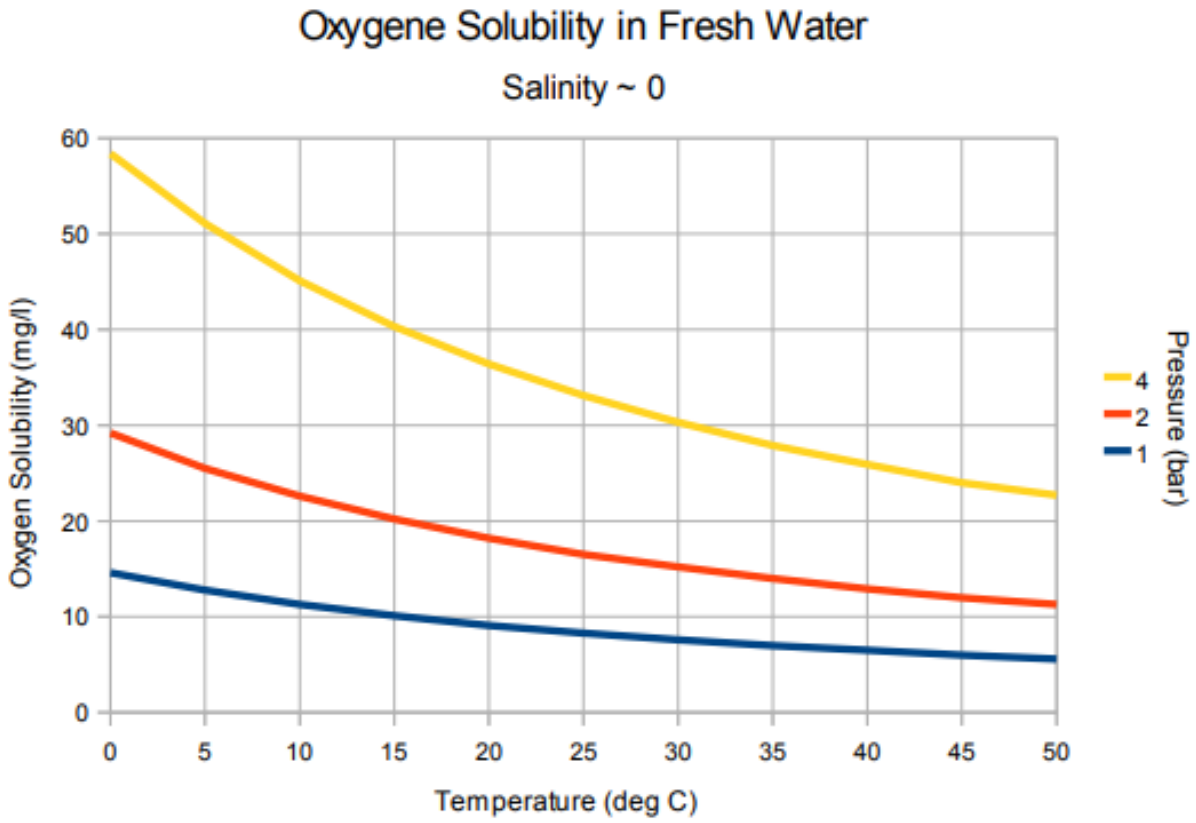
Implication of Mixed Metals



Eliminating oxygen is key - Initial fill

- Oxygen is held in solution in the water. How much can be dissolved depends on temperature and pressure. (Henry's Law)

Drinking water contains approximately 10mg/l of O2.

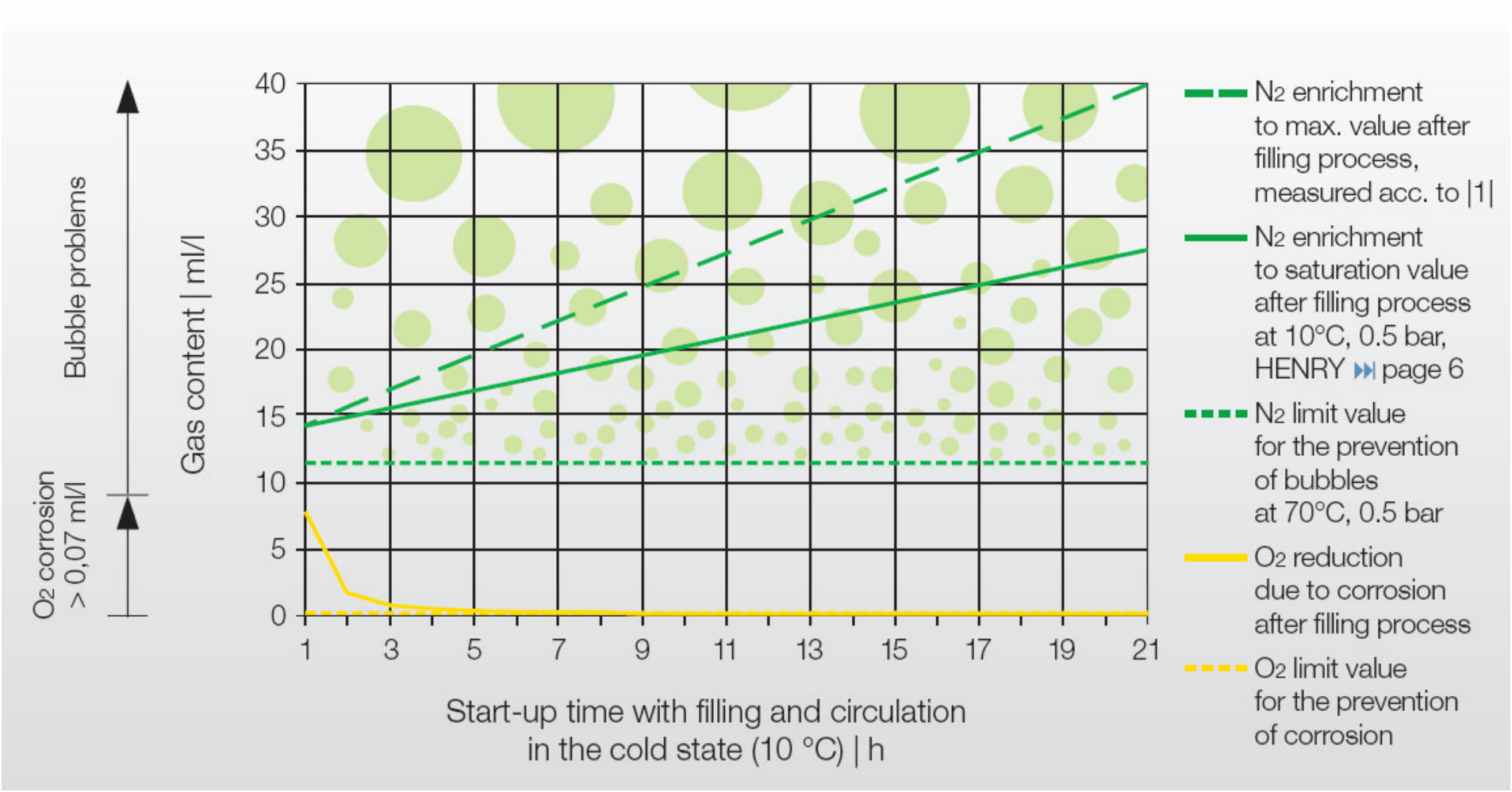


- Initial fill cont.

- When the system is filled under high pressure dissolved oxygen levels will also be higher.
- Trapped air pockets after filling get absorbed
- Repeated draining and filling during pre-commission cleaning and commissioning adds more oxygen = **more corrosion**.

Danger! After pressure testing and / or cleaning a system must never be left empty !

O_2 is consumed shortly after filling in an untreated system.



How much Magnetite is created?

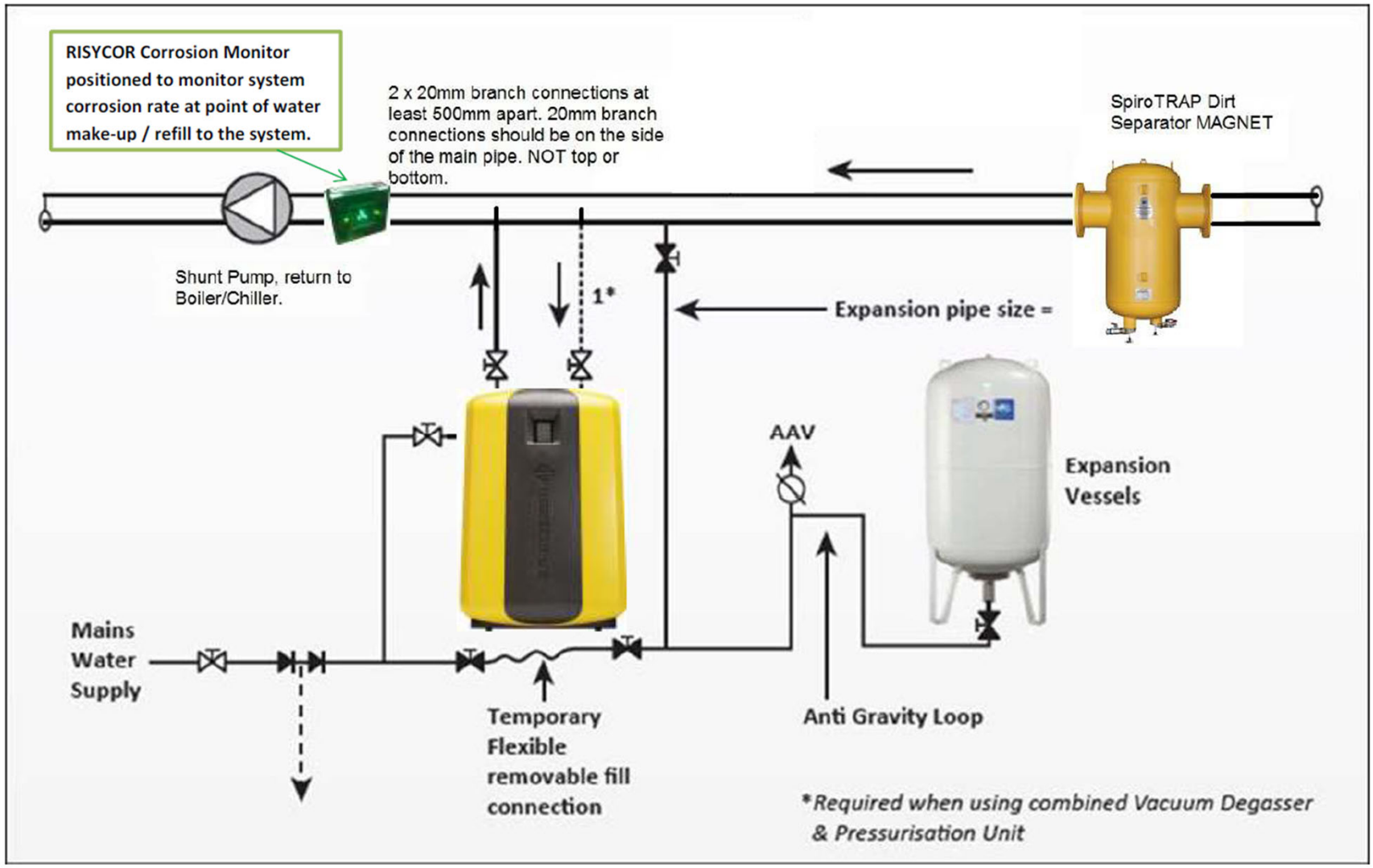
	Reason for oxygen ingress	Magnetite Once	Magnetite anually
1.	Restair 10%	91 g	
2.	First fill	36 g	
3.	Topping up		4g
4.	Negative pressure	3658 g	
5.1	Plastic pipe EVOH 500 m		130 g
5.3	Diffusion Butyl rubber hoses braided (50m)		5971 g
6.1	Diffusion expansion vessel	375 g	

Source: NL ISSO 13*

How does O_2 enter the system?

