中核集团 CNNC

秦山核电 Qinshan Nuclear Power

追求卓越 超越自我

虚拟现实技术在辐射工作组织过程的应用

The Application of Virtual Reality Technology in Radiation Protection Training

2025年10月

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1 项目背景和目标
Project Background and Objectives

项目背景
Project Background

实操培训一定程度上解决了“边做边学”的痛点，但组织难度大、耗费时间长、提升效果慢。

Hands-on training has to some extent addressed the pain point of “learning by doing”,but it is difficult to organize,time-consuming ,and slow to yield improvement.

核能行业有大量的辐射工作由劳务输入人员承担，普遍缺乏行业所需的基础知识和技能。

A large number of radiation workers in the nuclear energy industry are undertaken by labor import personnel ,who generally lack the basic knowledge and skills required by the industry.

传统培训模式动脑不动手，到了工作现场依然不知道该怎么使用防护装备，只能在实践中“边做边学”。

Traditional training methods engage the mind but not the hands, leaving workers unprepared to use protective equipment on the job—forcing them to "learn by doing" in practice.

项目背景 Project Background

行业现状与痛点
Industry Status and Pain Points

- 理论学习多，动手实践少，缺乏实用工具，培训成本高、效率低

There is an emphasis on theoretical learning, with limited hands-on practice. There is a lack of practical tools, leading to high training costs and low efficiency.

- 实操与理论缺乏有机联系，实操能力不强

There is a lack of organic connection between practical operation and theory, resulting in weak practical ability.

- 培训周期长，知识、技能巩固效率低

The training cycle is lengthy, leading to inefficiencies in consolidating knowledge and skills.

- 学员学习方式被动，主动性不强，学习效率低

The learning method of the trainees is passive, with weak initiative and low learning efficiency.

- 实操培训覆盖面窄，未充分满足技能培训期望

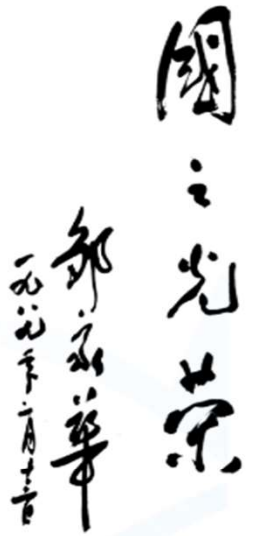
The practical training coverage is narrow, and it does not fully meet the expectations of skill training

项目目标 Project Objectives

降低非计划照射风险、减少污染扩散事件发生概率

Reduce the risk of unplanned exposure and the probability of contamination spread events.

2 实施方案
Implementation Plan



实施方案 Implementation Plan

平台 Platform

- 利用公司网络平台或虚拟现实设备（办公电脑、平板电脑）
- Utilize corporate network platforms or virtual reality devices (e.g., office computers, tablet PCs).

方式 Method

- 基于虚拟现实技术，以游戏化故事线模拟辐射工作组织过程
- VR-based simulated radiological operations featuring gamified storylines.

特点 Feature

- 学员无需进入辐射控制区
- Personnel can complete training without entering controlled radiation zones.
- 提供贴近现实的辐射防护技能培训场景
- Deliver immersive training environments for radiological protection skills.

功能 function

- 针对不同阶段的培训对象设置多条故事线
- Set up varied scenario paths for diverse learner levels.
- 学员根据故事线式培训任务做相应的响应
- Trainees execute corresponding responses to storyline-based training tasks.
- 人员行为判定和自动计分考核功能。
- Automated behavior assessment and scoring function.

辐射工作组织过程虚拟培训系统

Virtual Training System for Radiological Work Processes

实施方案 Implementation Plan

开发一种具有以下特点的培训方式：

Project Features

- 学员在办公电脑上即可联网进入3D仿真场景像玩第一人称视角游戏一样进行培训；

Trainees can access networked 3D simulation environments via office computers, engaging in first-person perspective training akin to interactive gaming experiences.

- 培训设置多条故事线，每条故事线针对不同阶段的培训对象覆盖不同任务；

The system incorporates branched storylines tailored to different training phases, with each narrative path covering distinct tasks for targeted trainee groups.

- 根据预设的故事线式培训任务让学员做相应的响应；

Trainees execute context-specific responses based on predefined storyline tasks, simulating real-world decision-making processes.

- 结合使用视频图像识别等多媒体技术手段，实现培训过程中的人员行为判定和自动计分考核功能。

Multimedia technologies (e.g., video analytics and image recognition) enable automated behavioral evaluation and scoring during training exercises.

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3 培训与应用
Training and Application

培训内容
TrainingContent

进出卫生出入口　　放射性污染控制　　辐射剂量控制

辐射控制区出入控制
Radiological Controlled Area Access and Egress Control

- 掌握进、出辐射控制的基本技能
- 电子剂量计和基本防护用品的使用
- 仪表物资借用
- 辐射防护标识和行为规范认知
- 出入控制系统的使用

a) Executing access/egress protocols under timed conditions.
b) Interpreting dosimeter readings against action levels.
c) Responding to access control system alerts.

