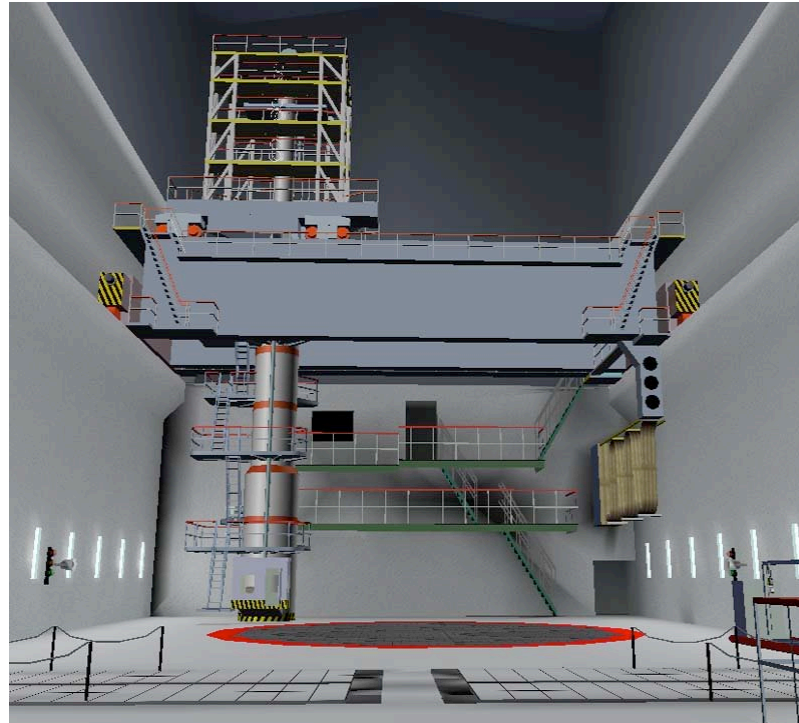


# VR-system for Procedural Training and Simulation of Safety Critical Operations in Relation to Refuelling at Leningrad NPP



**Presentation by Niels-Kr. Mark**

[www.ife.no/vr](http://www.ife.no/vr)

Halden Project VR Workshop 2005

Visual Interface Technologies Division  
Institute for Energy Technology, Halden, Norway



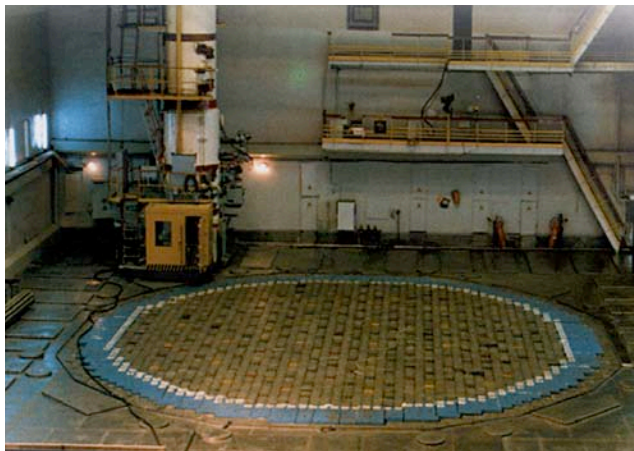
# Project Basis

- Institute for Energy Technology (IFE) collaborating with
  - Russian Research Centre Kurchatov Institute (RRC KI)
  - Leningrad Nuclear Power Plant (LNPP)
- Part of the Norwegian governments program for increasing nuclear safety in Eastern Europe
  - Currently the 3<sup>rd</sup> project at LNPP since 1999
  - Started in May 2003 and finished as scheduled in December 2004