- Poor pressure control accounts for 90% of all corrosion problems. Lack of understanding of EN12828.
  - Expansion Vessel too small
  - Pre-charge pressure too high
  - Pre-charge pressure too low
  - Loss of pre-charge pressure and lack of maintenance.
  - Incorrect Pump position (neutral point)
  - Defective bag or membrane (pump or compressor pressurisation*)
- Leaks
  - Automatic topping up with fresh water.
  - Compensation for water loss through Safety Valve. Usually due to incorrect pressure control!
- Diffusion
  - Rubber fan coil hoses (EPDM is highly permeable)
  - Non-barrier plastic pipes. Is the barrier 100% barrier?

Position Matters



Size Matters

SpiroPress Expansion Selection and Vessel Sizing

Customer:	IS ARUP
Project:	UNKNOWN
Reference:	BSMNT PLANT LTHW SPIROTECH
Date:	30/07/2019
Revision	POOR SELECTION

Information Available

System Volume	1200	litre
System kW Rating	120	kW
Operating Temperature	80	°C
Safety Valve Set Pressure	SEE MIN ACROSS	bar
Upper working Pressure	3	bar
Static Head	12	meter
Water / glycol	WATER	%
Pipe Size Main	50	mm
flow rate	1.43	l/sec

calculation acc (BS) EN12828

System type	Heating System	
Max Operating Temperature	80	°C
Temperature differential Max. return Temperature Medium	20 ≤70°C water	K
Minimum Safetey Valve Set Pressure Upper working Pressure	3.5 3	bar bar
Static Head above Vessel (Pst) pressure at highest point	12 0.5	m bar
Expansion pipe design load System Operating Load Design Rating - l/kW	120 120 10	kW kW
Degassing equipment	Superior S400	

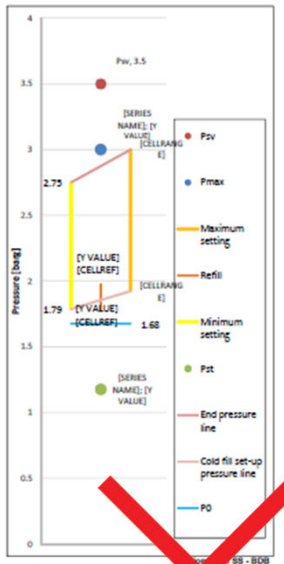
SpiroPress Control

Upper working Pressure	3 bar
Lower working Pressure	1.7 bar
Gas charge pressure	1.7 bar
System Volume	1200 litre
Ve physical expansion volume	35 litre
Water reserve volume	6 litre
Total expansion volume	43 litre
Actual Vessel acceptance	0.33
Calculated Vessel Volume	130 litre

Selected Vessel type

Calculated Vessel type	EV0160FP06
Selected Vessel type	EV0150FP06
Number of vessels	1
Select 1 whenever possible	
Selected vessel volume	150 litre
Expansion pipe diameter DN	25
cold fill pressure min	1.79 barg
Upper working Pressure	2.75 barg
cold fill pressure max	1.92 barg
Upper working Pressure	3.00 barg

Notes



SpiroPress Expansion Selection and Vessel Sizing

Customer:	IS ARUP
Project:	UNKNOWN
Reference:	BSMNT PLANT LTHW SPIROTECH
Date:	29/07/2019
Revision	

Information Available

System Volume	1200	litre
System kW Rating	120	kW
Operating Temperature	80	°C
Safety Valve Set Pressure	SEE MIN ACROSS	bar
Upper working Pressure	3	bar
Static Head	12	meter
Water / glycol	WATER	%
Pipe Size Main	50	mm
flow rate	1.43	l/sec

calculation acc (BS) EN12828

System type	Heating System	
Max Operating Temperature	80	°C
Temperature differential Max. return Temperature Medium	20 ≤70°C water	K
Minimum Safetey Valve Set Pressure Upper working Pressure	3.5 3	bar bar
Static Head above Vessel (Pst) pressure at highest point	12 0.5	m bar
Expansion pipe design load System Operating Load Design Rating - l/kW	120 120 10	kW kW
Degassing equipment	Superior S400	

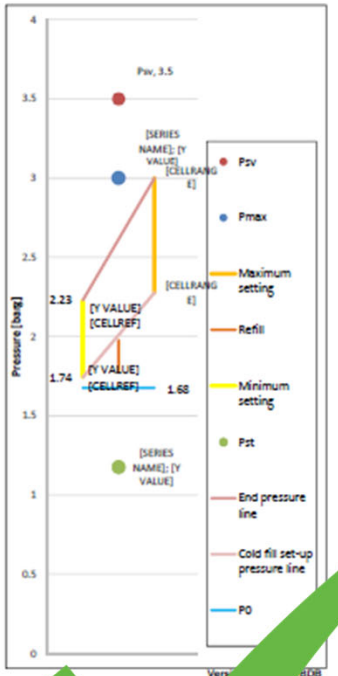
SpiroPress Control

Upper working Pressure	3 bar
Lower working Pressure	1.7 bar
Gas charge pressure	1.7 bar
System Volume	1200 litre
Ve physical expansion volume	35 litre
Water reserve volume	6 litre
Total expansion volume	43 litre
Actual Vessel acceptance	0.33
Calculated Vessel Volume	130 litre

Selected Vessel type

Calculated Vessel type	EV0160FP06
Selected Vessel type	EV0250F
Number of vessels	1
Select 1 whenever possible	
Selected vessel volume	250 litre
Expansion pipe diameter DN	25
cold fill pressure min	1.74 barg
Upper working Pressure	2.23 barg
cold fill pressure max	2.28 barg
Upper working Pressure	3.00 barg

Notes



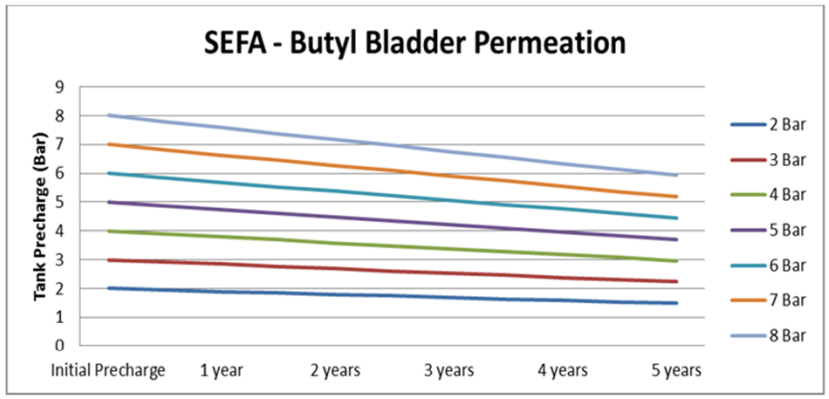
Permeation Matters on EV

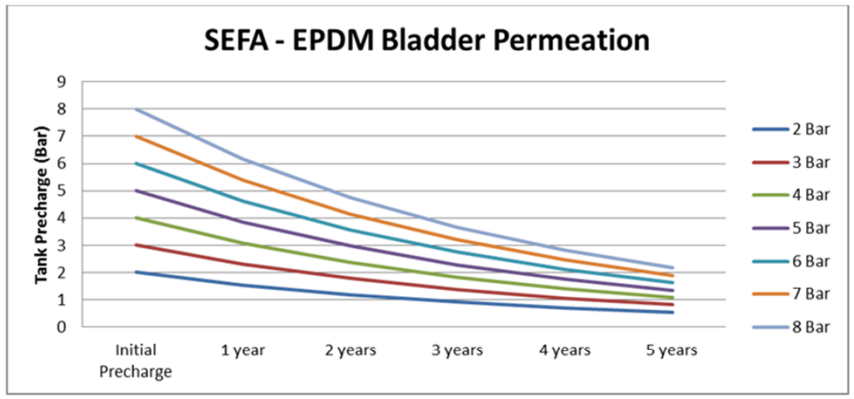
- Loss of Pre-Charge & lack of maintenance

AutoSave Off | SEFA bladder report - Compatibility... - Saved | Search | Gordon Pringle

File Home Insert Draw Design Layout References Mailings Review View Help Acrobat | Share Comments

Permeation Rate: xxxx found their butyl material has a permeation rate of 0.2% per 14 days, and their EPDM material has a permeation rate of 1% per 14 day period. See below charts for annual air loss rates due to permeation.

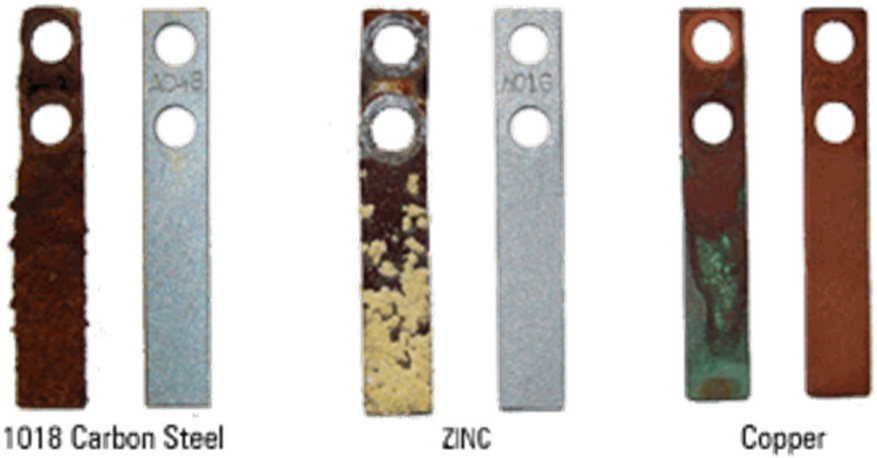




Conclusion: These figures are relevant as they show the air loss rates of the Italian and Turkey bladder tanks and present further evidence that bladder tanks are leaking air at high rates through permeation alone. When coupled with air loss at the flange, the total precharge air loss is much higher and thus requires the customer to check and maintain the air precharge at regular intervals.

