Life Time Extension

Managing mechanical integrity of aging equipment

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DSM Operations & Responsible Care

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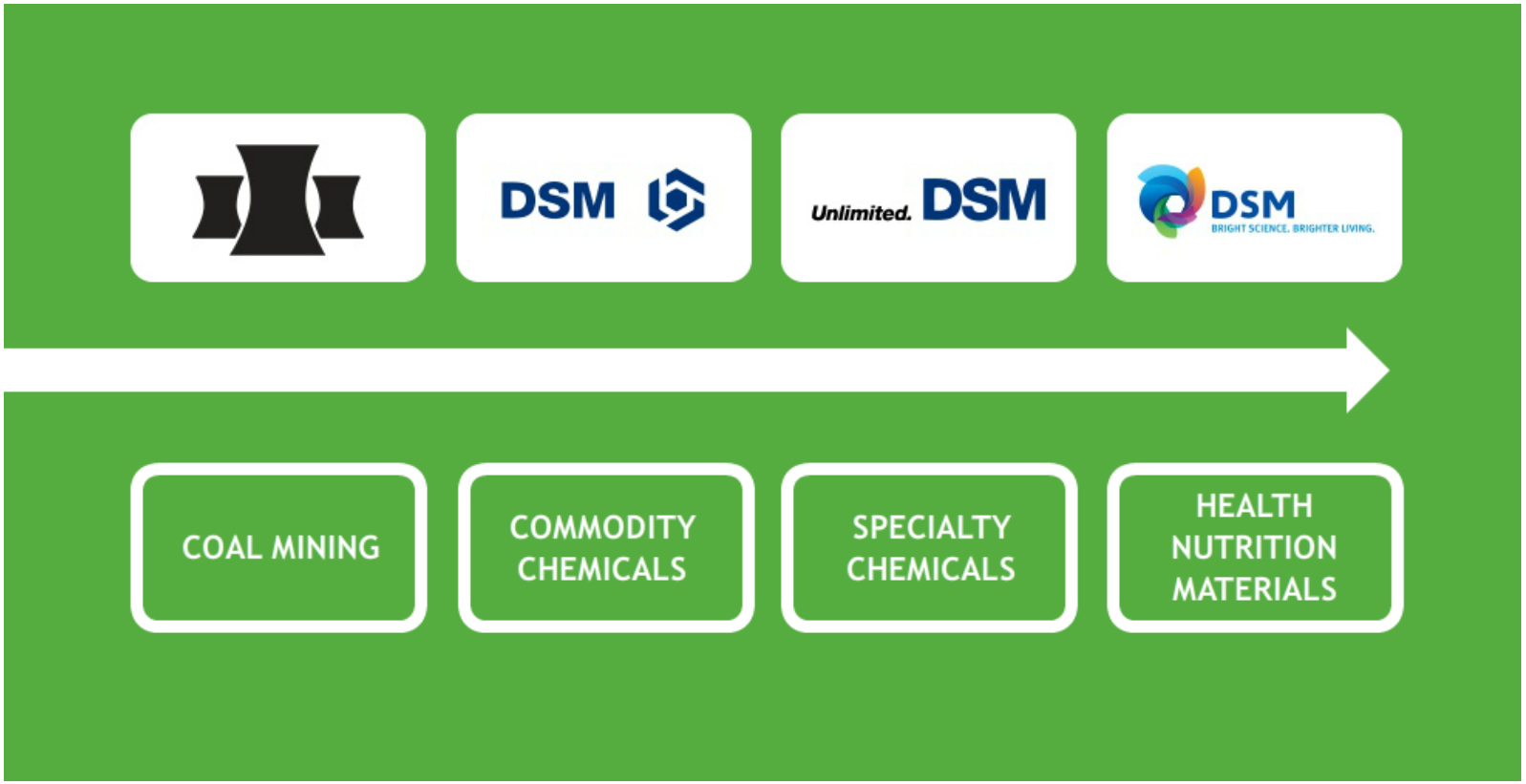
HEALTH · NUTRITION · MATERIALS

Transformations of DSM



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Asset Management developments

Before

- One huge central site (Geleen) + “satellites”
- Centralized engineering + maintenance
- One DSM engineering standard
- Comparable asset base → common expertise
- One culture – one language (Dutch)

Nowadays

- Global, >100 sites, most small
- Asset diversity
- Local engineering + maintenance
- Compliance to many different standards (GMP, etc.)
- Different engineering standards through acquisitions
- Cultural diversity – One DSM - company language (English)

