



Beitrag "Der Geothermiekongress DGK 2018"
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NORM in der Geothermie – Erfahrungen des praktischen Strahlenschutzes

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Scale formation in geothermal power plants



Origin of scales

- oversaturation of the brine
- chemical reaction with metal surfaces
- electrochemical corrosion (triggers also precipitation of genuine metals as lead)



Origin of scales - possible precipitating mineral phases:

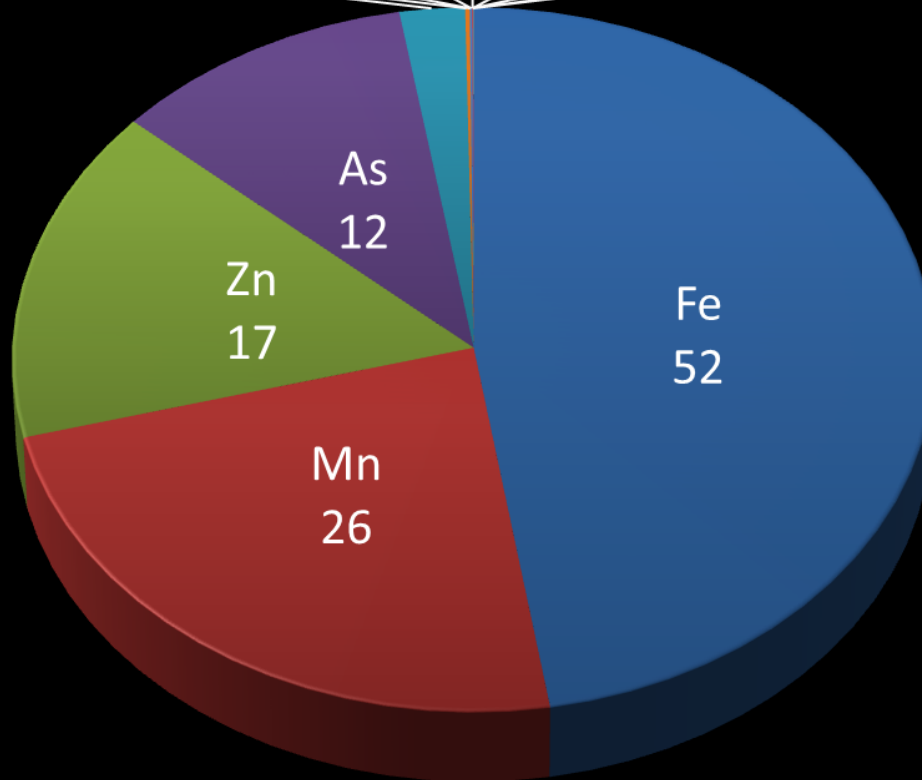
Calcite (CaCO_3),
 Gypsum (CaSO_4),
 Baryt (BaSO_4),
 Celestine (SrSO_4),
 Pyrrhotin (FeS),
 Galenite (PbS),
 elemental metals as Pb
 Covellin (CuS),
 Quartz (SiO_2)



average composition of heavy metals in thermal water

[mg/l]