Methods of corrosion monitoring

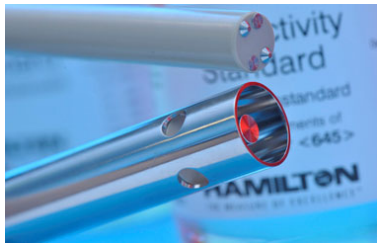
- Traditional
  - Water sample testing
  - Corrosion Coupons
  - Removeable pipe sections



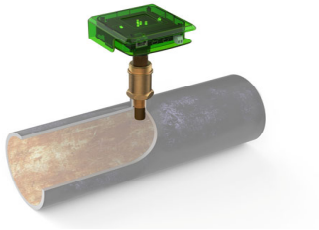
Methods of corrosion monitoring

- Advanced
  - Linear Polarisation Resistance (LPR method)
  - Sensors (PH, conductivity,O^2 ,etc.)
  - Corrosion Monitor (Electronic coupon method (ECM))

pH Sensor



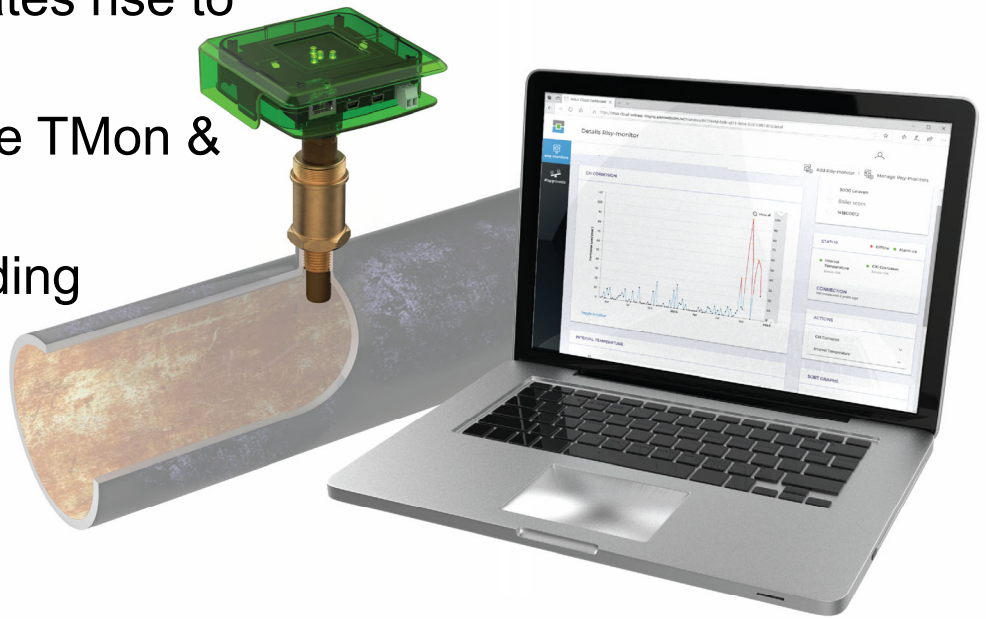
Conductivity Sensor


Corrosion Monitor


LPR Sensor

Continuous monitoring & recording with the ‘Electronic coupon’ method

- Direct corrosion measurement through loss of material mass. Not water chemistry
- Continuous measurement and recording
- Recording corrosion rate in microns (um/year)
- Lifetime analysis of corrosion activity is possible
- Instant VFC warning when corrosion rates rise to damaging levels
- Temperature recording and can validate TMon & improved seasonal Cx.
- Graphic output to assist with cause finding
- Optional Pressure Monitoring via PCXI soft launched in Oct2020.



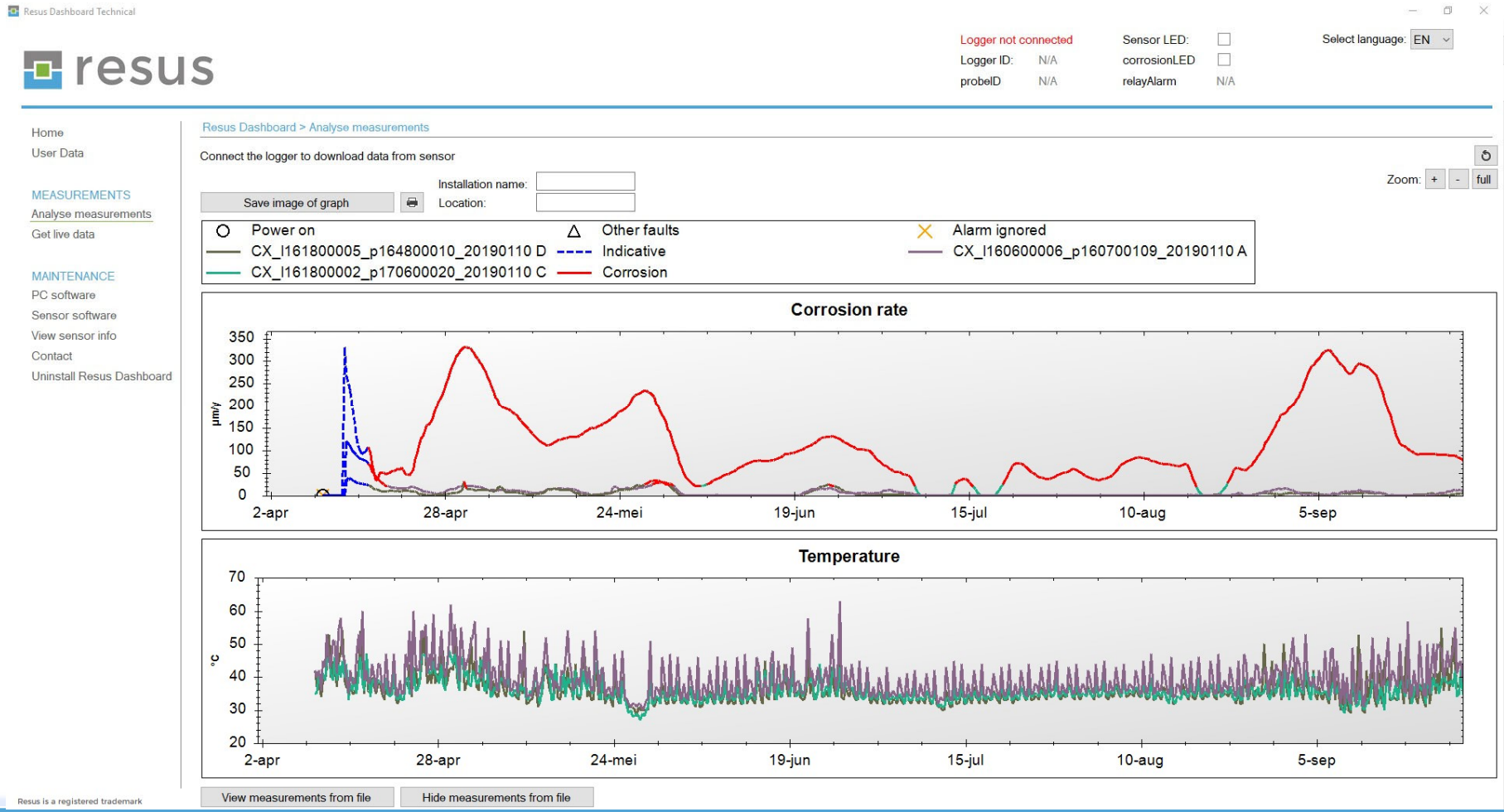
Why monitor system corrosion?

- Although the corrosion process is fast it takes time before the damage becomes disruptive
- An early warning that the corrosion rate in the system has increased allows timely preventative intervention
- Water sampling is not very reliable and will not always reveal that there is a problem. For cost saving reasons it is often done too infrequently or not at all.
- Corrosion coupons are a sound method but only indicate a corrosion rate over a longer period of time (3 months) and do not give a VFC warning.
- The LPR (Linear Polarisation Resistance) is accurate but expensive
- Sensors that detect water quality can be useful but need expert interpretation, maintenance and recalibration.
- The newest method is the electronic coupon method. It combines the accuracy of coupons with the ease of reading and recording of a permanent sensor.
- BG29/2020, BG50/2021 Guidance and now CIBSE CP1 (2020) advises as best practice.

To be able to act in time it is essential to have some form of early warning or alarm system

Recording corrosion history

Detailed logging of every change in corrosion rate(s) and temperature since commissioning



Field Experience

- Some examples how monitoring can detect problems that could have led to severe corrosion damage and also maintain system efficiency.
  - Expansion vessel bladder ruptured (DE)
  - District Heating Gateshead (UK)
  - Resi biomass system without inhibitors (DE)
  - Perth Crematorium Refurbishment (UK)
  - Newbyres Care Home in East Lothian (UK)
  - **Kells & Carlow School SC5 (NI)**
  - **Harvesters Way DH Edinburgh (UK)**
  - **Waterfront DH Edinburgh (UK)**

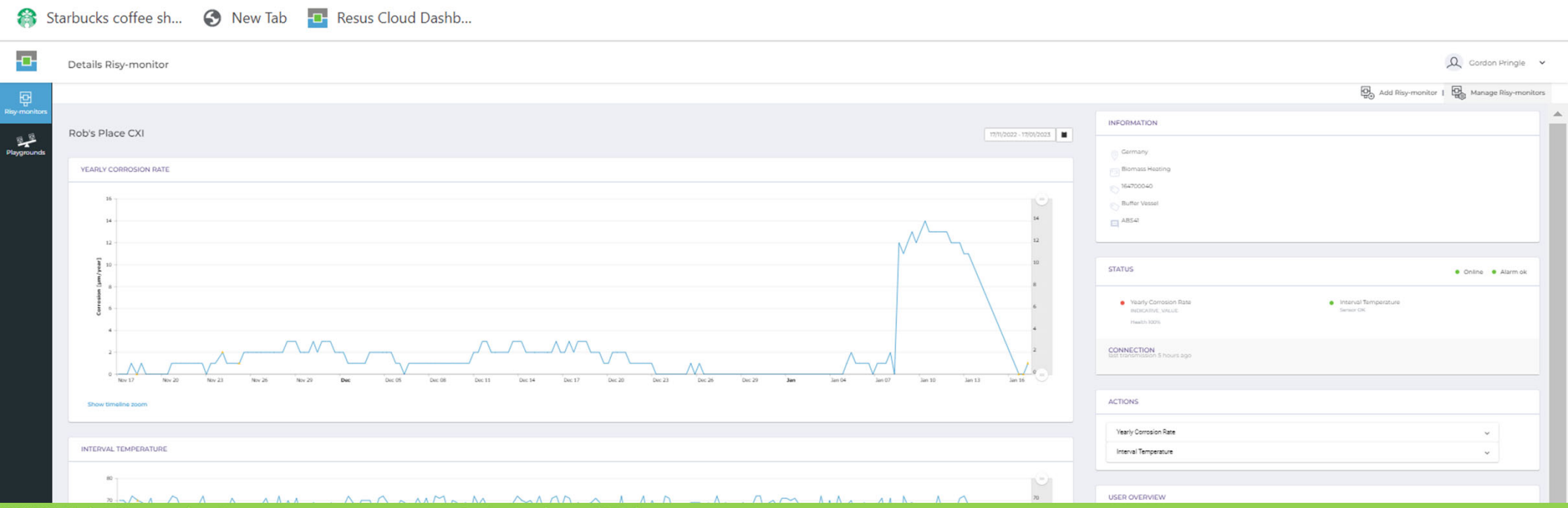
Example 3- Apartment building with biomass boiler