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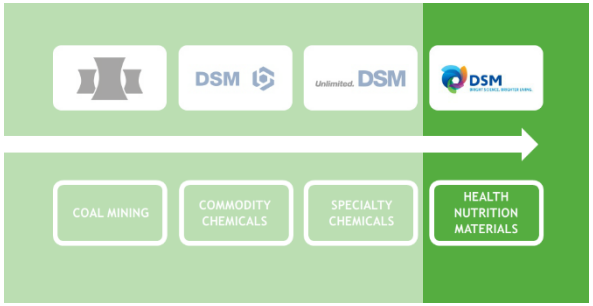
Asset Management challenge



Realize value today

- Integrity and compliance
- SHE
- Asset Utilization
- Costs
- Energy

Realize value tomorrow

- Condition of the organization → competence plans
- Condition of the assets → LTE

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How old is this air filter?

2.5 y - 5 y - 10 y - 15 y

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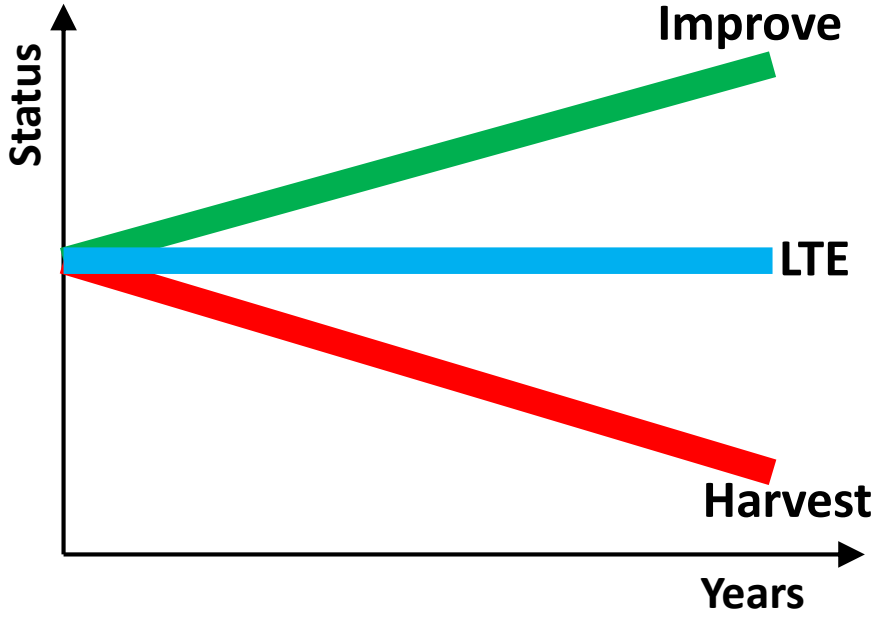
Is it just old, or is it aged?

"Ageing is not about how old your equipment is: It's about what you know about its condition, and how that's changing over time"
From: Plant Ageing RR509 HSE 2008

Age of this plant is (only) **5!** years



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DSM LTE - Background

- Aging plants, beyond design lifetime
- Acquired plants, unknown integrity status
- Need for long term sustainable, robust, reliable operation
- Top down pressure: “NO SURPRISES”
- Missed opportunities for improvement
- Move from project “wish list” to structured 10y CAPEX program
- DSM LTE approach developed in line with outcome ‘Vitale’ project.

Vitale
Joint Industry Project in NL aimed at asset management of ageing equipment

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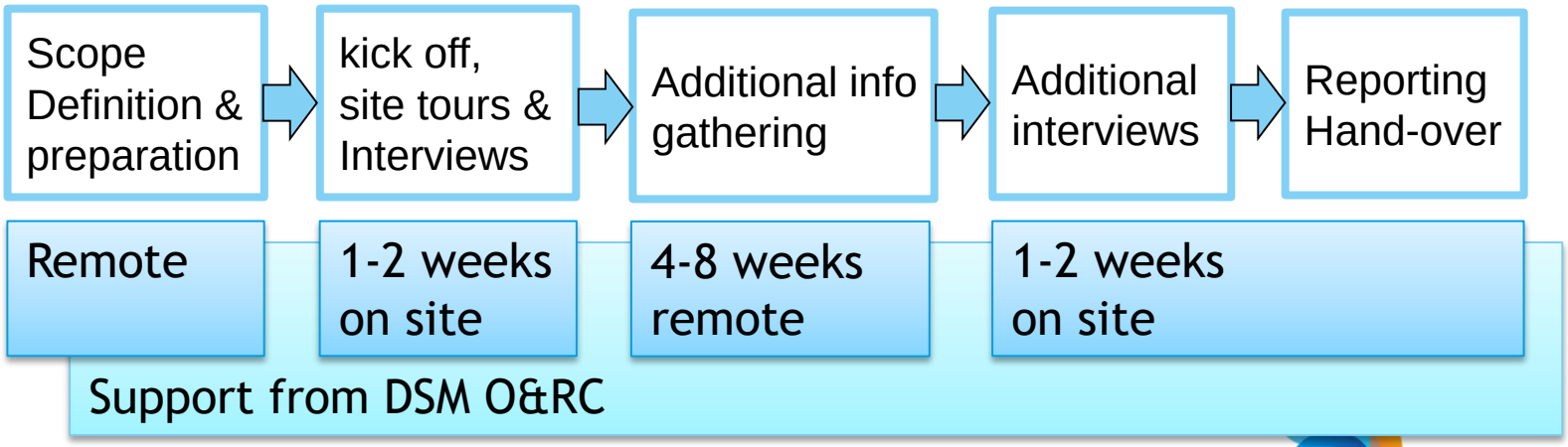
Execution process flow LTE study

