



Organization of radiation protection and exposure control measures for "work activities" in the oil and gas production industry

Presenter:

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- **For "work activities" no specific requirements for a radiation protection organization are pre-determined by the German Radiation Protection Ordinance (RPO).**
- **So uncontrolled activities associated with NORM can contaminate the environment and pose a risk to human health - the main health risk is judged to be inhaled NORM dust - the Oil & Gas industry has applied own standards since the early 80-ties,**
- **The German Oil and Gas industry has recently implemented standardized awareness and training programs.**



The following presentation will cover the following topics:

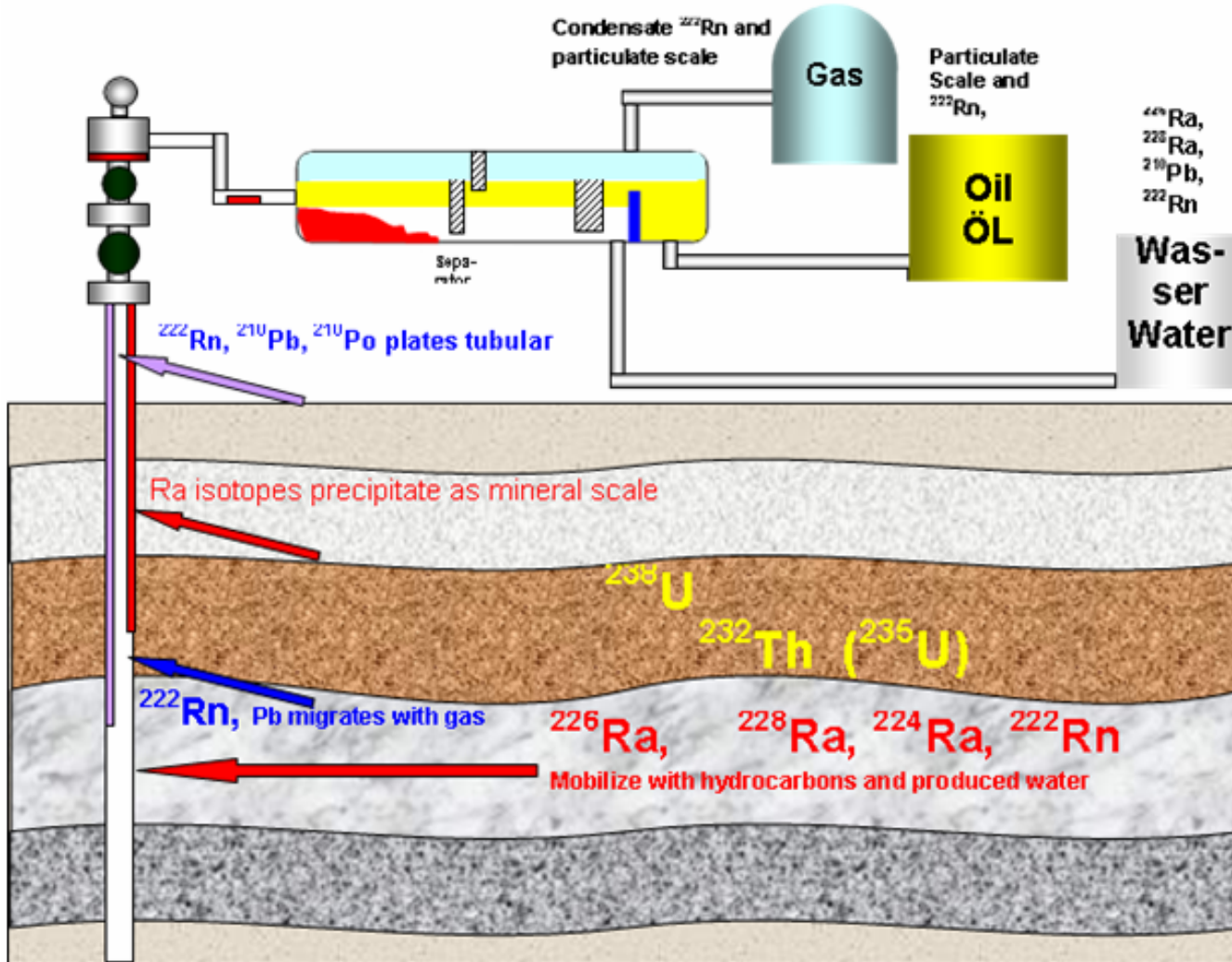
- I. Introduction / Short overview about NORM resulting from crude oil and natural gas production**
- II. Organization - Radiation protection functions in the oil & gas production industry according to industry standards**
- III. Industry NORM Guideline – Key elements of radiation protection measures according to the NORM Guideline(s):**
 1. NORM Management Process Cycle
 2. NORM Assessment and Monitoring Procedures
 3. Industry NORM Action Limits
 4. Training and Awareness and the role of "Drilling School, Celle" as a provider of special trainings for the Oil & Gas industry -
 5. Contamination Control - In Plant Organizational Radiation Protection Measures -
 6. Control of NORM Contaminated Waste
 7. Control of NORM Contaminated Equipment / Decontamination
 8. Workers Protection Requirements
 9. Documentation.