- 1969 4 apartment building energy efficient refurbishment 2016/2017
- 31kw Biomass boiler
- 2.5 km UFH pipe, 1300 Ltrs
- Materials:
  - Pipe -Copper, barrier plastic
  - Boiler heat exchanger, towel rads and 1000l buffer vessel - steel
  - Heat stations with copper plate heat exchanger, brass fittings

Apartment building

- A Risycor corrosion monitor was fitted in the buffer vessel before first fill
- System filled with softened water.(1500 l)
- No chemical inhibitors were added
- Deaerator and dirt separator fitted
- 200 l ‘Oversized’ expansion vessel fitted

Output CXI Analysis



HOVAL Biolyt Biomass heating system — System volume 1400 l

	CBU	CXI	System Status		Water make up (l)	Water make
	AYCR (µm/y)					
2016		19.57	Observe	1 Month , New System commissioned 5/12/2016		
2017	13.8	0.64	Healthy	Expansion vessel check 100l	100	7%
2018	7.45	0.1	Healthy		5	0%
2019	9.32	0.73	Healthy	System water demineralised in side stream (mixed bed) Exp. Vessel check 100 l	110	8%
2020	12.3	2.43	Healthy	Immersion heater installation. Partial drain down and refill with demin water 427 l 25 S/cm	440	31%
2021	11.2	1	Healthy	Solar thermal panels installed with partial loss of water. Refill with 280 L demineralised water	280	20%
2022		2.72	Healthy	Readings taken 28.06.2022		0%
2023						0%
Total System Life		1.37	Healthy	Total % of water make up	935	67%

Current situation after 5 years

- Very low levels of corrosion < 2 micron/year
- Low conductivity 40 micro Siemens
- Stable PH 8.6 - 10
- Water condition values are in line with VDI 2035

Water is totally clear

Example 4 Perth Crematorium

PERTH & KINROSS COUNCIL

Example 4 Crematorium

80/60C F&R Htg & DHWS

400kW refurb Oct 2017

Expansion Vessel Line

PH1 2PE

Example 4 Crematorium

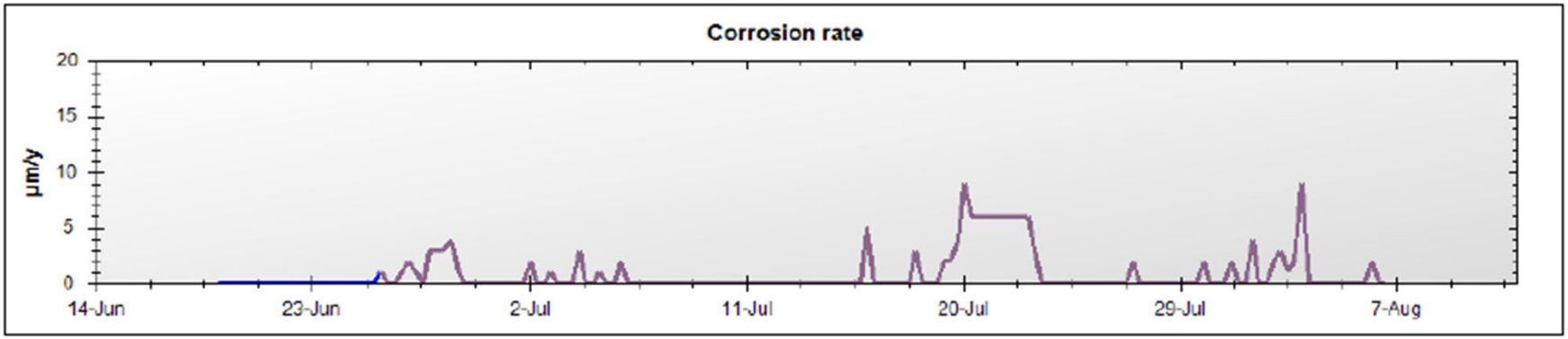
resus

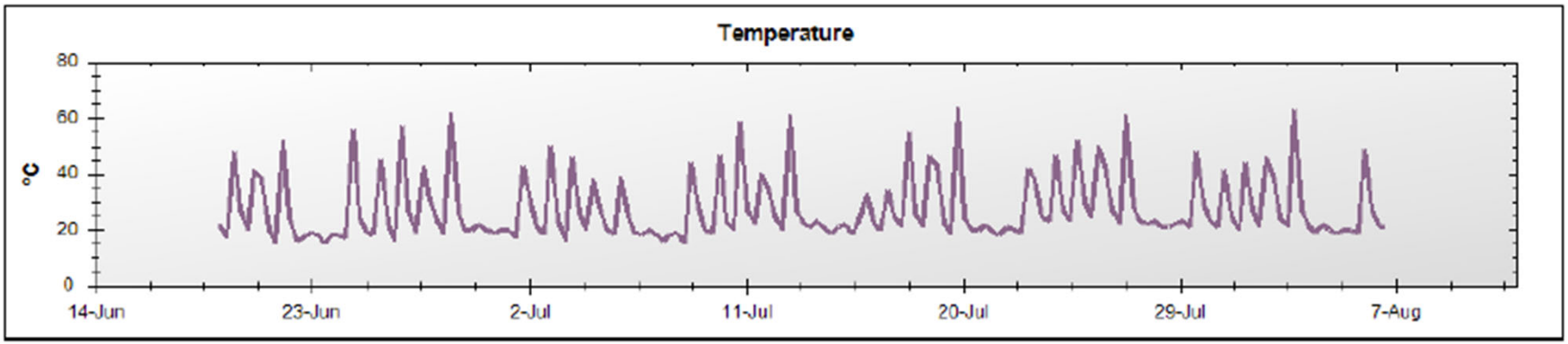
Perth Crematorium
LPHW Main Shunt Return Pipework

Gordon Pringle
10 Grange Road
Houstoun Industrial Estate
LIVINGSTON EH54 5DE
West Lothian
01506 438083
gpringle@hasl.co.uk

X2_I152400062_p152400104_20190805 — Corrosion — Other faults
Power on — Alarm ignored — Indicative

Report date: 09/08/2019





Example 4 Crematorium cont..

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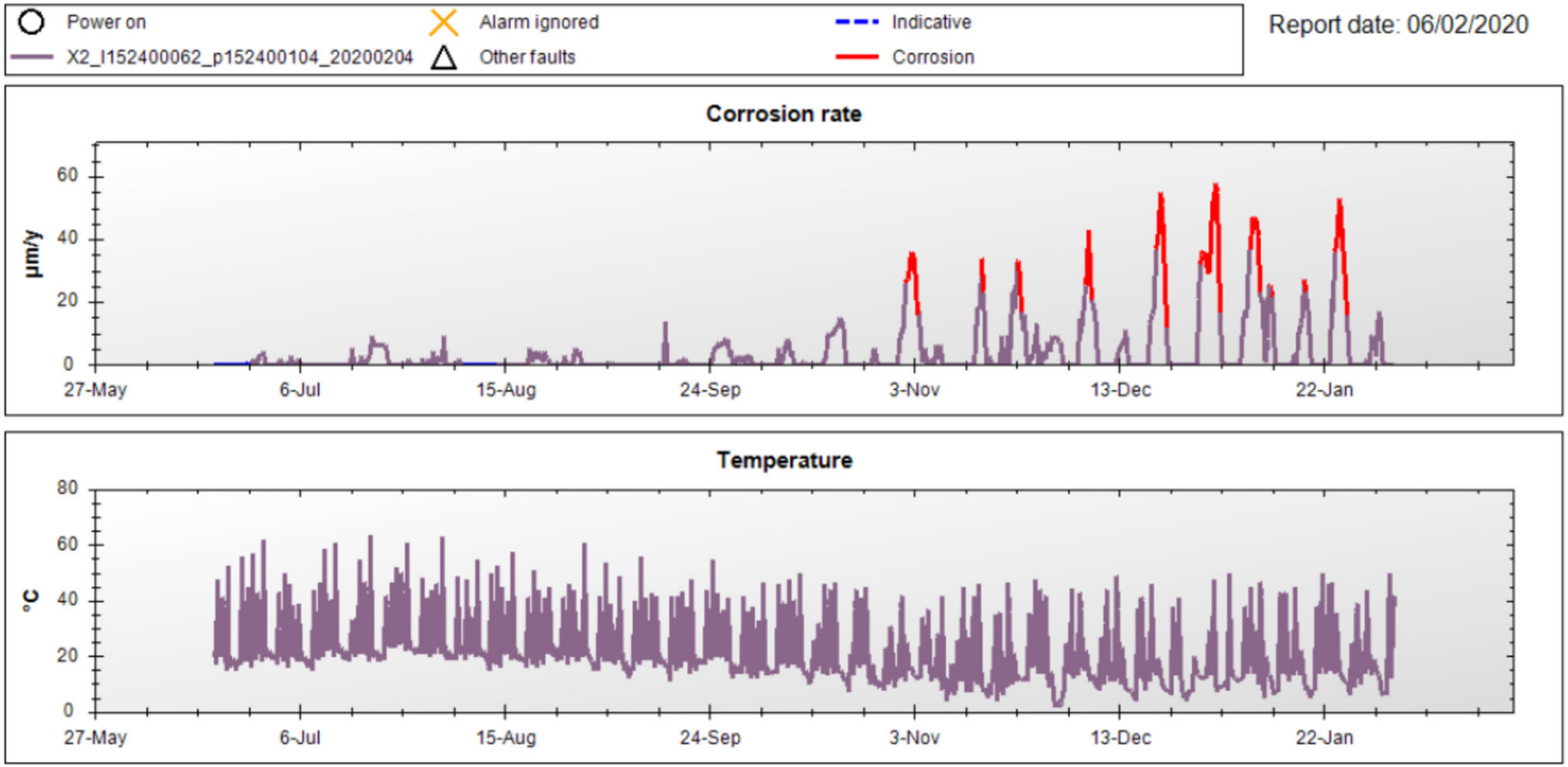
LTHW Expansion Vessel Line / Make Up
Perth Crematorium