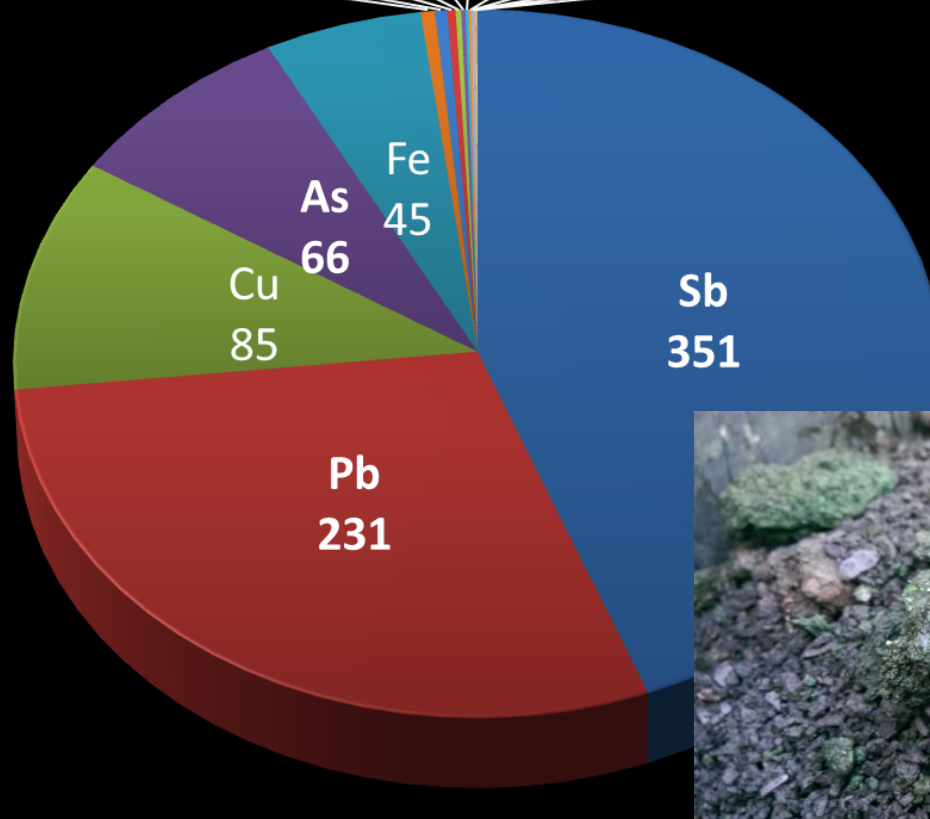
Pb	Cd	Sb	Cu	Cs	Ni	Mo	Cr	Hg
2,6	0,2	0,1	0,03	0,01	0,01	0,003	0,002	0,0002



average composition of heavy metals in scales

[g/kg]