Ia. Introduction

During E&P activities, radioactive Ra-²²⁴,-²²⁶,-²²⁸ and lead (Pb-²¹⁰) - flows with oil, gas and water mixture.

These naturally occurring radioactive materials (NORM) can be concentrated by oil & gas production activities within production residues.



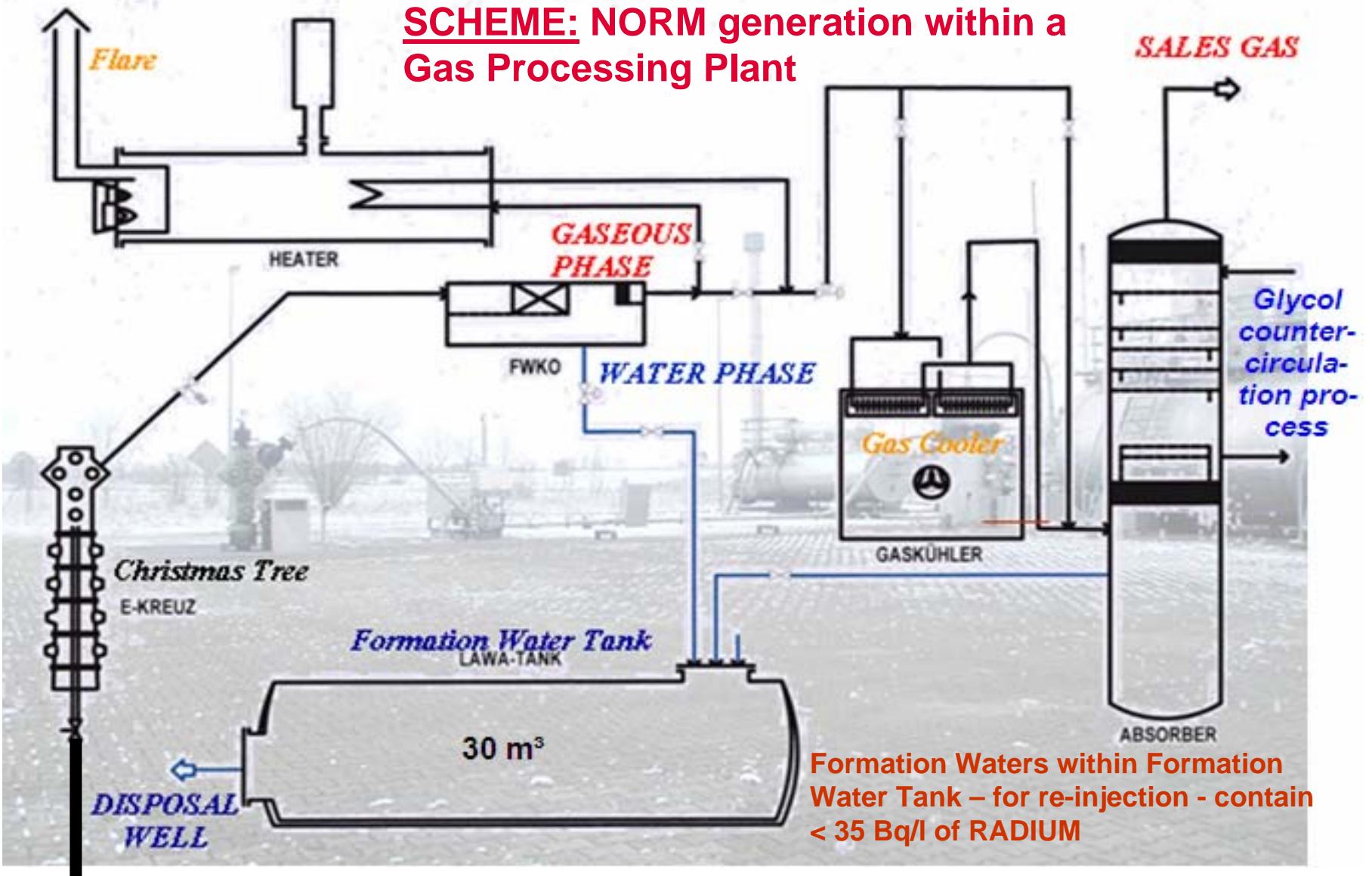


- **NORM accumulates in hard scale, as disseminated scale particles within sludge, and as a thin (lead-/ lead) film on the interior surfaces of gas processing and gas compressing equipment.**
- **Estimated from the known volumes of co-produced formation waters and the observed accumulated total activities within generated NORM waste, formation waters from German Gas Reservoirs contain up to more than 300 Bq/l of Radium, probably up to 1.200 Bq/l.**
- **As the finally re-injected waters contain less than 10 % of the initial radionuclide inventory, about 1 to 2 GBq were accumulated within about 300 to 500 Mg of German E & P NORM waste.**



Ic. Introduction

SCHEME: NORM generation within a Gas Processing Plant



Formation Waters from Rotliegend and Carboniferous Gas Reservoirs contain >300 Bq/l of Radium



- **The avoidance of unnecessary Radiation Exposure, requires not only procedures, but a “lawfully” organization.**

A „lawfully“ organization is characterized by:

A well - defined, id est documented organisational structure and process-oriented organisation,

to

- ⇒ assign liabilities for directive-, selection- and control
- ⇒ transparent delegation of tasks and competences,
- ⇒ adequate feedback controls

as

- ⇒ system of directives / procedures and as
- ⇒ evidence for conformity

- **A liable or lawfully Organization has to incorporate the existence of experts with adequate kknowledge in Radiation Protection at all sites for:**

- **Instruction of employees**
- **Surveying**
- **Qualified sampling**
- **Fixing protection measures**



Radiation Protection Organization for "Work Activities"

ORGANIZATION RESPONSIBILITY!

Radiation Protection Guarantor ("Entrepreneur")

shares responsibilities and tasks with
delegate executive employees

„MANAGEMENT LEVEL“

ORGANIZATION OF RADIATION PROTECTION

In-Plant Organization of Radiation Protection

In-Plant Organization of Radiation Protection

Radiation Protection Assignee (Site Manager A)

Radiation Protection Assignee (Site Manager B)

Radiation Protection Assignee (Site Manager C)

CONTROL RESPONSIBILITY!