Gordon Pringle
10 Grange Road
Houstoun Industrial Estate
LIVINGSTON EH54 5DE
West Lothian
01506 438083
gpringle@hasl.co.uk

Report date: 06/02/2020



Example 6 Kells & Carlow SC5

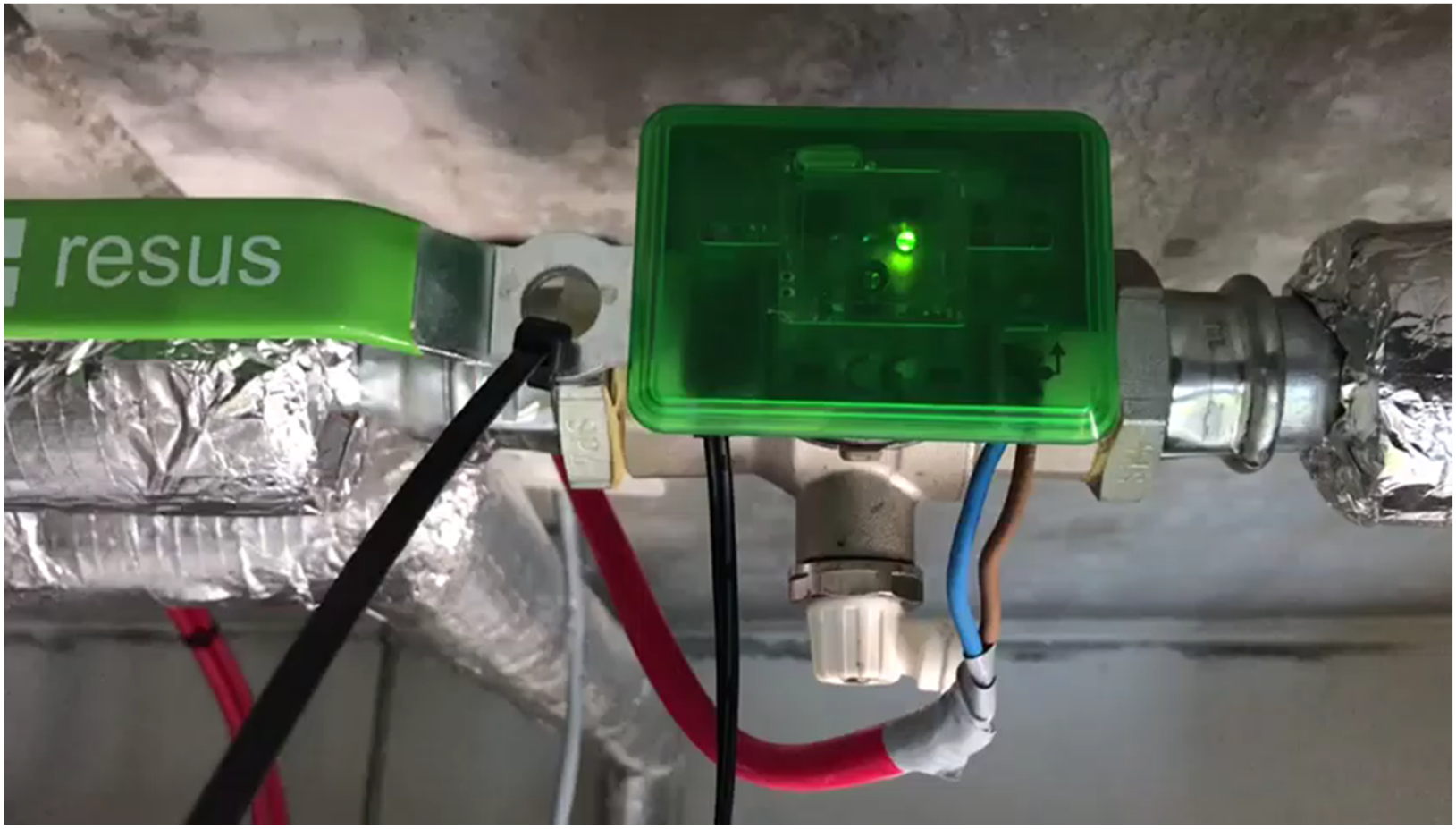
80/60C F&R Htg & DHWS

400kW New Build c 2019

119 Students & Staff

Ireland R93 X0FX

Kells & Carlow SC5



Example 6 Kells & Carlow SC5

resus

woodvale CONSTRUCTION COMPANY

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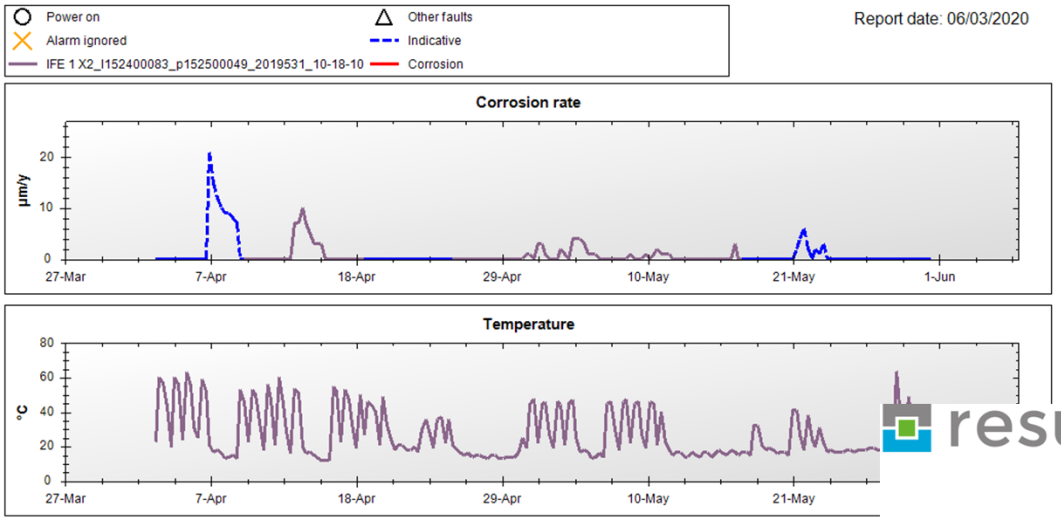
Houstoun Industrial Estate
LIVINGSTON EH54 5DE
West Lothian
01506 438083
gpringle@hasl.co.uk

Report date: 06/03/2020



resus

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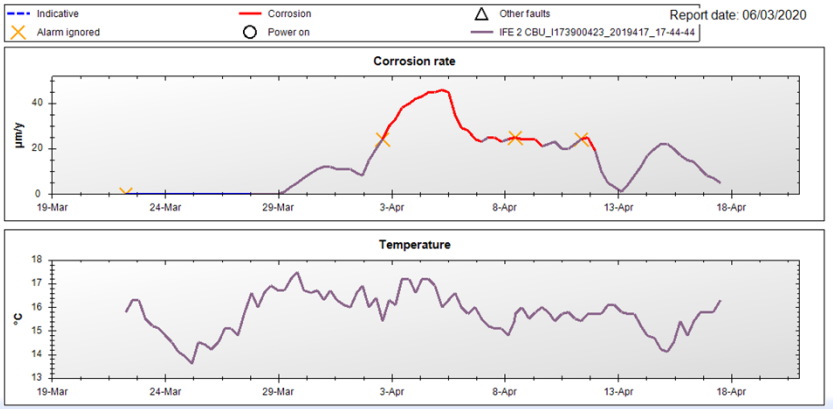


GEBERIT UK

Example 7 Harvesters Way EH14

70/40C F&R Htg & DHWS

400kW Peak New Build c 2016

183 Maisonettes, Flats & Town Houses

Edinburgh EH14

Harvesters Way EH14

the keenan consultancy

SPECIALIST H&V DISTRIBUTORS

Steps

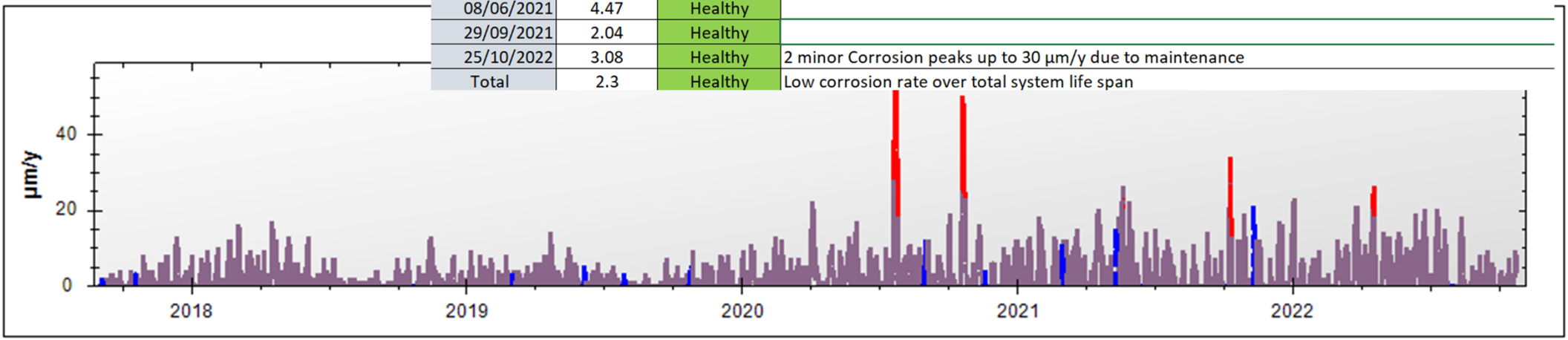
1. Download Resus PC Dashboard from www.resus.eu.
2. Install Resus PC Dashboard.
3. Open Resus PC Dashboard.
4. Disconnect power supply from the data logger and connect the mini-USB connector with a PC using a USB/mini-USB data cable.
5. Data will be downloaded automatically, wait until it is completed.
   (When it's not started automatically click on 'Analyse measurements')
6. You can zoom in on the graphs to get a more detailed view.
7. You can add installation name and Location of the monitor if wanted.
8. You can save the measurements on your PC, you do this by clicking on 'Save sensor measurements to file'. A .csv file will be created.
9. You can save the graph image on your PC, you do this by clicking on 'Save image of graph'. A .png will be created.