Sc	S	Cl	Ca	Si	Na	Ni	Al	K	Mn	Cr
4,0	3,5	2,4	1,6	1,2	0,9	0,8	0,6	0,6	0,4	0,1

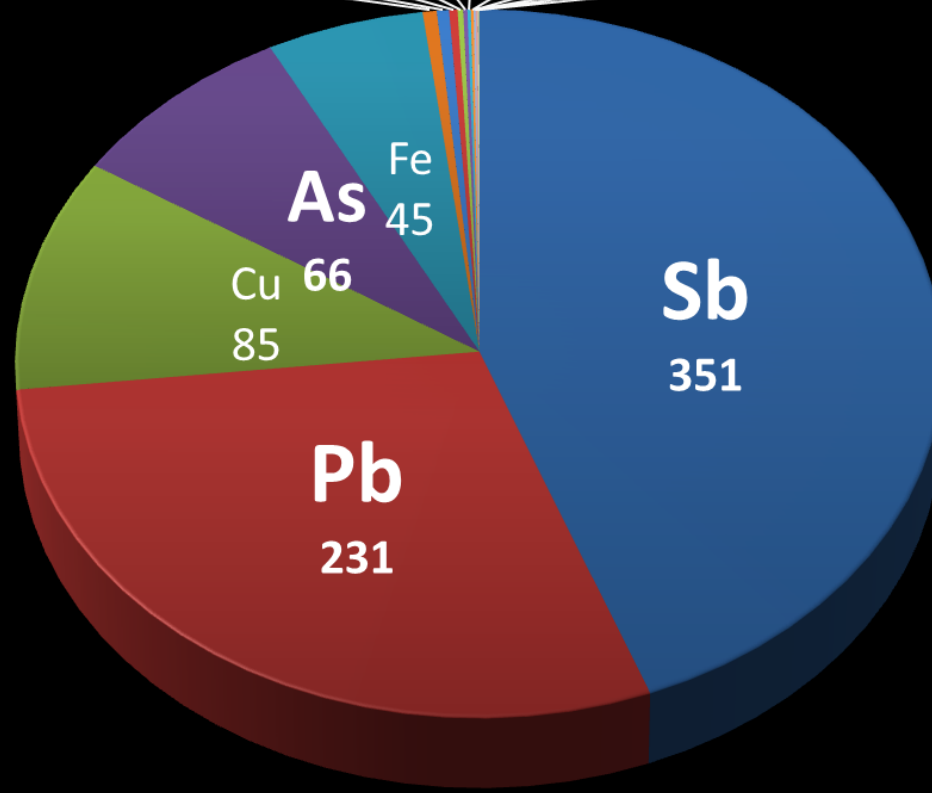


Scale formation in geothermal power plants

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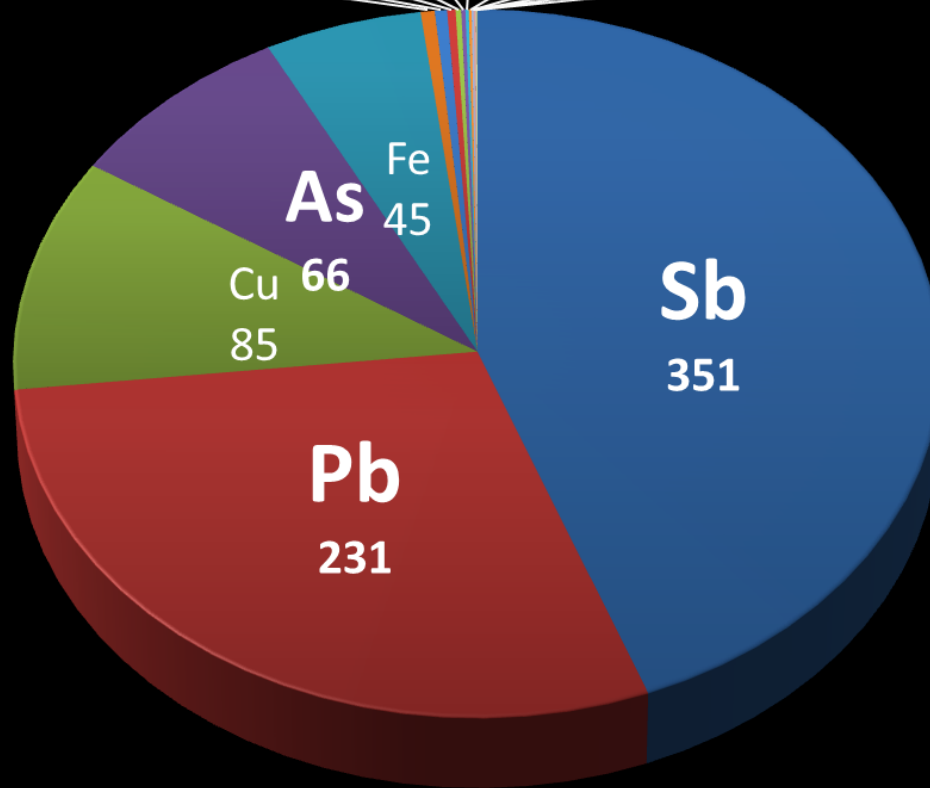