Practical Radiation Protection

Practical Radiation Protection

Site Expert

Site Expert

Site Expert

Site Expert

Site Expert

Site Expert

PRO-VIDING
ADVISE & SUPPORT

Radiation Protection Officer



1. NORM Management Process Cycle:

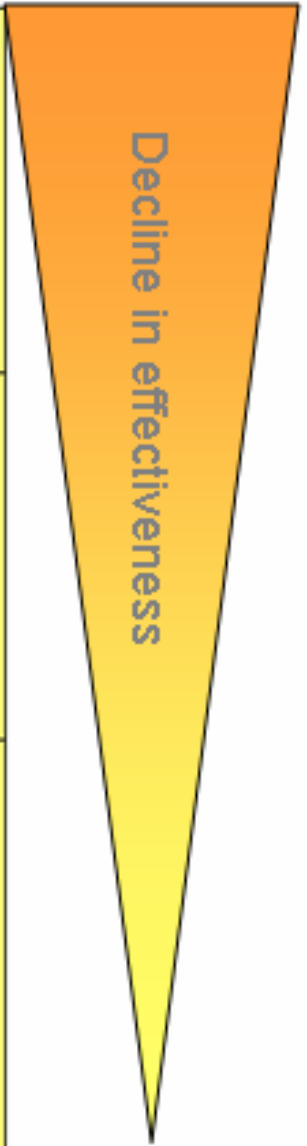
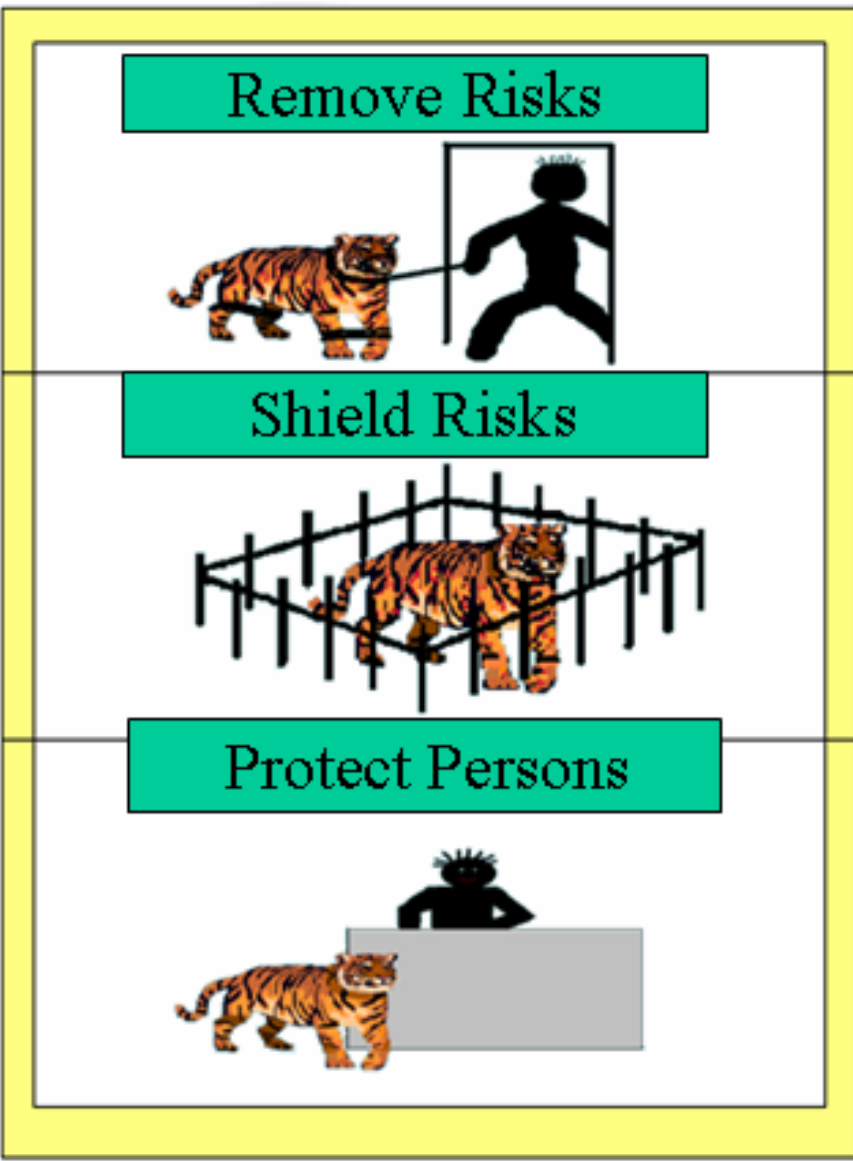
- **Contentious nature of radioactive material requires consultation and engagement of stakeholders, especially regulatory or competent authorities.**
- **To ensure all aspects of NORM are managed effectively, a process cycle has been developed to ensure protection of workers, public and the environment in a practical and cost effective manner...**



Risk Minimization Procedures



- **Strategic Measures**
- **Technical Measures**
- **Organizational Measures**
- **Personnel Protection Equipment**