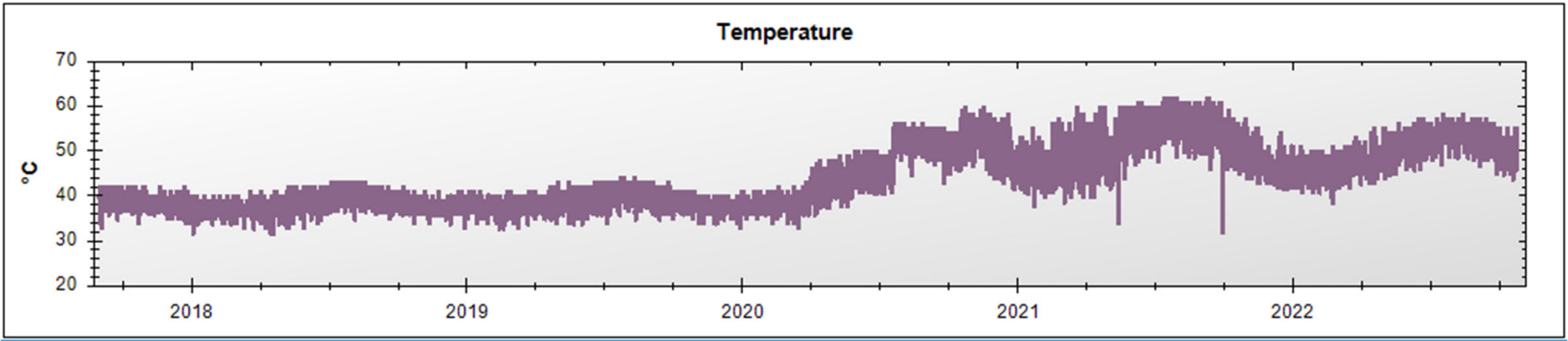
Updated: 10/09/2019

Method Statement/s used		MS4			
System Details					
System Location					
System Type		LTHW			
Sample Point Location					
Dosing Equipment					
How is Chemical Dosed					
Condition of Dosing Equipment					
Biocide in Use - Type					
On-Site Analysis (where applicable)					
Test	Control Limit				
Conductivity μScm^{-1}	Reference	121			
TDS		93			
pH	>8.0 < 10.5	6.9			
Dissolved Iron mg/l Fe	<5	<1			
Total Iron mg/l Fe	<15				
Molybdate	300 - 500	<25			
Nitrite mg/l N	800 -1200	<25			
Hardness mg/l $CaCO_3$	<5				
Tannin	100 - 150				
Alkalinity mg/l $CaCO_3$					
Chloride mg/l Cl	<mains				
Sulphate mg/l SO_4	=mains				
Biocide		No			
Micro Sample Taken	Yes / No	No			
Glycol % Solution	% / oC	Not Applicable			
	0 / 0				
	10 / -3				
	20 / -8				
	30 / -14				
	40 / -22				
	50 / -34				
Comments					
Sample was clear and particulate free. System should be dosed with a suitable scale/corrosion inhibitor.					
Site Contact Signature		**Print Name**		**Position**	

Harvesters Way EH14

Harvester Way			
Period	X2	System Status	
Up To	AYCR (µm/y)		(Average Yearly Corrosion Rate)
11/10/2017	0.4	Healthy	New Installation
22/02/2019	1.46	Healthy	
30/05/2019	1.51	Healthy	
18/10/2019	0.63	Healthy	
13/11/2020	3.11	Healthy	2 Corrosion peaks up to 50 µm/y due to expansion vessel maintenance
22/02/2021	2.19	Healthy	
08/06/2021	4.47	Healthy	
29/09/2021	2.04	Healthy	
25/10/2022	3.08	Healthy	2 minor Corrosion peaks up to 30 µm/y due to maintenance
Total	2.3	Healthy	Low corrosion rate over total system life span





Example 8 Waterfront EH5 1HS

70/40C F&R Htg & DHWS

140kW Peak New Build c 2018

136 Flats & Town Houses

Edinburgh EH5

the keenan consultancy

places for people

Waterfront EH5 1HS

the keenan consultancy

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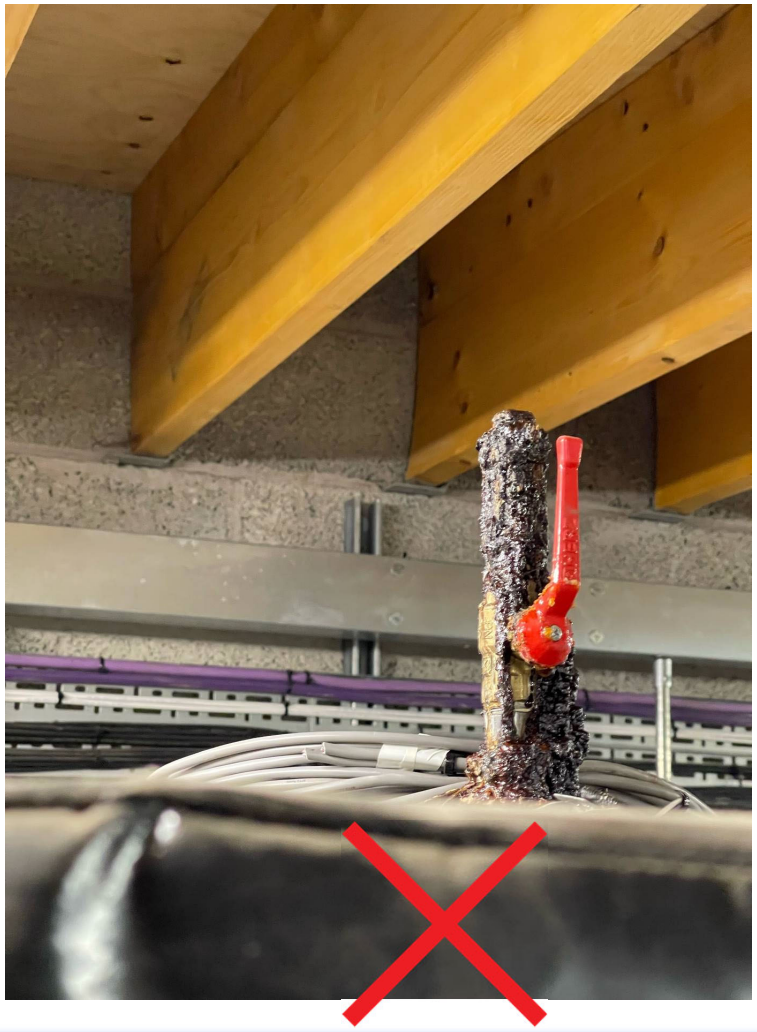

Waterfront EH5 1HS

the keenan consultancy

resus

HASL
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risycor

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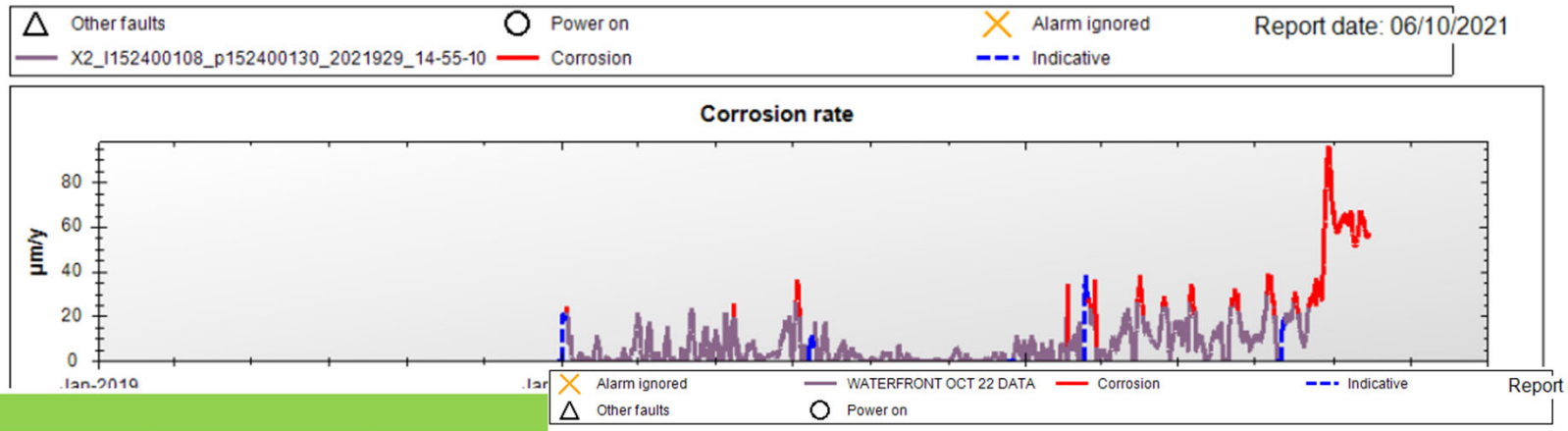
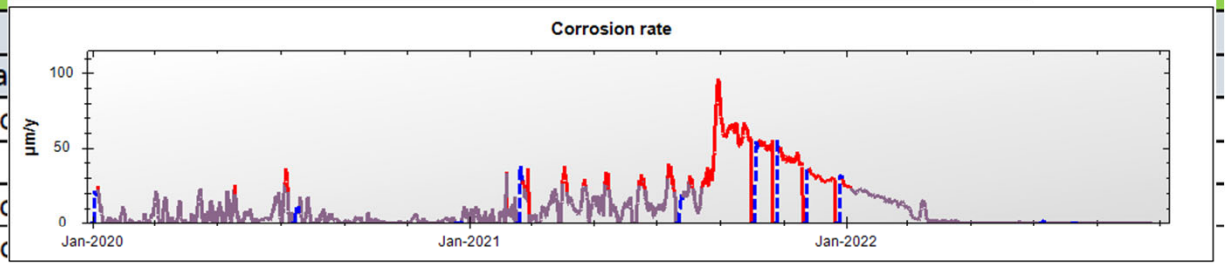
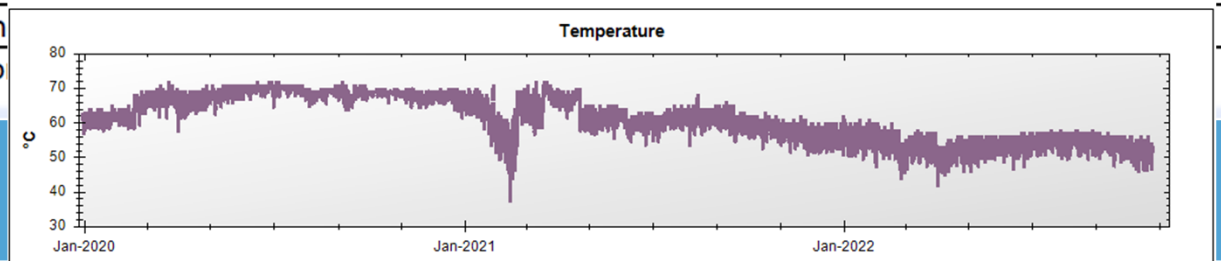


Waterfront			
Period 29/12/19	X2	System Status	
Up To	AYCR (µm/y)		(Average Yea
12/07/2020	5.04	Healthy	3 minor corr
20/12/2020	1.55		No Alarms
12/02/2021	3.92	Healthy	1 minor corr
23/07/2021	13.19	Healthy	7 minor corr
29/09/2021	41.56	Alarming	1 incident en
Total	10.23	Healthy	Low corrosio





Know your systems AYCR?