- Goal is 10 more years operation “as is” (no debottlenecking, no harvest), in a safe, reliable and robust way.
- Assessment on equipment level: status (“why”) → action (“what”) → year (priority) → cost (guestimate)
- LTE represents the “Technical need of the plant”; no restrictions regarding budget or people are considered.
- LTE actions are on top of normal maintenance
- Next to off-site support (“cold eye view”) from DSM O&RC and/or BG, having experienced site people available for LTE interviews is key.



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DSM LTE scope

In Scope

- Future integrity
- Spare parts availability
- Knowledge availability
- Reliability/ Robustness
- Repair ←→ replace
- Compliance/LTO

Out of scope

- Normal maintenance
- Debottlenecking/ improvement projects
- Engineering and detailed costing
- Operational cost savings
- Office ICT

Spare parts / knowledge still available?

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LTE covers all disciplines

Static	Piping, vessels, heat exchangers, etc.
Rotating	Pumps, centrifuges, compressors, etc.
Electrical	Transformers, switchgear, cables, E-motors, etc.
Instrumentation	Flow, pressure, MSP's, etc.
Control systems	DCS, PLC's, etc.
Civil	Buildings, sewers, fence, etc.

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Tankfarm, piperacks, roads, grounds, ponds

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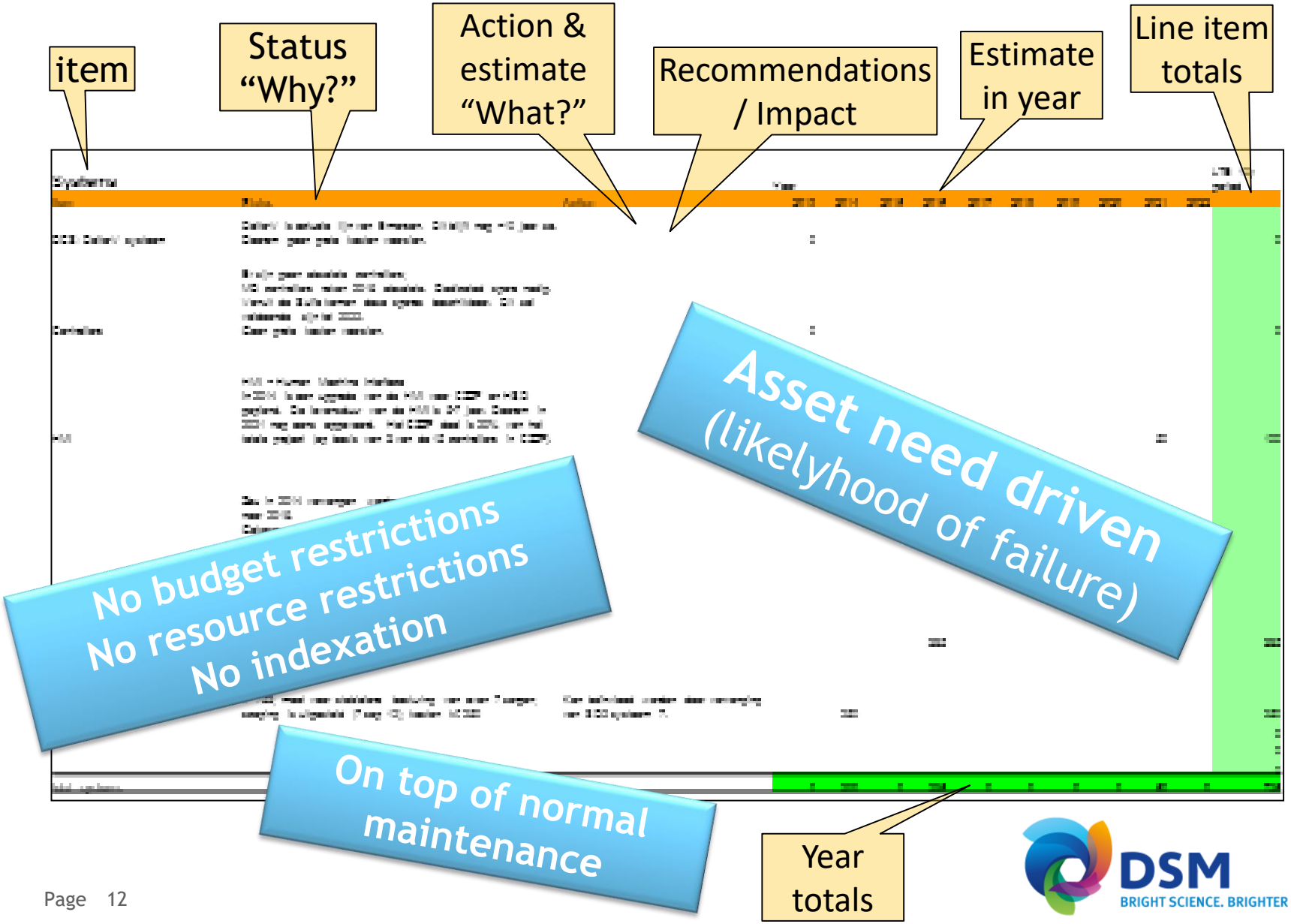
DSM LTE Reporting