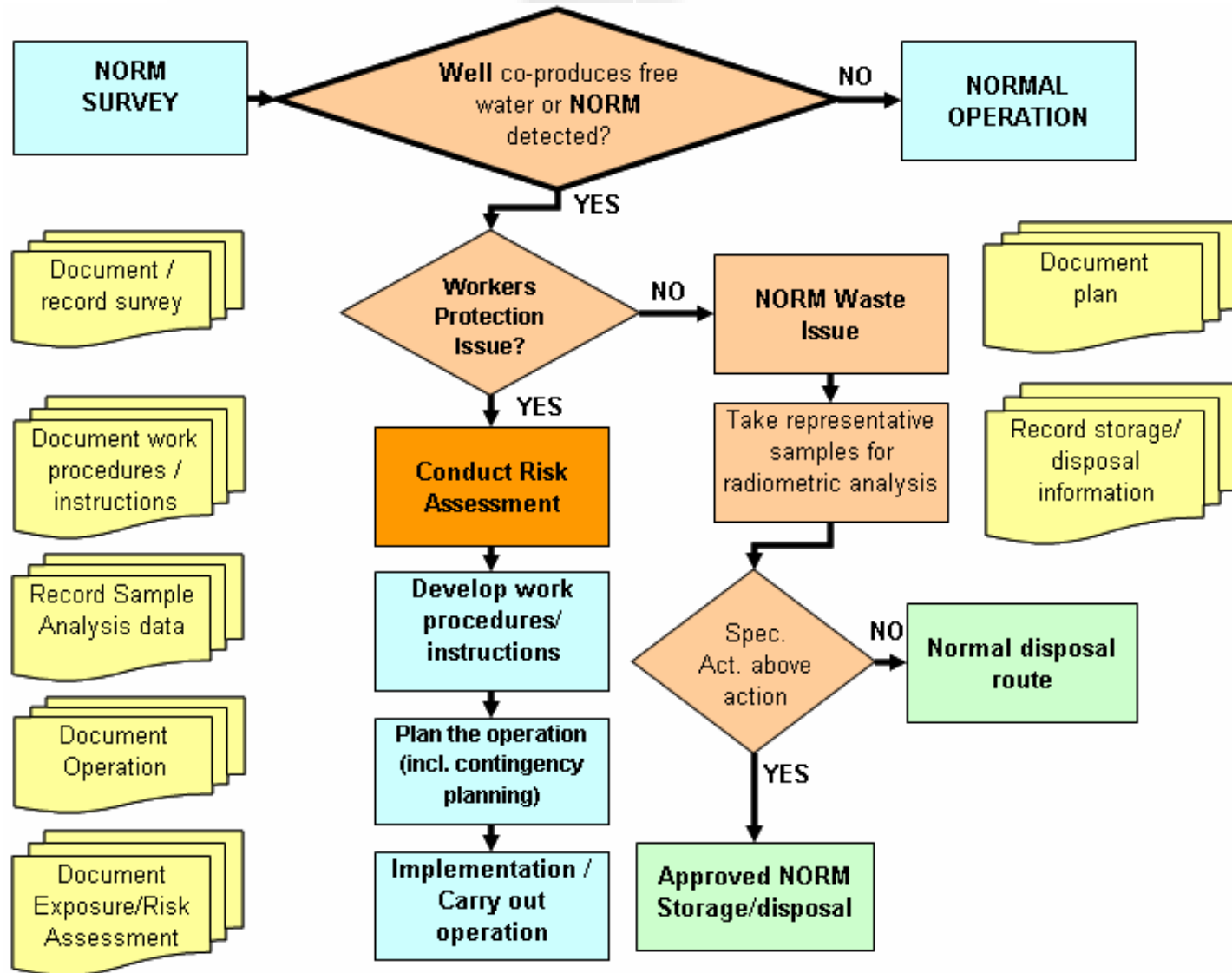




III-1b. NORM Guideline



1. NORM Management Process Cycle:





III-2a. NORM Guideline

2. NORM Assessment and Monitoring Procedures

- **System analysis** and monitoring is required to see if NORM is or will be present within a system according to production and reservoir data.
- Can utilize direct measurement instruments to measure the levels of radiation emitted; or samples can be collected and sent to a laboratory for radiometric analysis.
- Various components of a monitoring program may include:
 - **Baseline surveys** – establishes a baseline of the spread and level of NORM accumulation in facilities based on generic models and sample data.
 - **Pre-shutdown surveys** – to determine the locations of NORM accumulation in facilities where contamination is suspected.
 - **Operational assessments** – to identify NORM contamination promptly during routine operational scenarios.