Scale formation in geothermal power plants

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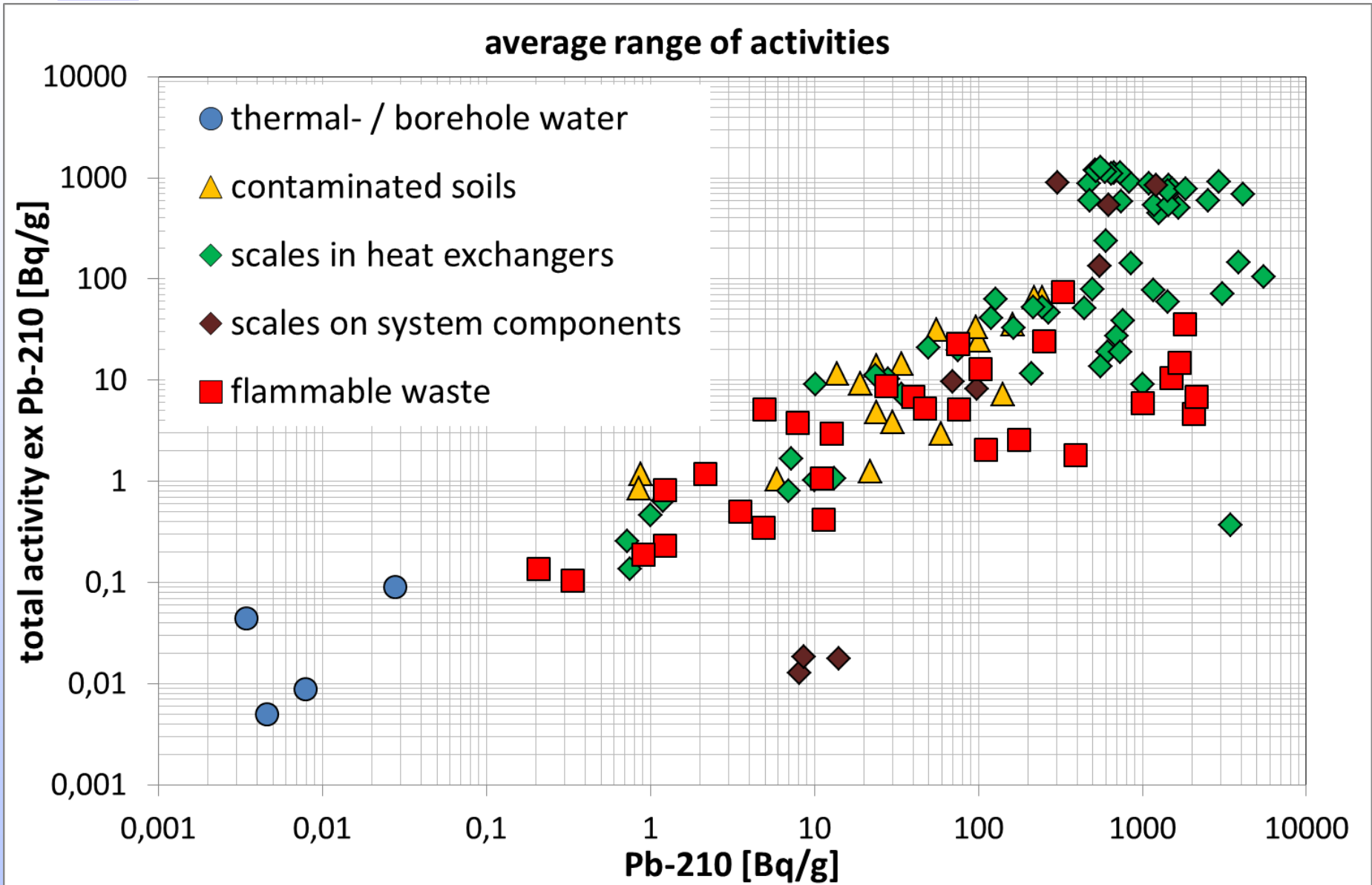


Lead
(e.g. as PbS, solid Pb etc.)

radioactive isotope **Pb-210**

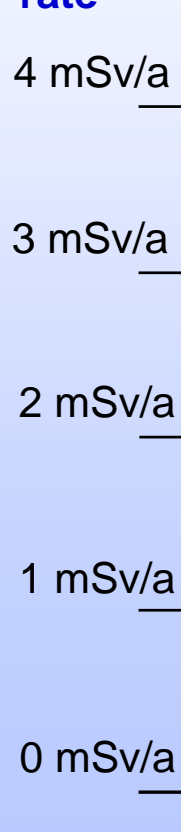
β - decay
half life ~22 a





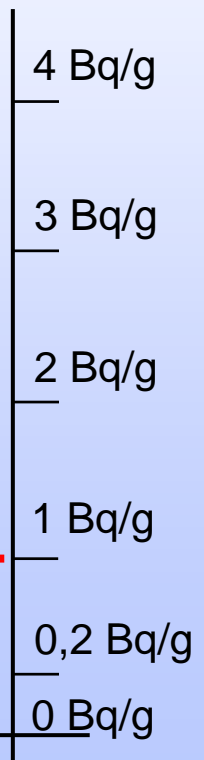
- **Announcement at authorities** (§56 German StrlSchG)
supervision of exposure situation
- **Permission** (§12 German StrlSchG) may be mandatory or licence/permission acc. to German **BBergG**
- appointment for **supervision of the practical radiation protection** acc. to German BBergG
- Installing a **supervision area** (§52 German StrlSchV) maybe necessary
- **Professionally exposed persons** §5 German StrlSchG, (category B) §71 German StrlSchV)
- **Medical supervision** (§77 German StrlSchV)
- ...
- To some extent “harmless”