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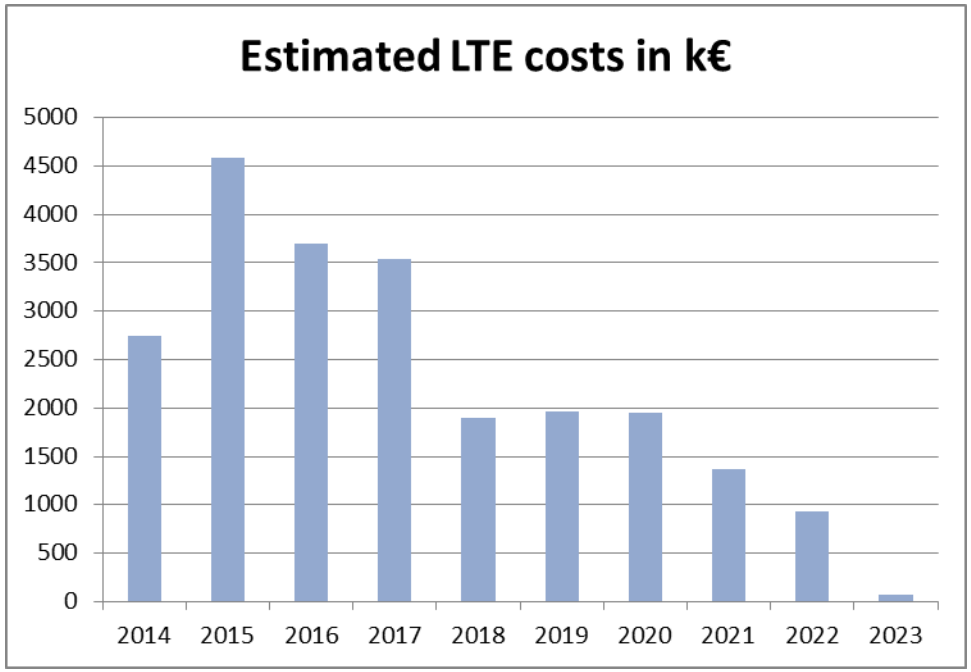
DSM LTE Costs

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	LTE 10y+
Civil	468	644	800	728	338	293	256	72	72	72	3740
Static	1388	650	2217	2405	1190	325	371	0	858	0	9403
Rotating	468	124	91	0	0	0	0	0	0	0	683
Systems	273	228	228	65	65	1300	1300	1300	0	0	4758
Instrumentation	52	176	91	150	72	0	0	0	0	0	540
Electrical	91	2769	267	195	234	52	26	0	0	0	3634
Grand total	**2740**	**4589**	**3692**	**3543**	**1898**	**1970**	**1953**	**1372**	**930**	**72**	**22757**



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DSM LTE : from Issue to Action