3. Industry NORM Action Limits

- **Production residues and soil shall not have a Ra₋₂₂₆ contamination > 0.2 Bq (max. specific activity of a single element of each decay chain) per gram above background averaged over 10m² or unless risk assessment demonstrates an acceptable level of risk.**
- **Equipment, vessels and clothing shall be considered 'NORM contaminated' if internal or external surface contamination measures double the radiation background level.**



III-4a. Training and Awareness

- Training and awareness are major components of a NORM management system.
- Operational personnel must be aware of hazards associated with NORM; the controls required for their protection; and methods for preventing environmental contamination.
- A formally structured training programs provides training as follows:
 - Workers' instruction
 - Surveyors' course
 - Supervisors' Expert course



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Staatlich anerkannte Fachschule
für Bohr-, Förder- und Rohrleitungstechnik



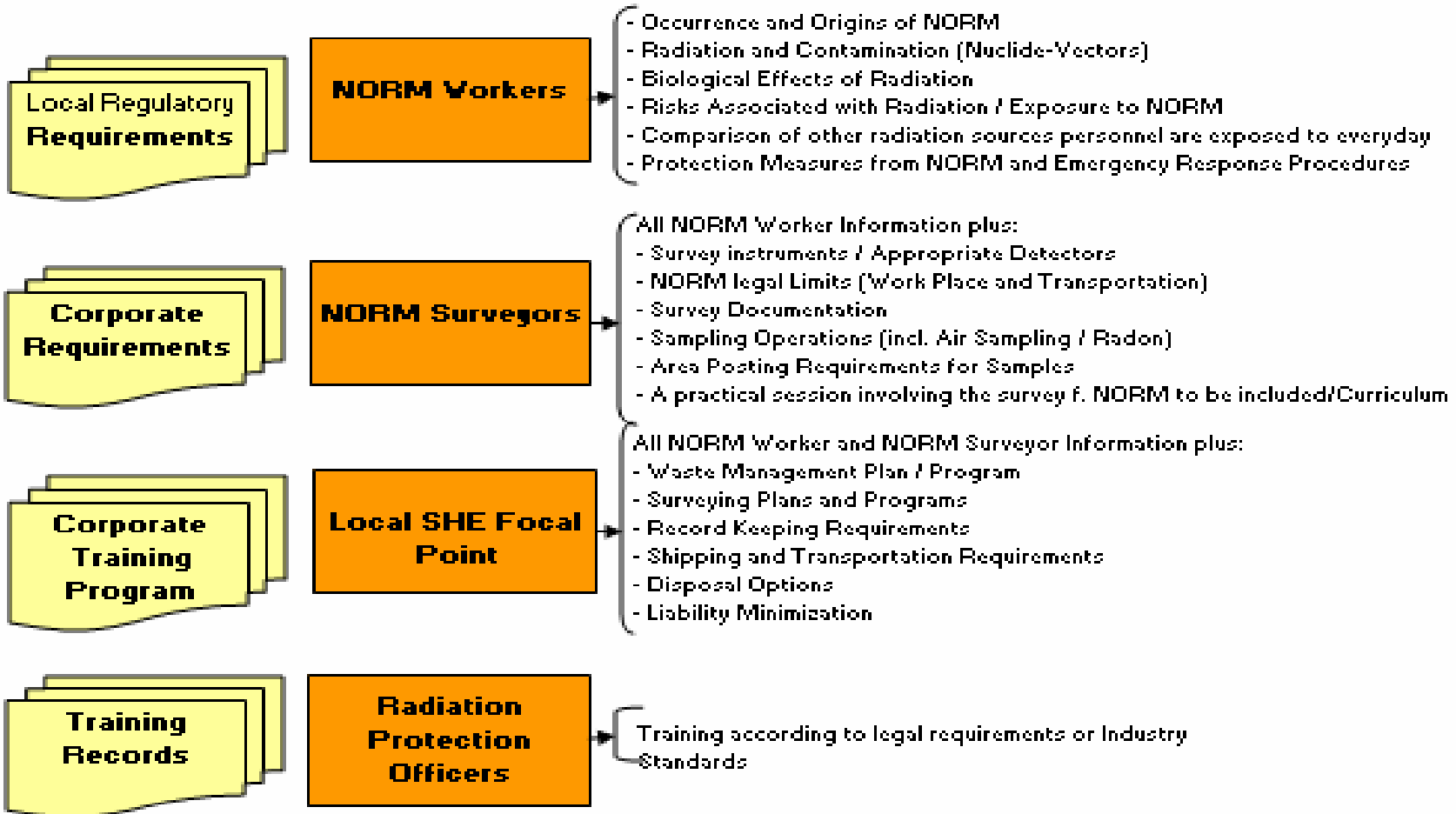
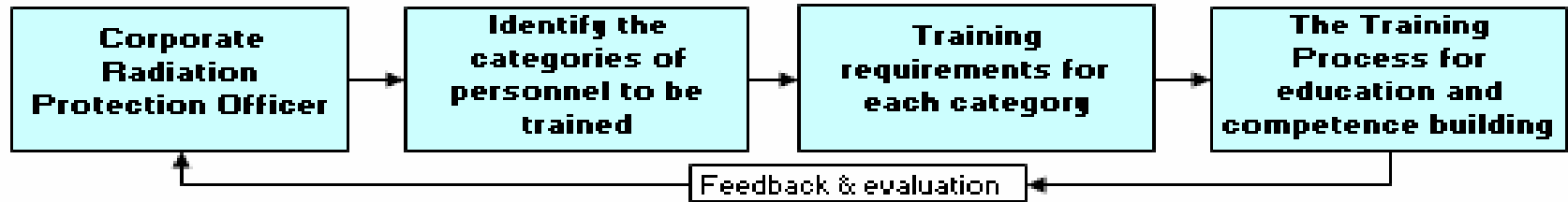
III-4b. Training and Awareness