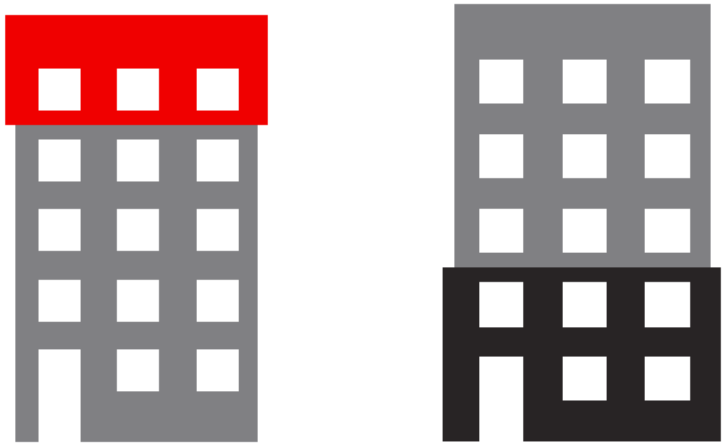
What do standards and guidelines say?

As also explained in the Risycor Application Guideline, occasional spikes in corrosion rate (YCR) are usually not a problem. As far as we know, very little research has been done on corrosion rates in closed heating systems. This is possibly due to the fact that until now there has never been a practical, economical and accurate measuring method. Based on the extensive experience gained with thousands of Risycors in real installations, RESUS currently use:

Average Yearly Corrosion Rate (AYCR)		
< 7 µm/yr	**7 - 21 µm/yr**	**> 21 µm/yr**
Risk of Corrosion Damage		
Low	Medium	High
Result in the long term		
little chance of corrosion damage	corrosion damage probable	serious chance of corrosion failure

Optimum Corrosion Monitoring

- Monitor circuits that reach to the top of the system and / or futhermost extremities i.e. Index legs.



- Monitor close to cold feed (topping up) i.e. Shunt return*

- Monitor circuits containing plastic pipes or EPDM hoses which are not diffusion tight

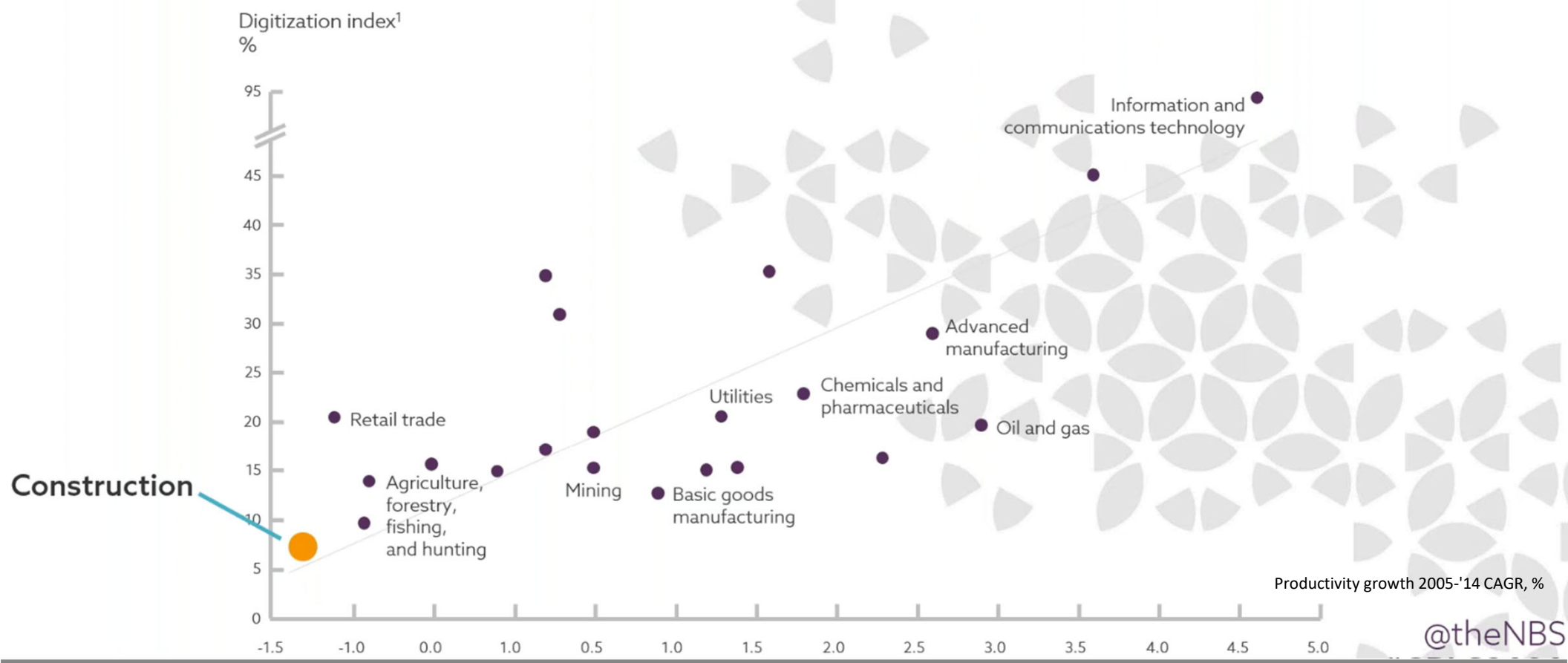
CPLS2020 Digitisation

SPECIALIST H&V DISTRIBUTORS

risycor

NBS

Construction is under-digitised



IoT – Smart Buildings

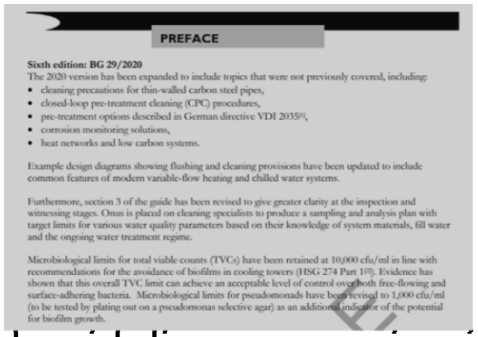
- *"Smart Buildings deliver a solid foundation to enhance a building's attractiveness, sustainability and efficiency"*
  Robert Thorogood Hurley Palmer Flatt

- *"Smart technology will actually make FMs more valuable, as they can provide strategic guidance on all this data"*
  Harry Badham MRICS, Axa Real Estate

- *"The future of FM is more about predictability and less of a helpdesk"* Phil Ratcliffe, Drees & Sommer

- RICS Modus FM in a post-pandemic world Author: Helen Parton 3rd Sept 2020

Summary



PREFACE

Sixth edition: BG 29/2020

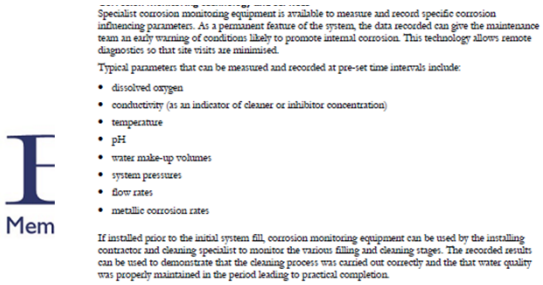
The 2020 version has been expanded to include topics that were not previously covered, including:

- cleaning precautions for thin-walled carbon steel pipes,
- closed-loop pre-treatment cleaning (CPC) procedures,
- pre-treatment options described in German directive VDI 2035[6],
- corrosion monitoring solutions,
- heat networks and low carbon systems.

Example design diagrams showing flushing and cleaning provisions have been updated to include common features of modern variable-flow heating and chilled water systems.

Furthermore, section 3 of the guide has been revised to give greater clarity at the inspection and witnessing stages. Onus is placed on cleaning specialists to produce a sampling and analysis plan with target limits for various water quality parameters based on their knowledge of system materials, fill water and the ongoing water treatment regime.

Microbiological limits for total viable counts (TVCs) have been retained at 10,000 cfu/ml in line with recommendations for the avoidance of biofilms in cooling towers (HSG 274 Part 1[7]). Evidence has shown that this overall TVC limit can achieve an acceptable level of control over both free-flowing and surface-adhering bacteria. Microbiological limits for pseudomonads have been revised to 1,000 cfu/ml (to be tested by plating out on a pseudomonas selective agar) as an additional indicator of the potential for biofilm growth.



Specialist corrosion monitoring equipment is available to measure and record specific corrosion influencing parameters. As a permanent feature of the system, the data recorded can give the maintenance team an early warning of conditions likely to promote internal corrosion. This technology allows remote diagnostics so that site visits are minimised.