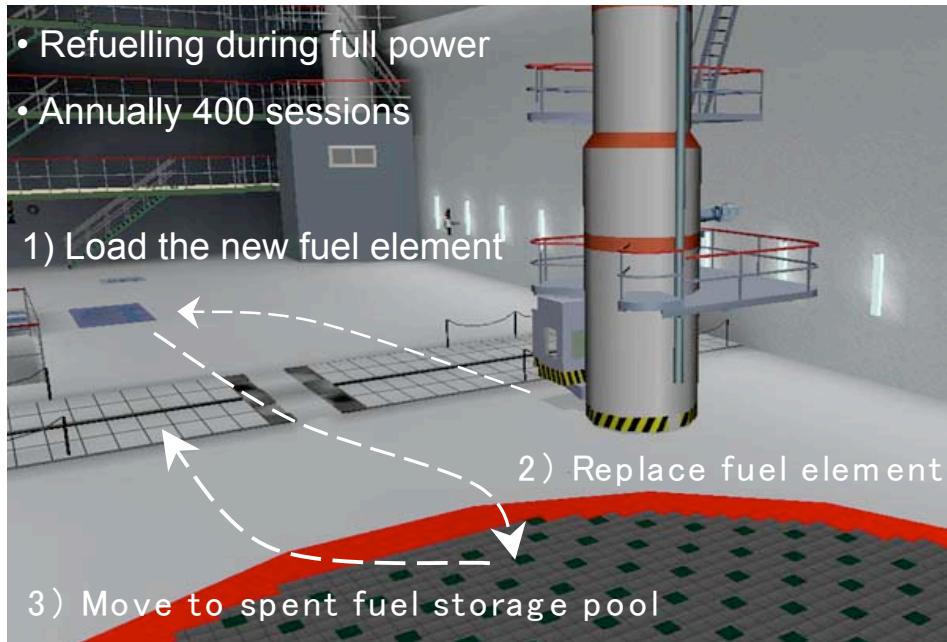
# Project Objectives

- 1) Improve safety at LNPP by more effective training
  - a) The refuelling operation done using the refuelling machine
    - Using a simulator system
  - b) The safety critical maintenance procedures on the refuelling machine
    - Using a procedural training system
- 2) Enhance the qualifications of LNPP personnel
  - The operation and maintenance of the refuelling machine
  - Training methods and technology for training
- 3) Introduce new LNPP employees and visitors to the refuelling machine



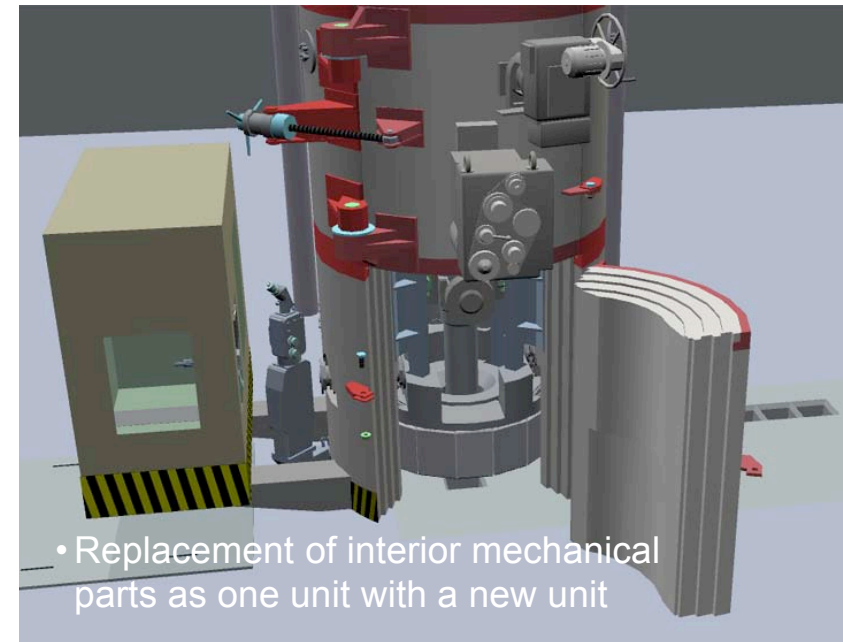
# The Scenarios to Train

## a) The refuelling operation



- Refuelling done by the refuelling operators
- Close cooperation with reactor operators