- **The Oil & Gas industry has applied standard procedures as “NORM Guidelines” in the early 80-ties first.**
- **Practical work shows the need for trained site experts to conduct these procedures.**
- **As a consequence, the single E & P companies implemented own awareness and training programs.**
- **To enhance the quality of the training, and to open the trainings for remediation contractors, the industry decided in 2007 centralize the training. As provider for a centralized training, the Driller School in Celle traditional is the first choice. Therefore, the Driller School has been asked to plan the trainings in cooperation with the industry and the University of Hannover.**



III-4c. Training and Awareness





5. Contamination Control. What exposure control measures are required for NORM:

- **Risk Assessment programs and processes which evaluates/consider NORM.**
- **Periodic surveys/assessments to detect presence of NORM.**
- **NORM survey programs when:**
 - Opening equipment (n.b: typically TURNAROUNDS)
 - Handling NORM contaminated items.
 - Working in areas where NORM hazards may exist.
- **Ready access to independent expertise (i.e. Radiation Protection Adviser) to advise & supervise NORM-associated activities].**
- **Exposure Controls strategy in the event of NORM.**



5. Basic control procedures to be practiced when handling NORM contaminated items:

- **Establish a boundary around the work area big enough to allow access and for work to be carried out safely.**
- **Segregated waste storage for contaminated material at the exit.**
- **Only essential personnel allowed in the work areas.**
- **Prior to maintenance of contaminated equipment sufficient ground cover shall be placed below the item in the work area e.g. plastic, waterproof material capable of resisting tears/rips, or drip-trays.**
- **Post radiation warning signs ‘Caution: NORM Material’ with the radiation trefoil.**
- **Safety briefing for all personnel performing work.**