放射性污染控制
Radioactive Contamination Control

- 污染隔离区的建立
- 污染隔离区的进出及作业
- 各类附加防护用品的使用
- 污染隔离区内的作业行为控制
- 放射性污染处理、放射性物品的分类、收集、转运、贮存

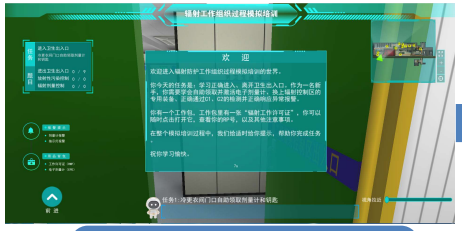
a) Establishment of contamination control zones.
b) Access/Egress and operations within control zones.
c) Utilization of supplementary protective equipment.
d) Behavioral control for work in contaminated areas.
e) Radioactive material management.

辐射剂量控制
Radiological Dose Control

- “辐射工作许可证”实施和工作号切换
- 辐射防护控制点执行
- 便携式辐射仪表的使用及现场测量
- 作业剂量预估及电子剂量计报警响应
- 铅衣使用及低剂量区待命

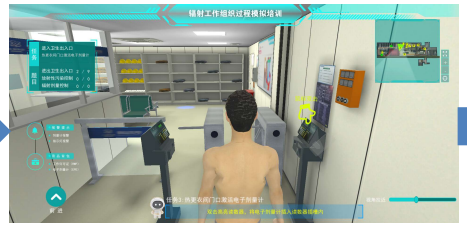
a) RWP Implementation & work Order Switching.
b) Radiological protection control points execution.
c) Portable survey meters operation & field radiation surveys.
d) Dose projection & EPD alarm response.
e) Lead apron utilization & cold zone standby.

进入辐射控制区
Access to the RCA



任务说明
Explain the Task

个人剂量计借用
Check-out of Personal Dosimeters



个人剂量计开启
Activation of Personal Dosimeters

防护用品穿戴
Donning of PPE

离开辐射控制区
Egress from the RCA

衣物污染测量
Measuring Clothing Contamination

脱除控制区衣物
Remove the Clothes in the RCA

随身物品测量
Measuring Personal Belongings

个人剂量计归还
Check-in of Personal Dosimeters

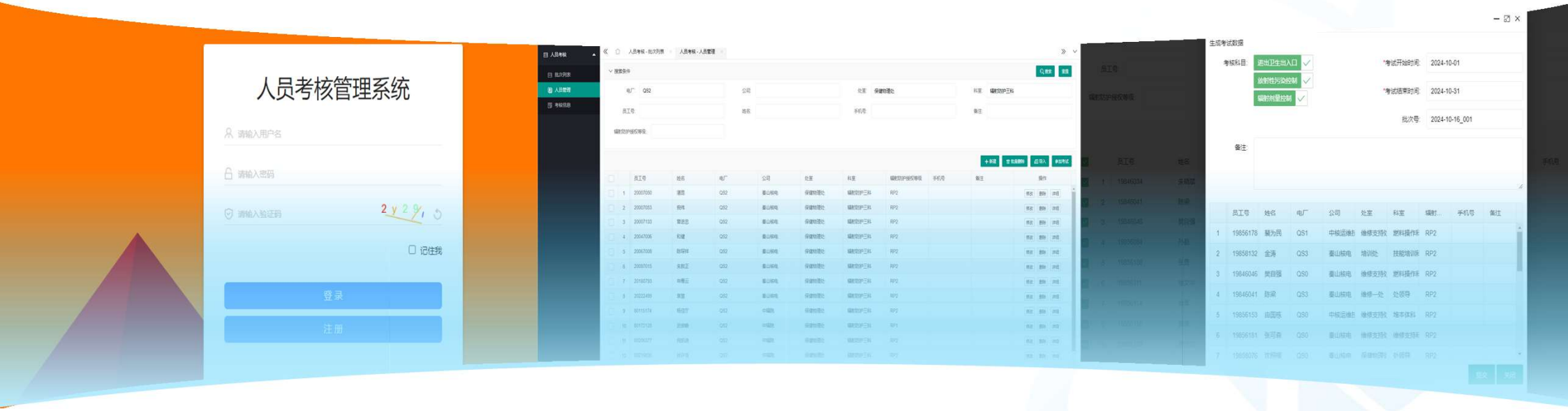
体表污染测量
Personal Contamination Monitoring

培训考核
Training Assessment

考核人员管理
Assessor Management

考试科目配置
Examination Subject Configuration

考核数据生成
Generate Assessment Data



THANKS

FOR WATCHING

请各位专家领导指正

谢 谢 观 看

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