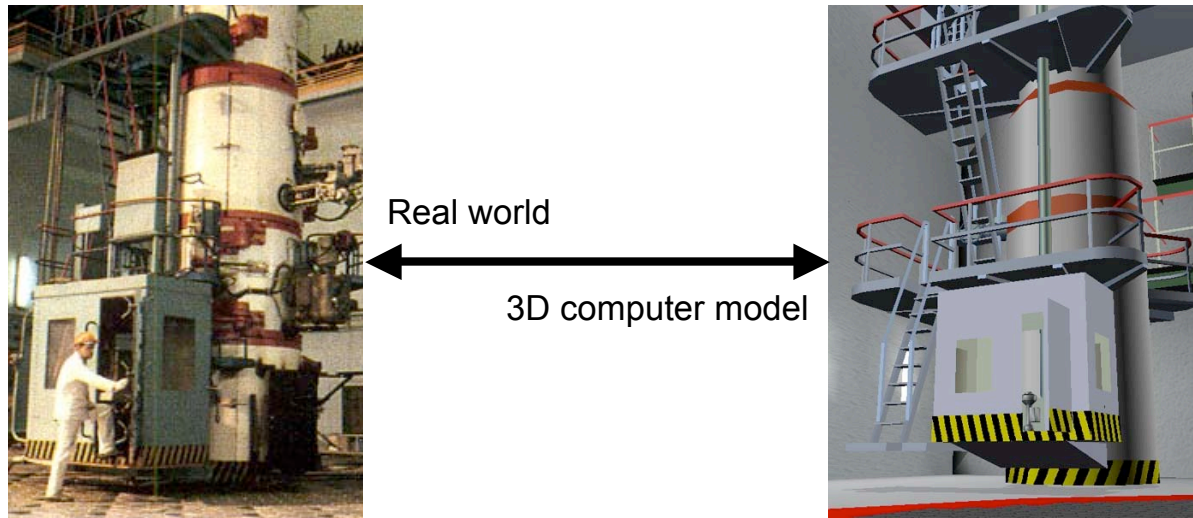
## b) The maintenance procedure



- Done by the maintenance workers

# Effective Training

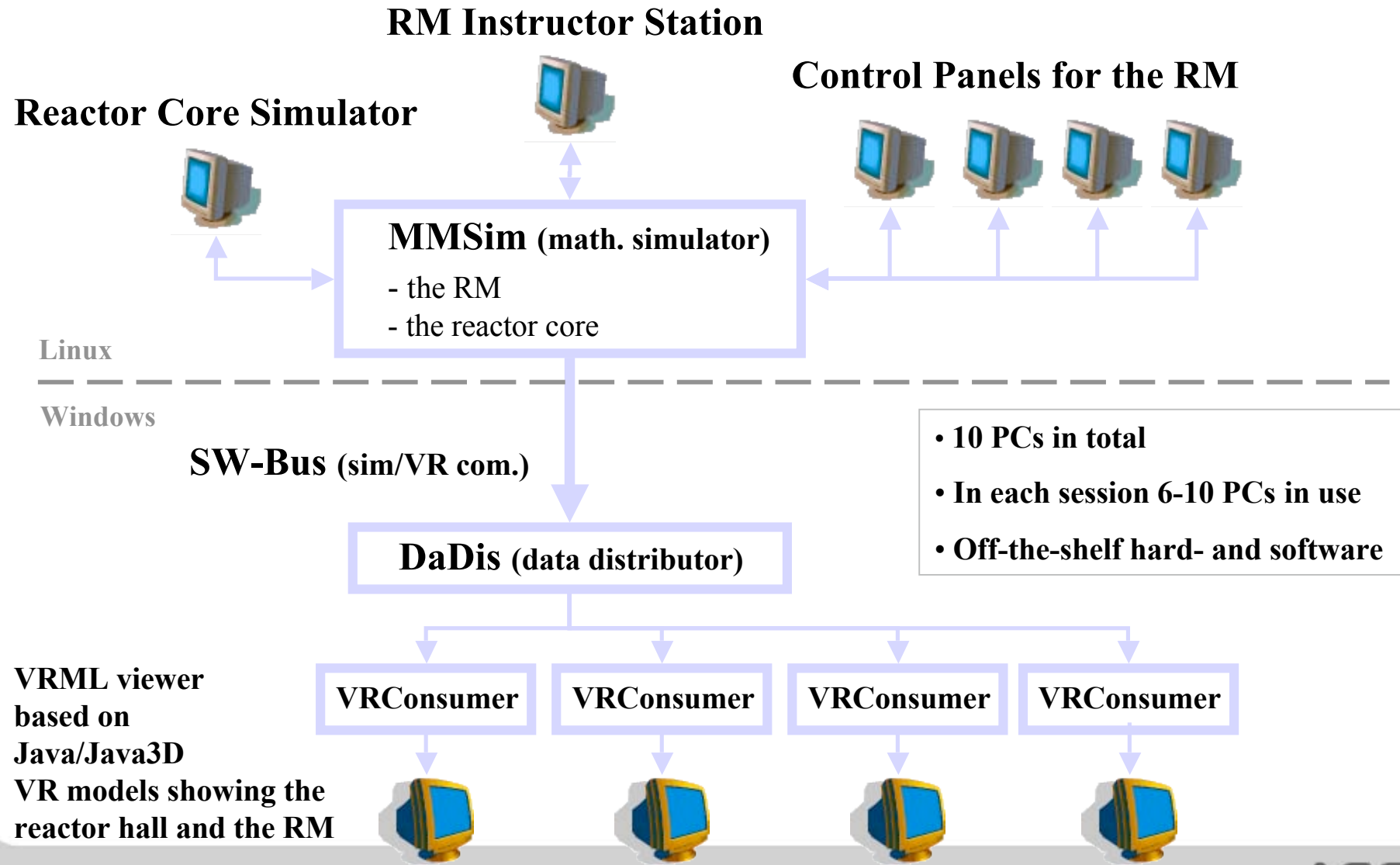
- General requirements of effective training
  - Familiarise the trainee with procedures, equipment, safety concerns etc.
  - Training must
    - Involve the trainee by requiring active interaction
    - Give proper feedback to the trainee
    - Be sufficiently realistic making it possible to transfer the training to the actual work environment