Resource limitations

Budget limitations

Consequences

(integrity) issue

LTE or Maintenance

Maintenance

LTE based on likelyhood

LTE based on risk

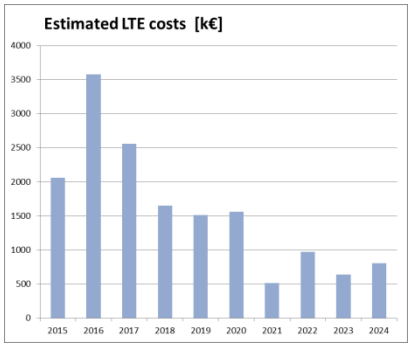
LTE Criticality Matrix

	SHE/ Compliance Category				Cost Category		Quality	Probability			
	Safety	Health	LTO	Environment	Maintenance costs (k€)	Production losses	Quality problems	< 1x per 10 year	< 1x per 5 year	< 1x per year	< 1x per month
Near loss		Light nuisance	NA	NA	2-10	<8 hr	Process deviation without quality loss				
First aid		Health complaints	Problem > 10 years	Light local emission to be cleaned up/ small spillage	10-20	8 - 24 hrs	Process deviation with quality loss				
Medical treatment		Exceeding occupational limits	Problem 5-10 years	Exceeding permit limits/LOPC	20-100	24 hrs - 1 wk	Customer complaint without financial consequence				
Lost time injury			Problem 1-5 years	Serious emission leading to damage on the site	100 - 250	1 wk - 1 month	Customer complaint with financial consequence				
Fatality		Occupational illness	Problem < 1 year	Serious emission leading to damage of the site	> 250	> 1 month	Serious complaint with business loss				

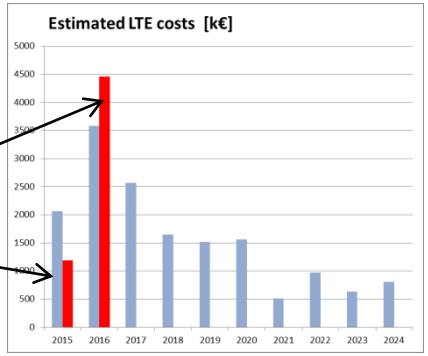
Potential Consequence

All amounts in kEUR

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	LTE 10y+
Civil	512	1015	695	535	525	415	155	325	165	510	4852
Static	870	3996	815	289	243	570	135	404	186	175	7683
Rotating	214	506	458	624	516	360	121	233	277	91	3400
Systems	290	540	450	5	0	60	0	5	0	5	1355
Instrumentation	105	80	50	35	81	43	0	0	5	20	419
Electrical	70	226	96	165	150	115	105	5	5	5	942
Grand total	2061	6363	2564	1653	1515	1563	516	972	638	806	18651
											18651



But the costs don't disappear!



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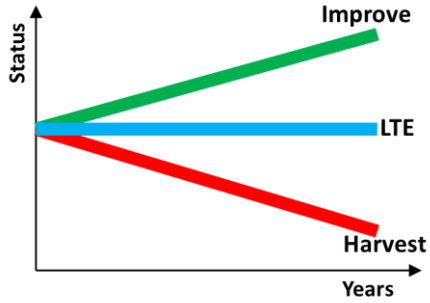
DSM LTE: Added value for maintaining mechanical integrity



- Known CAPEX investments to secure future operations
- Status of equipment known
- Support strategic investment decisions
- Prevention of nasty surprises / SHE incidents

Challenges:

- LTE gives ‘guestimates’, Financials read hard numbers
- Connect LTE with process improvements
- Experienced people doing LTE

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NO SURPRISES ?