personal dose rate



- **Waste is residue that demands supervision** (§27 German StrlSchV)
- **Rad. exposure** of the waste has to be **assessed; proof of “1 mSv”** (§28 German StrlSchV)
- Waste is under supervision of authorities, **disposal must be applied**; ways of disposal are **ordered by authorities** (§29 German StrlSchV)
- ...
- **Waste is Residue** (§5 German StrlSchG)
- **Mostly harmless**

Specific activity in material



Radiology on site – background measurements

Surface contamination

ambient dose rate



Bac

Radiology on site – ambient dose rates at relevant places

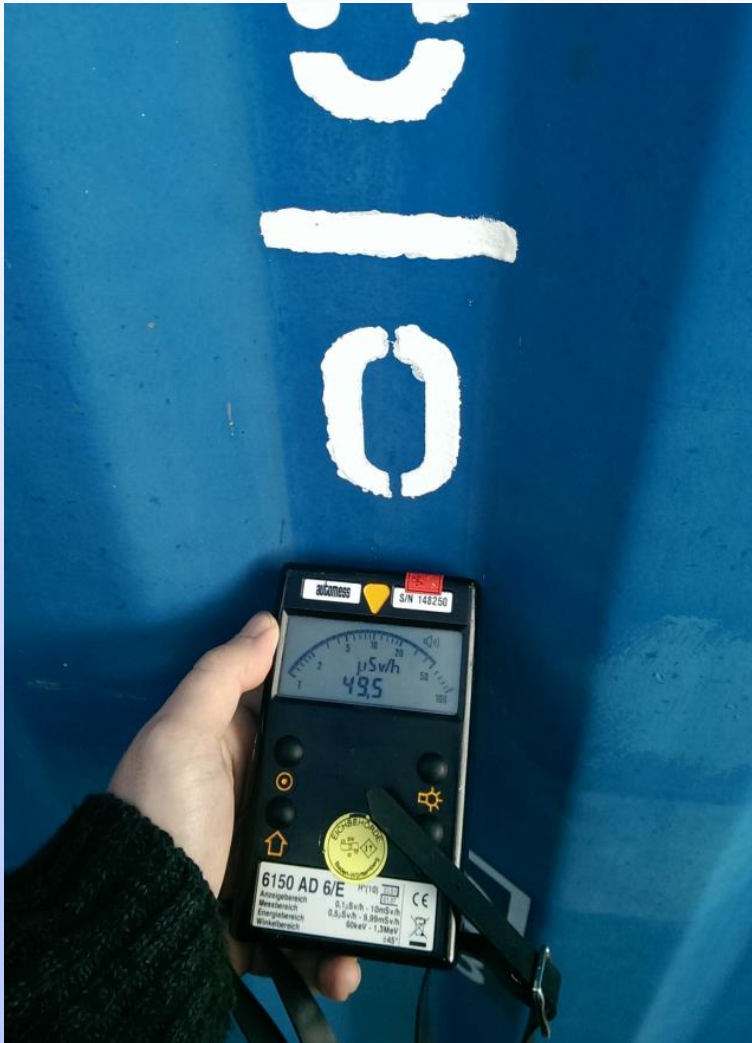


Background
0.09 µSv/h



Radiology on site – ambient dose rates at relevant places

Background
0.09 $\mu\text{Sv/h}$



Radiology on site – surface contamination at relevant places

Background
22 Ips




Radiology on site – surface contamination at relevant places

Background
22 Ips



Effort for a safe handling

- Detailed risk assesment for all working fields at thermal systems
- risk assesment of exposition, incorporation, emergencies
- Leads to specific operation directives with the focus on radiation protection for all work at thermal systems