# The Training Program Outline

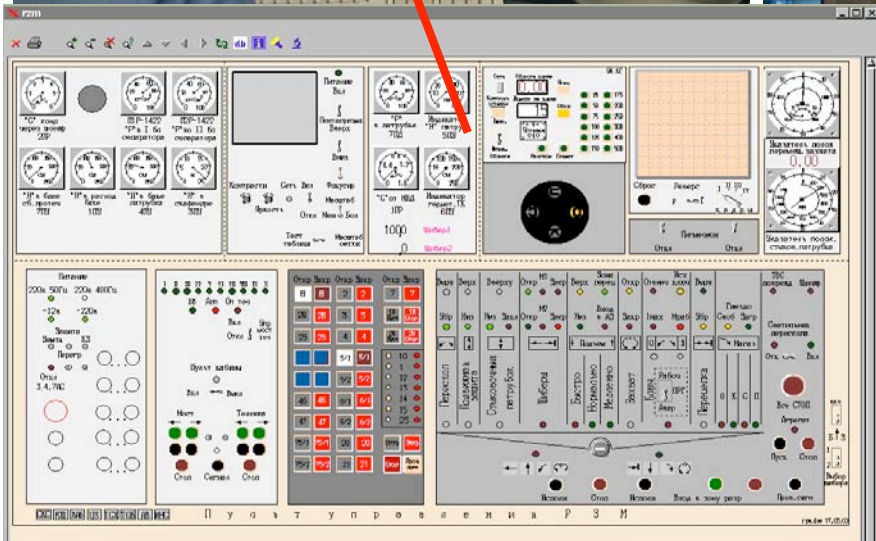
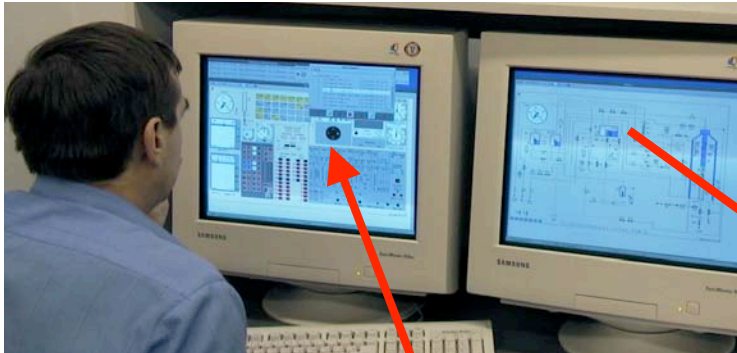
- Objectives met by using Virtual Reality (VR) technology for training:
  - Uses a virtual environment instead of the real world as training environment
    - Possible to train without risk to personnel or equipment
    - Allow training on situations difficult to train in real life
    - Visualising the invisible giving a better view of scenarios than in reality
    - Interactive training being more efficient than traditional training
  - Advanced, but low cost training system using off-the-shelf PCs and software
    - Easy to maintain and extend
  - Installed at the Technical Training Centre at LNPP
  - Transfer of knowledge from IFE about training systems and training
- Two training systems based on the same VR technology
  - 1) The refuelling operation simulator
  - 2) The procedural training system