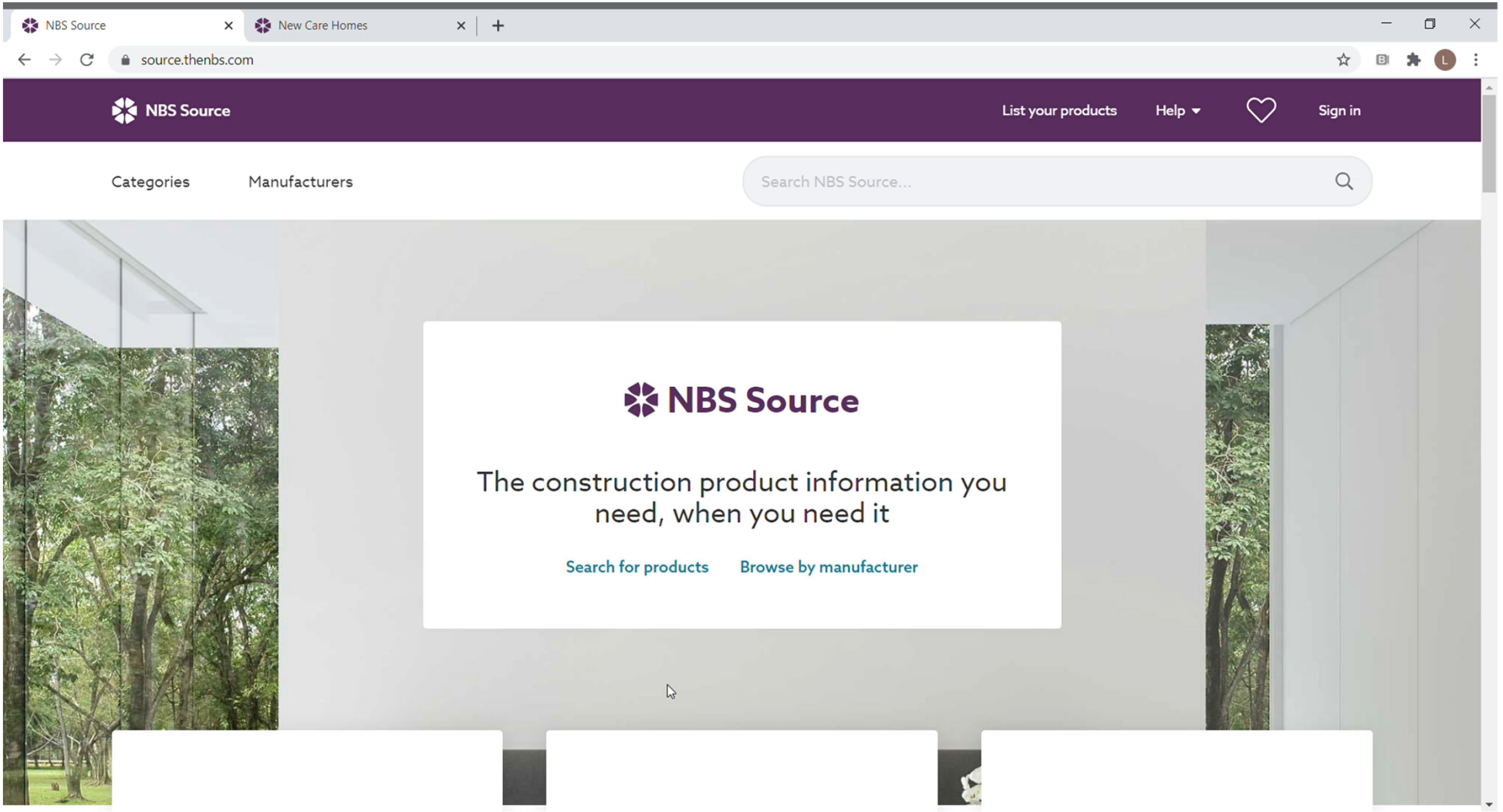
Typical parameters that can be measured and recorded at pre-set time intervals include:

- dissolved oxygen
- conductivity (as an indicator of cleaner or inhibitor concentration)
- temperature
- pH
- water make-up volumes
- system pressures
- flow rates
- metallic corrosion rates

If installed prior to the initial system fill, corrosion monitoring equipment can be used by the installing contractor and cleaning specialist to monitor the various filling and cleaning stages. The recorded results can be used to demonstrate that the cleaning process was carried out correctly and the that water quality was properly maintained in the period leading to practical completion.

- Despite many good standards and guidelines corrosion is still a problem. Not just PCS!
- Modern system components are much more susceptible to corrosion sludge. Therefore the problem will get worse not better.
- Corrosion inhibitors are not a universal miracle cure in isolation.
- By reducing O_2 levels it is possible to achieve very low levels of corrosion even without inhibitors.
- Corrosion caused by the first fill is minimal and not detrimental. Frequent refill is to be avoided.
- Correct pressure control/monitoring and minimising topping up is vital for enhanced corrosion control. Vacuum degassing make up water can only be advantageous if affordable.
- Monitoring corrosion should be mandatory to warn for sudden changes in the system. BG29/2020 has recently introduced *Real Time Monitoring & Data Retrieval* as has CP1 2020 Heat Networks. We commend BSRIA for this adoption to provide transparency. BG50/2013 Already had p76 6.6.4!
- Smart sensors such as the Risycor corrosion sensor sends alarms upon increased corrosion and records the entire corrosion history of the system.
- *Greater consideration should be given to Northern European Standards DE VDI 2035 & pending* 2021-03 VDI 6044, Austrian ONORM H5195-1, ISSO NL Publication 13 and the Swiss SWKI for Hot & Cold Water plus Cooling Circuits, BE WTCB.*
- *Heard of the Golden Thread! Why it Matters….Transparency is required as Condition based maintenance will improve TMon and Cx in delivering predictive maintenance.*

NBS Source Collaboration



#RisyCord Come & Join Us

Thank you

Any Questions?

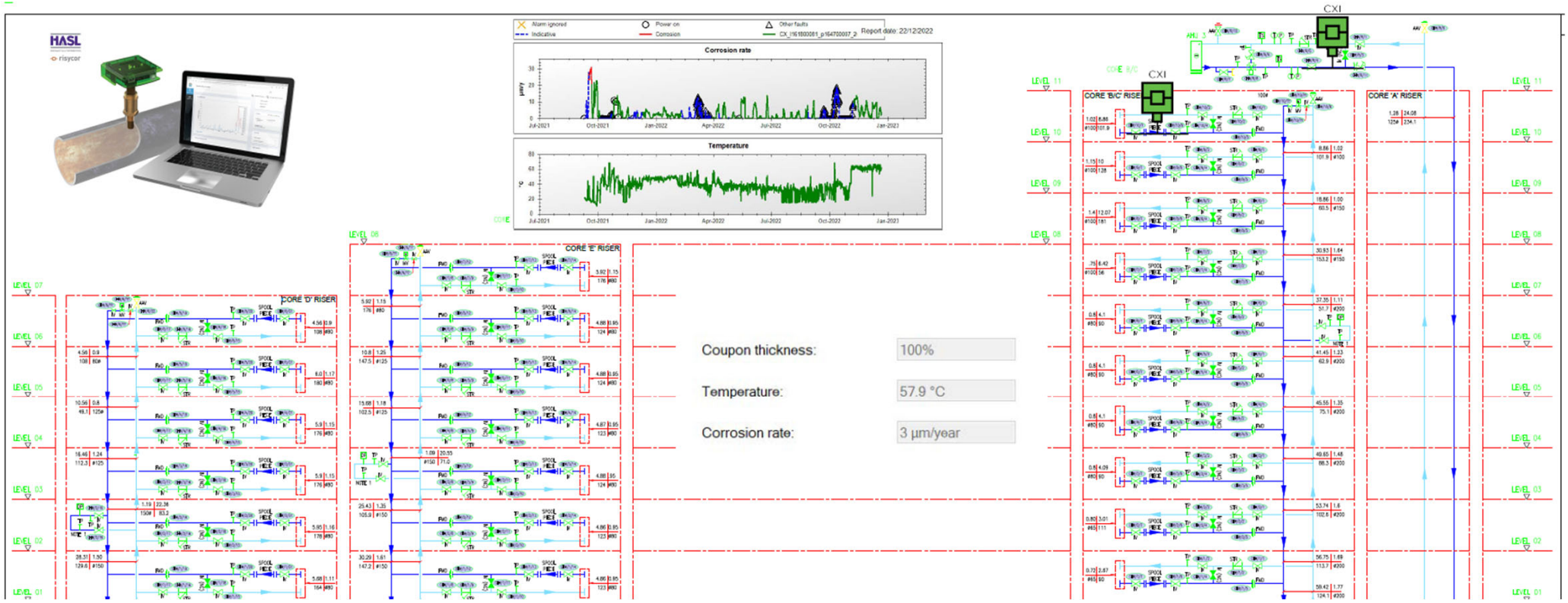
On behalf of HASL/RESUS we would like to thank you for attending this CIBSE HCSE Accredited CPD's.

Gordon Pringle gpringle@hasl.co.uk

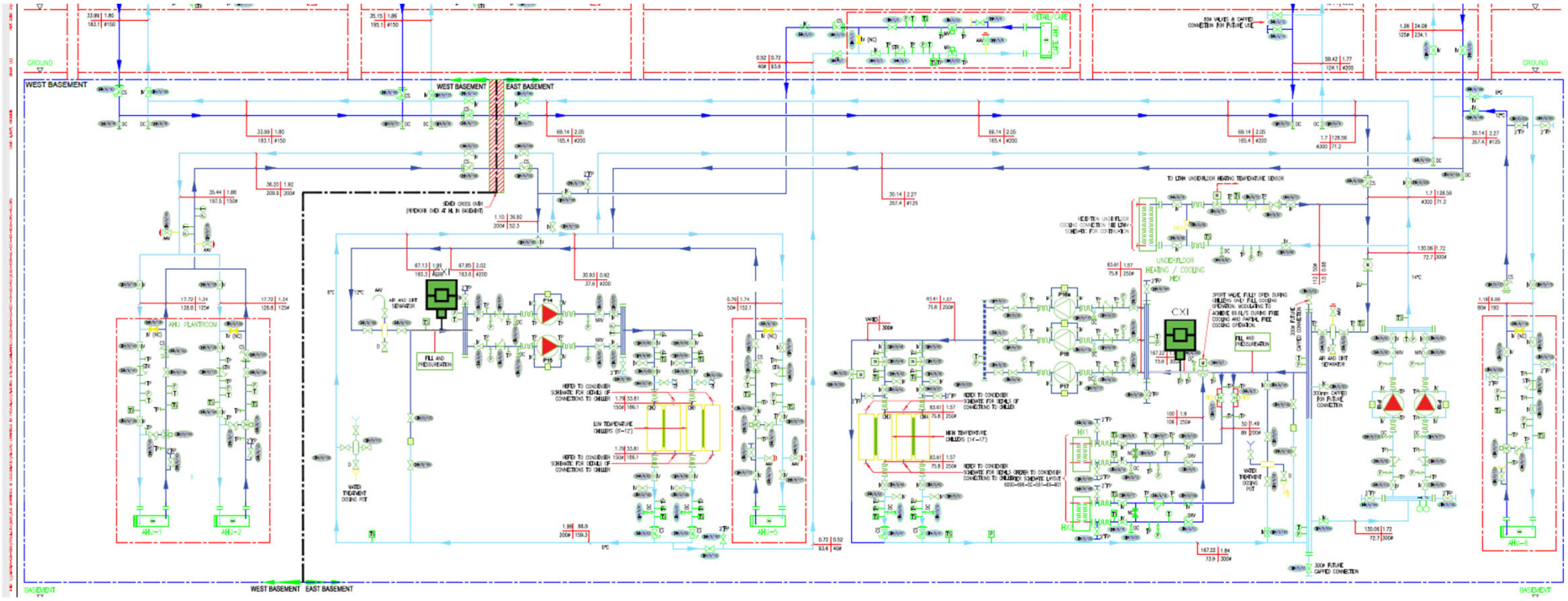
Feel free to connect with me on LinkedIn or follow me on Twitter @jugtastic67

Technical Due Diligence is coming more into focus!

Get #Risycord – Where do they go?



Get #Risycord – Where do they go?



Interoperability

- BMS Volt Free Contact on all units
- Excel .csv file availed via PC dashboard & Risycom.
- Optional Cloud data (via router by others) which can be mapped back to 3rd Party software via API.
- Our Interval Temperature on all units will demonstrate good hydraulic control and energy efficiency of the circuit. Likewise short circuiting will present as an error code.