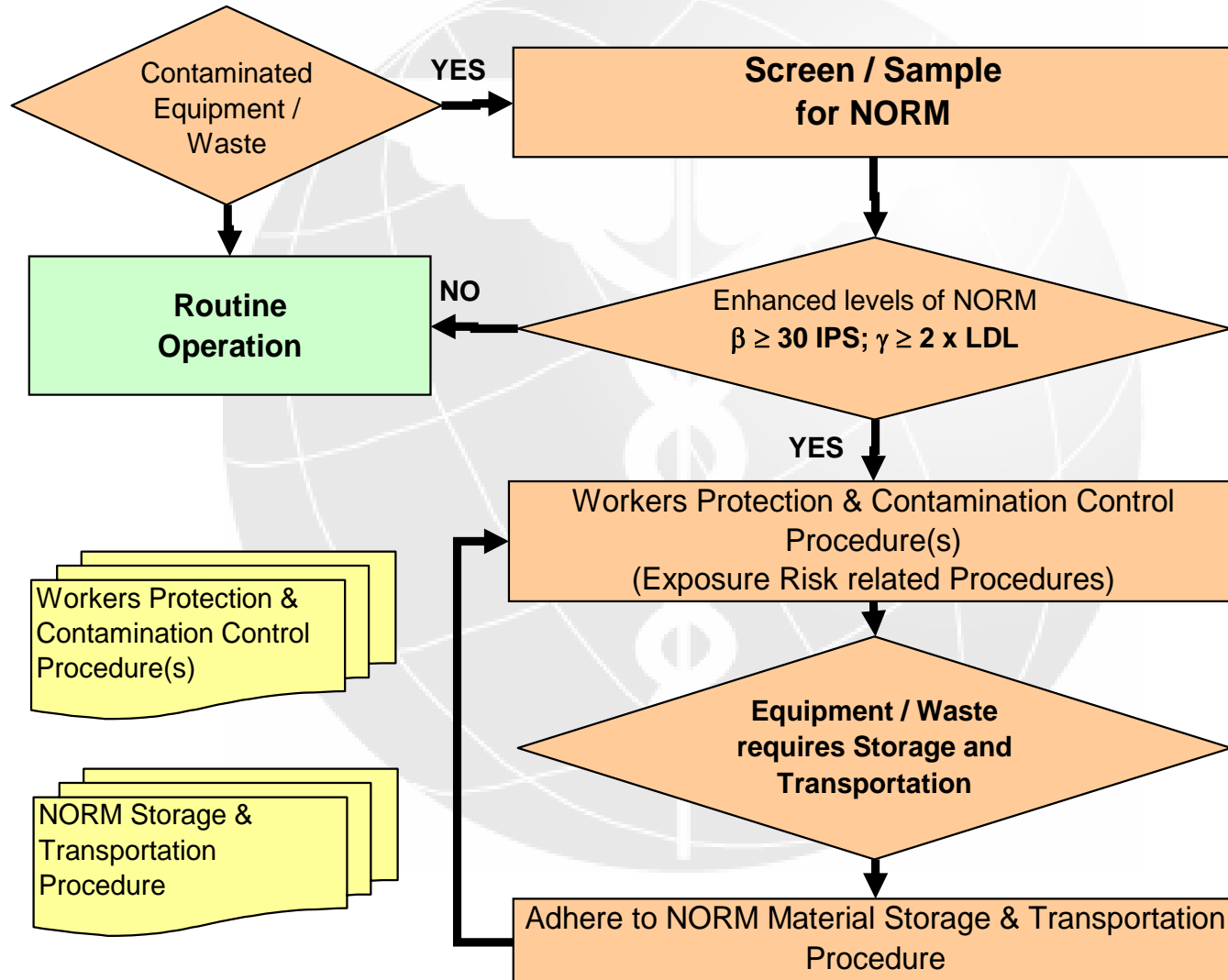


- **Out-of-service, contaminated equipment, removed from its prior interconnected status, shall be identified individually or as bundled or containerized group. The operator must identify this NORM-contaminated oil and gas equipment with a securely attached, clearly visible tag or by marking with paint or ink**
- **If appropriate tag may include acronym for NORM in additional languages**
- **Interconnected equipment (i.e. wellhead) that is NORM contaminated may be identified with a single tag – non visible for the public - while in service .**



III-6a. NORM Guideline

6. Control of NORM Contaminated Waste





7. Control of NORM Contaminated Equipment

- **Basic control procedures to be practiced when handling NORM contaminated items:**
- **Establish a boundary around the work area big enough to allow access and for work to be carried out safely.**
- **Segregated waste storage for contaminated material at the exit.**
- **Only essential personnel allowed in the work areas.**
- **Prior to maintenance of contaminated equipment sufficient ground cover shall be placed below the item in the work area e.g. plastic, waterproof material capable of resisting tears/rips, or drip-trays.**
- **Post radiation warning signs ‘Caution: NORM Material’ with the radiation trefoil.**
- **Safety briefing / instruction for all personnel performing work.**



Worker Protection Standards

- **Persons who dispose of oil and gas NORM shall comply with provisions of radiation protection ordinance including:**
 - **Radiation protection program**
 - **Occupations dose control**
 - **Surveys and monitoring**
 - **Signs and labels**
 - **Record keeping**



Record keeping

- **The operator shall maintain records on the exposure level of equipment, date, location, and identification of equipment**
- **The operator of a unit that generates NORM waste shall maintain records on**
 - **Identity of generating property and producing formation**
 - **Identity of facility / lease receiving waste**
 - **Nature, volume, and level of NORM waste (in Bq/kg; Bq/g)**



Record keeping

- **Records shall be retained for 5 years**
- **Retention period shall be extended during any pending Commission enforcement proceeding**
- **The operator who maintains the records shall make them available for examination and copying during reasonable working hours and shall file such records on request.**



Questions ???