# The Refuelling Operation Simulator Overview

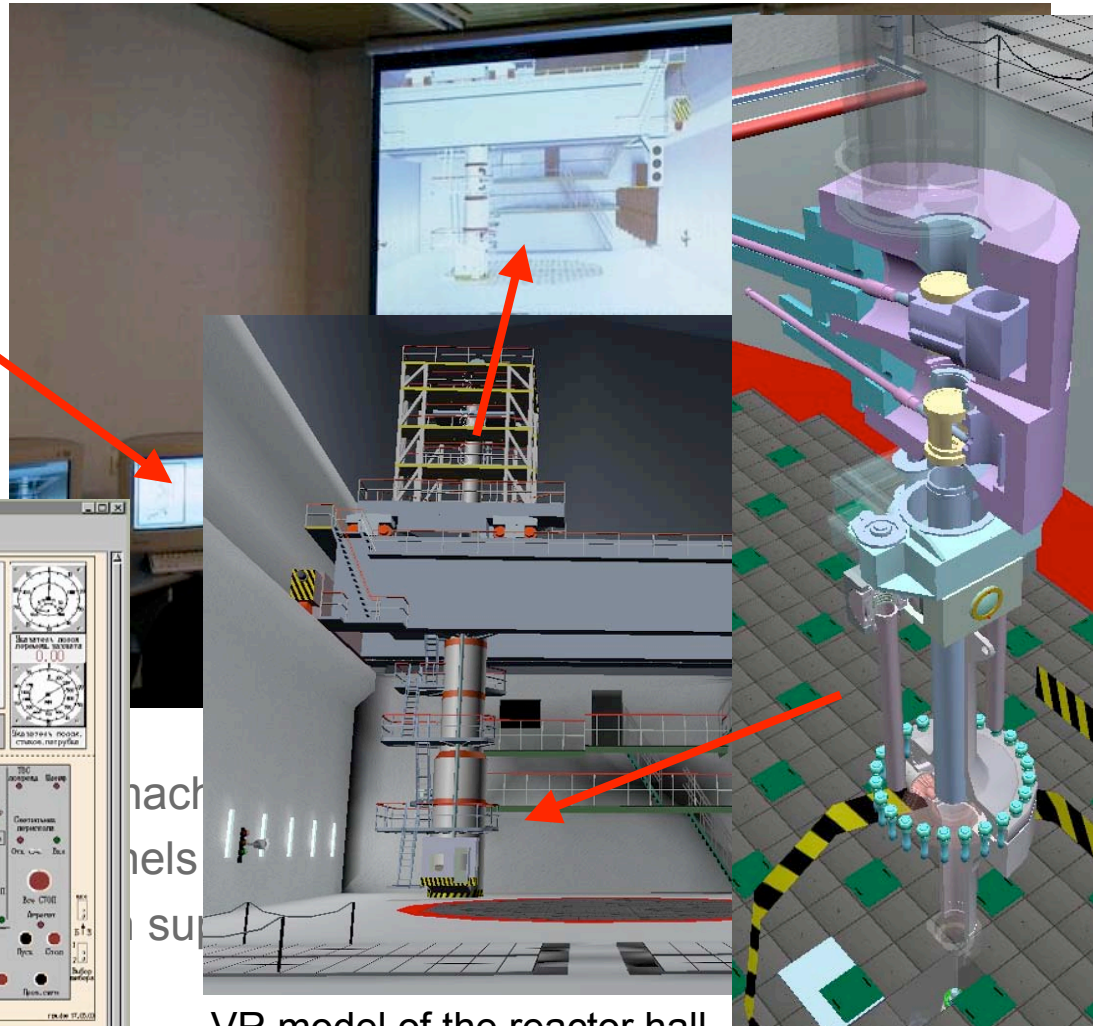


# Snap shots of the Refuelling Operation Simulator

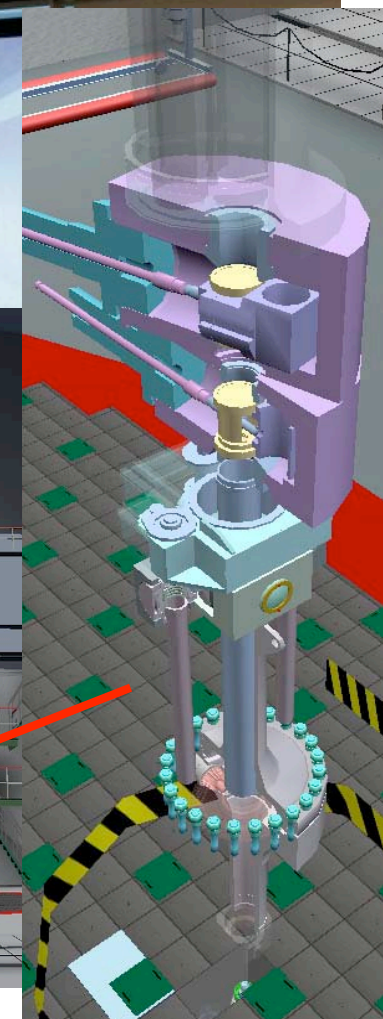
The set-up of the screens



Updated and enhanced 2003-2004  
Control panels



VR model of the reactor hall

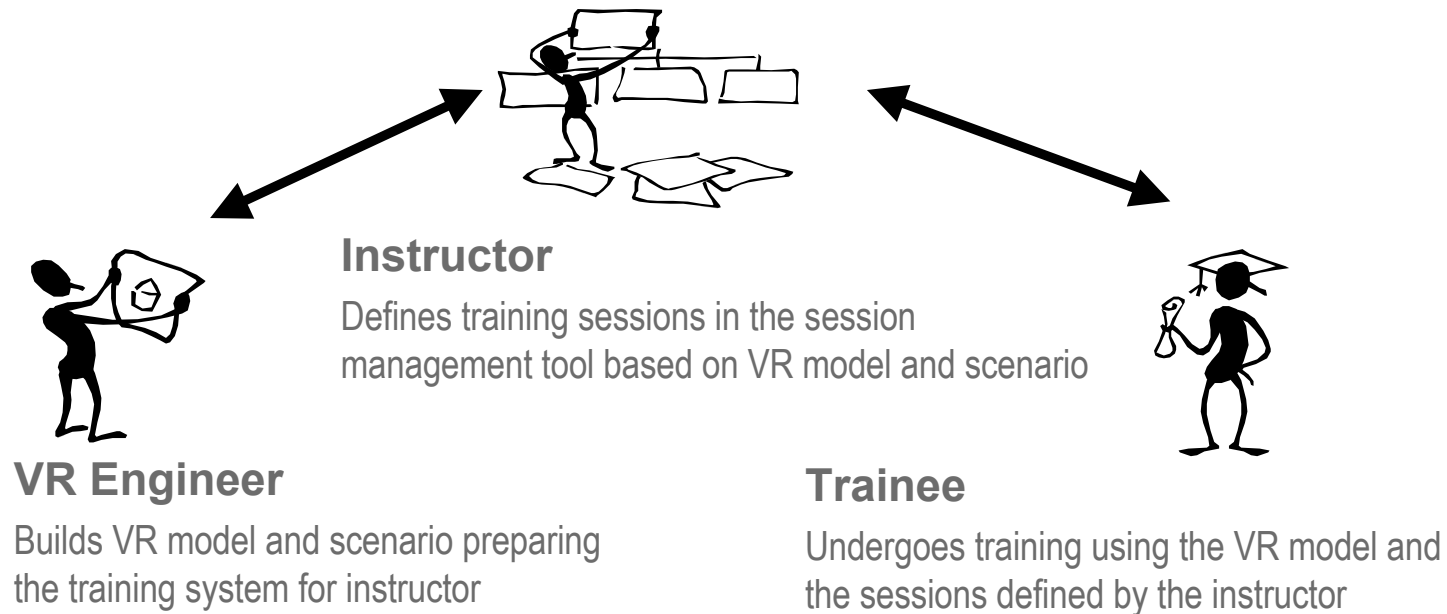


Explorative mode



# Contents of the Procedure Training System

- User groups based on HRP research in training systems:

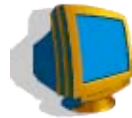


- Types of training:
  - Introductory training for new employees and visitors
  - Procedural training where the trainee works alone
  - Instructor-led training e.g. in a classroom

# The Procedure Training System Overview

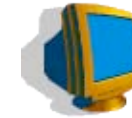
## VR world

- the refuelling machine
- the reactor hall
- procedural info
- action menu



## Procedural doc.

- work instructions
- technical doc.



### **Consumer**

- VRML viewer
- Based on Java/Java3D

### **TrainingManager**

- Scenario set-up
- Session set-up
- Session management and evaluation
- Logging of trainee actions