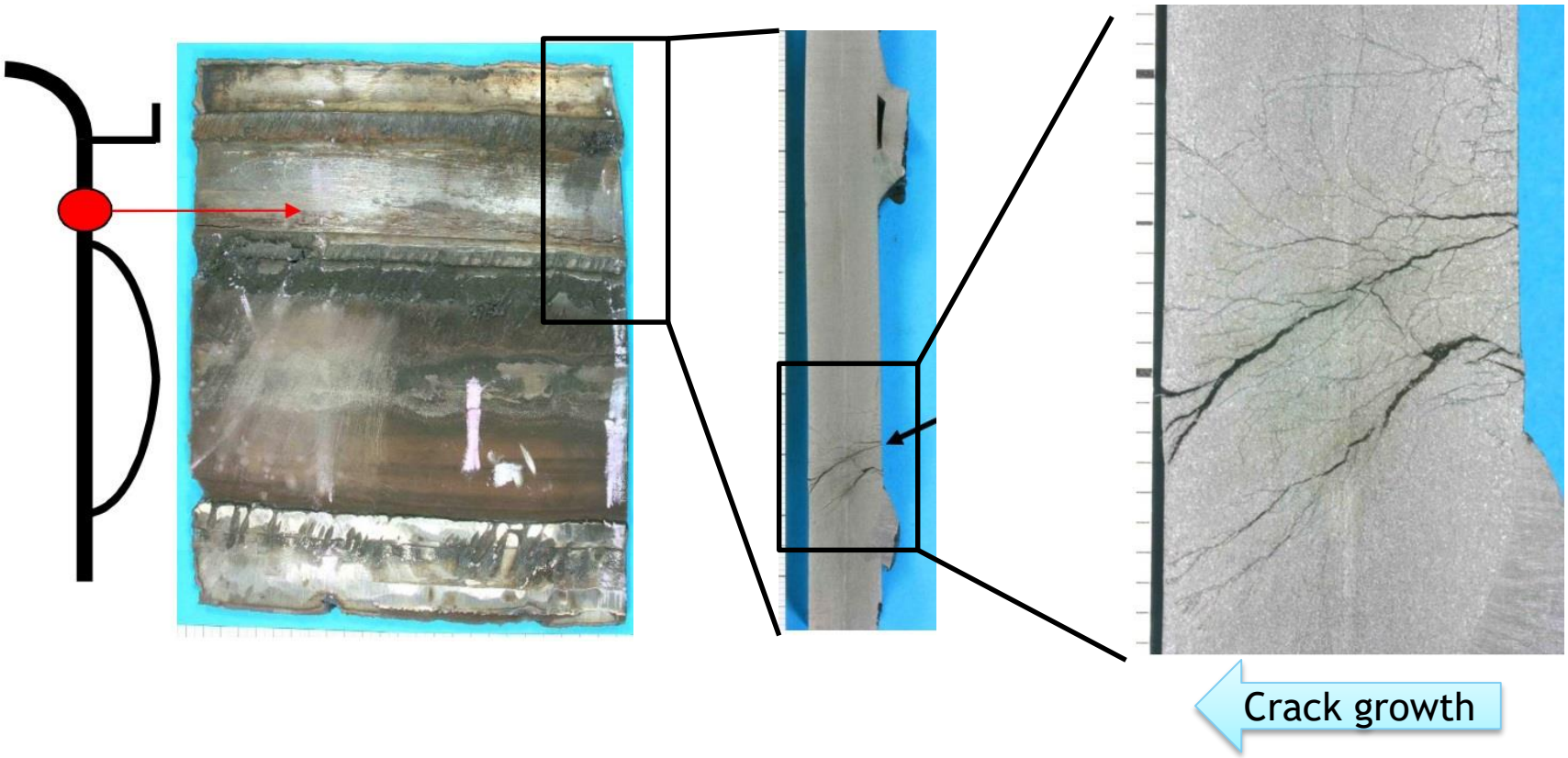
A case study

Case: external pollution of reactor found

Cracks along ¾ of circumference.

After cleaning and penetrant testing no leaks in half-coil found.

Damage investigation: Stress Corrosion Cracking (SCC), starting from outside surface