BETRIEBSANWEISUNG		Stand:
Demontage Thermalwasserleitung		07.04.2016
GEFAHREN FÜR MENSCH UND UMWELT		
	Strahlenexposition durch radioaktive Beläge an der Innenseite des Thermalwasserkreises	
SCHUTZMASSNAHMEN UND VERHALTENSREGELN Bei mechanischen Trenn- und Demontearbeiten		
	<ul style="list-style-type: none"> • Nur geschultes und unterwiesenes Personal einsetzen • Gekennzeichneten Sicherheitsbereich um Öffnungsstelle einrichten • Kontaminationsschutz verwenden: <ul style="list-style-type: none"> • Arbeitsbereich mit Folie als Kontaminationsschutz auslegen • Persönliche Schutzausrüstung: <ul style="list-style-type: none"> • Einwegoverall • Handschuhe und Schutzbrille • Atemschutzmaske P3 	
		
		
		
		
	<ul style="list-style-type: none"> • Zutritt zum Sicherheitsbereich nur für befugte Personen • Aufenthaltsdauer in direkter Nähe der Rohrleitungen auf notwendiges Maß beschränken • Austretende Stoffe auffangen (Späne, gelöste Beläge, etc.) • Rohrenden mit Kunststoffkappen oder Folien verschließen • Werkzeuge durch feuchtes Abwischen reinigen • PSA, Folienabdeckungen und alle sonstigen anfallenden Materialien und Abfälle gesondert verpacken (z.B. Kunststofffässer) und kennzeichnen • Kontaminationskontrolle an Mitarbeitern, Werkzeugen und Abfällen durch Strahlenschutzexperten 	
ZUSÄTZLICHE SCHUTZMASSNAHMEN UND VERHALTENSREGELN bei thermischem Trennverfahren (Winkelschleifer) an Thermalleitung		
	<ul style="list-style-type: none"> • Abdeckung der Fläche um Öffnung mit B1 Folie (schwerentflammbar) • PSA: Einsatz Vollschutzmaske mit ABEK Hg P3 Kombinationsfilter • PSA: Einsatz schwerentflammbarer Einwegoveralls 	
VERHALTEN BEI UNFÄLLEN, ERSTE HILFE		
	<ul style="list-style-type: none"> • Arbeitsvorgang sofort unterbrechen • Unter Beachtung von Selbstschutz Verletzte aus Gefahrenbereich retten • Bei Kontaminationen: Dekontaminationsmaßnahmen nach Rücksprache mit Strahlenschutzexperten einleiten • Bei Verletzungen: Arzt aufsuchen • Betriebsleitung / Baustellenleitung informieren! 	
ANSPRECHPARTNER		
	<ul style="list-style-type: none"> • Betriebsleiter: _____ • Baustellenleiter: _____ • Strahlenschutzexperte: _____ 	
FOLGEN BEI NICHTBEACHTUNG		
	<ul style="list-style-type: none"> • Gesundheits-, Körper- und Umweltschäden • Disziplinarmaßnahmen 	

Effort for a safe handling

- instructions in radiation protection topics for all employees in contact with thermal systems bevor work starts (~30 min) – at least once a year



Effort for a safe handling

Radiological supervision of all work at the thermal system

- Planning of work process (minimizing of radiological risks)
- Preparing of work areas (plastic foils, barriers, containers etc.)
- Radiological measurement of workers, tools and instruments, facility, area and wastes)



Effort for a safe handling

- Personal dose meters for workers (during work on thermal systems)
- Ambient dose measurements, Rn-222 measurements



Rn-222 ambient dose meter

Effort for a safe handling

Personal protective clothes (PSA) as masks, gloves, safety goggles, overalls etc., beside conventional protective clothes



maybe also



Effort for a safe handling

- Register of all scale influenced material
- Register of contamination at the site (frequent measurements)
- Official authorities to be informed frequently and detailed (reports)



Effort for a safe handling

- Establishing ways for disposal
- organisation of radioactive transports according to ADR (announcements at authorities, declaration etc.)



Disposal - after release from supervision

All flammable waste to be disposed by combustion in rotary kiln at an industrial waste combustion facility



Disposal - after release from supervision

All metal scrap to be deposited at a landfill for industrial waste



Until recently melting in a special smelting furnace was possible



Disposal - after release from supervision

All scales and mineral waste to be deposited at a landfill for industrial waste

Chemical inertisation of scale by cementation – enable for deposition



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