### **SW-Bus communication**

- Physical action menu
- Physical behaviour
- VR-model settings

### **SW-Bus communication**

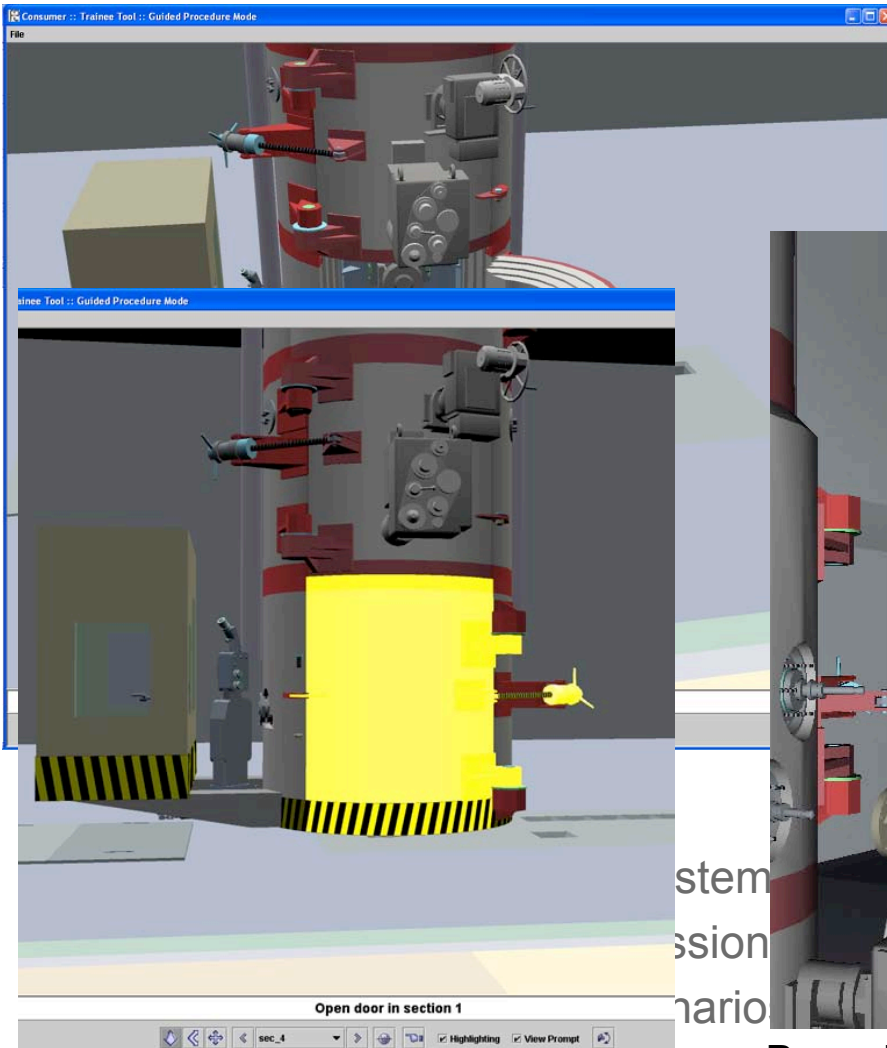
- Physical action to do
- VR settings

### **Physical Simulator**

- Mechanical behaviour
- VR-model settings (transparency etc.)

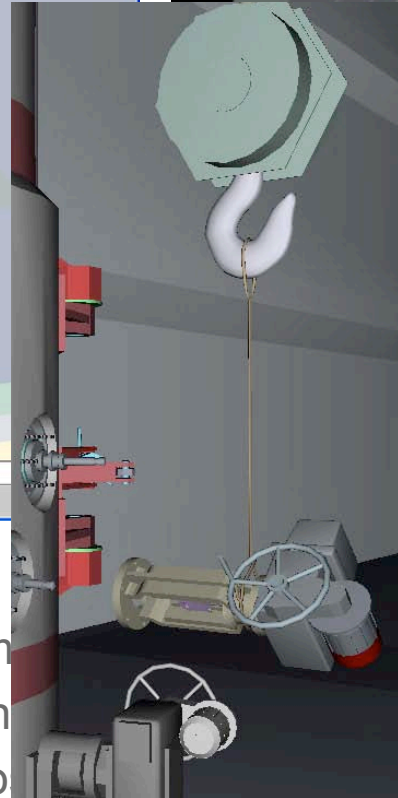
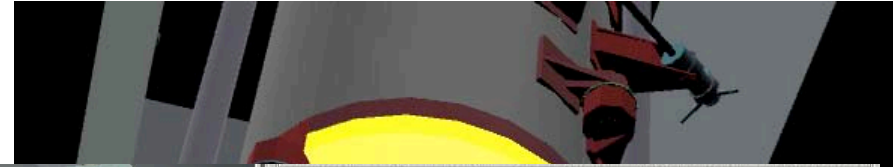
- One PC running Windows
- Off-the-shelf hard- and software

# Snap shorts of the Procedure Training System



Highlighted object

Training in guided mode



**Operation:**

- Dismantle the plath A16001-0.150.58 and the plug A16001-0.150.54 for lower drive.
- Release stopper washers from locking wires 16ÄÑÒ 13463-68, then unscrew 6 nuts M16 ÄÑÒ 5915-70 for lower drive.
- **Dismantle the electro-drive Ä099-098.00M as an assembly with post A16001.00.150Ä of lower drive gate and deliver to servicing place.**
- Move the flange A16001-150.36 in drifting for upper drive gate aside the gate case A16001-150.A in order that to have access to semirings A16001-150.31. Extract these (2un.)semirings from circular gnowing-through, then take away the flange for upper drive.

Procedural documentation

Advanced functions for creating, running and evaluating the training

# Summary

- Improved safety at LNPP by more effective training
  - Advanced refuelling operation simulator in use today at LNPP
  - Advanced training system for procedural training finished in December 2004
  - VR technology used in both training systems gives realistic and efficient training
- The future
  - The Norwegian government will support yet another period 2005-2006
    - Focus on enhancing the procedure training system with new functions and scenarios
  - Rosenergoatom supports further use of VR systems in training at Russian NPP
    - Plans to deploy the refuelling operation simulator to Smolensk and Kursk NPP 2006-2008