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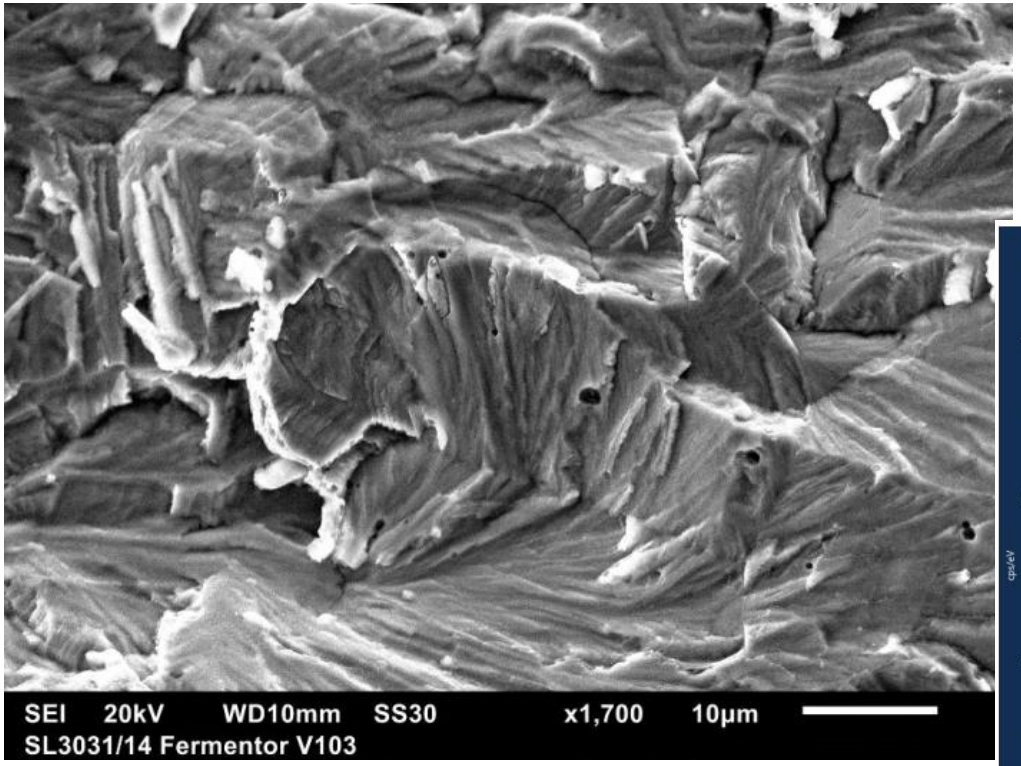
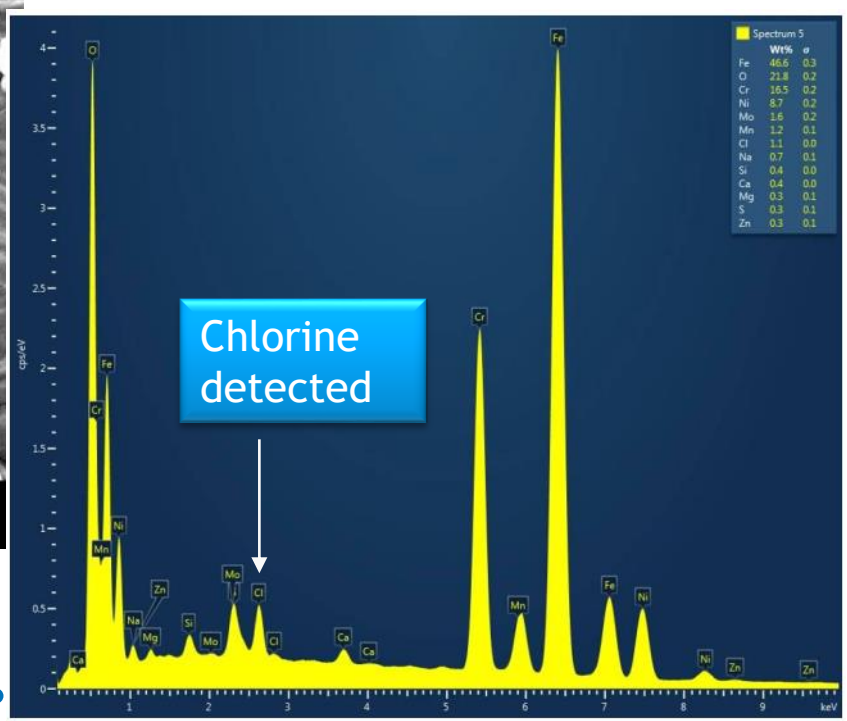
SCC: feather shape features on fracture surface (SEM image)





Chlorine detected: chloride-SCC

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Remains of adhesive tape found, with pits and cracks underneath

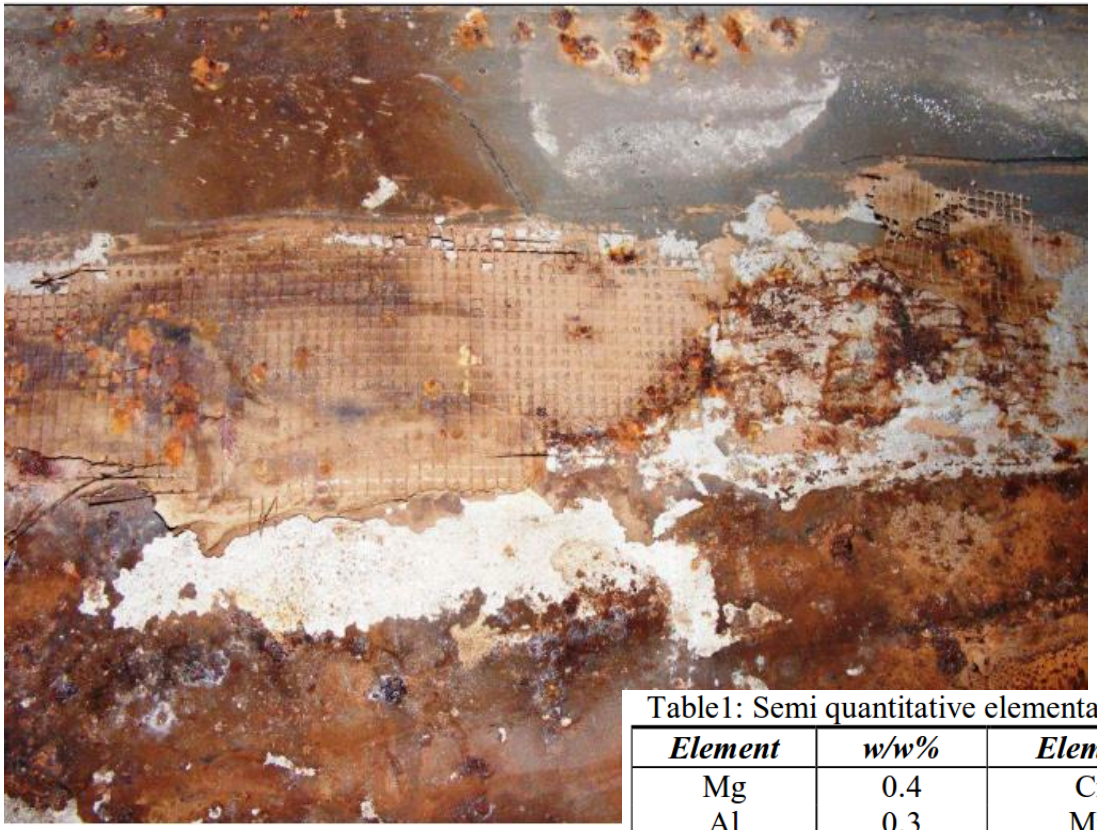


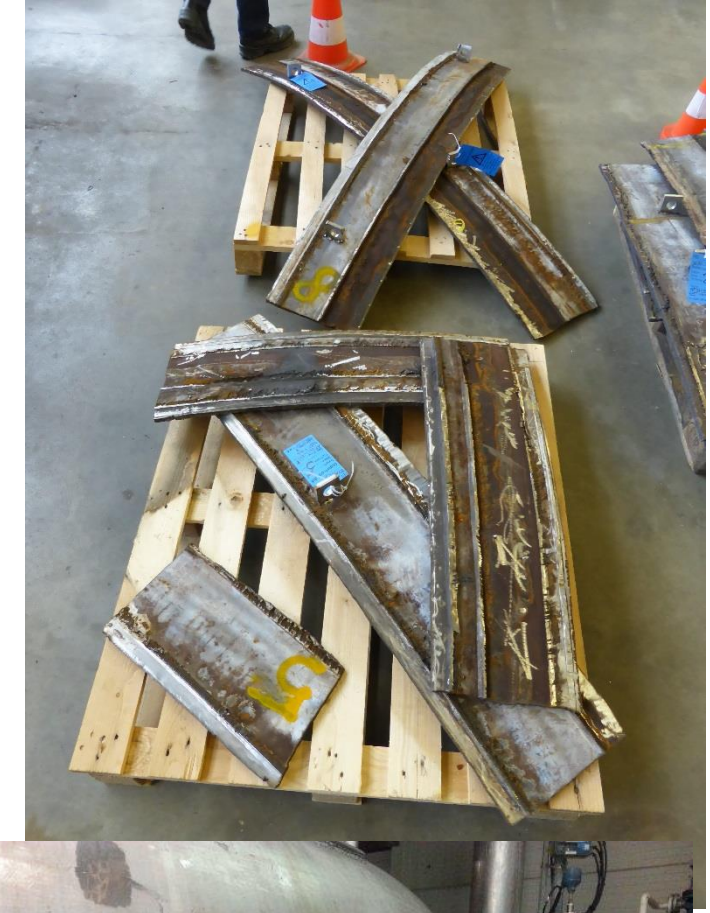
Table1: Semi quantitative elemental composition of elements > F in the periodic system

Element	*w/w%*	*Element*	*w/w%*
Mg	0.4	Cr	0.02
Al	0.3	Mn	0.02
Si	0.8	Fe	0.2
P	0.03	Ni	0.03
S	0.1	Zn	0.4
Cl	4	Sr	0.04
K	0.1	Sb	0.3
Ca	29	Ba	0.8
Ti	0.4		

4% chlorine detected

Repair procedure

- Cut out ring (also laminating with FRP considered)
- Ca. 15 cm under lowest crack location; upper half-coil sacrificed.
- Ca. 15 cm above highest crack location: on existing weld head-cylinder
- Total ring height ca. 40 cm
- Weld in new ring (316L)
- Weld bevels 100% penetrant tested: validate that these are free of cracks.



For you to check tomorrow:

Do you use labels / glue / ink with chlorides?

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