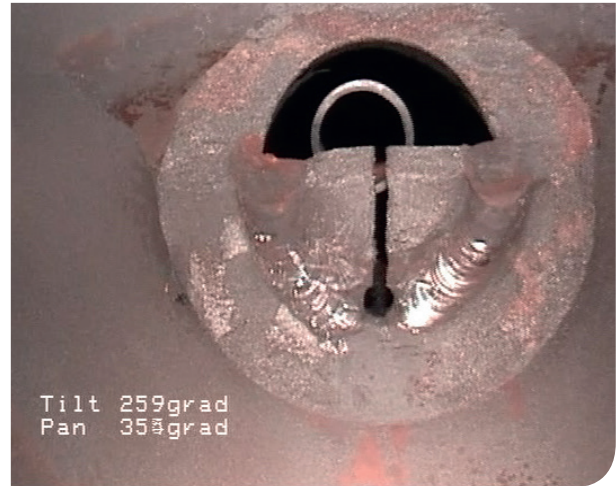


# Visual Testing

– Underwater inspections of nuclear reactor vessels and internals



*Visual inspection of a core grid in a reactor vessel*



*Visual inspection of a level measuring nozzle*

Fast, cost effective and flexible method for planned or urgently required under water inspections of otherwise difficult accessible welds and components.

## Introduction

Visual inspection of reactor pressure vessel internals can be performed with special cameras.

Our cameras are of a type with a colour CCD camera enclosed in a water tight and radiation resistant house and have been qualified for visual inspection of reactor vessel internals at the Swedish Nuclear Power Plants. The cameras can be mounted on a manipulator arm in order to give the best possible position or they can hang from the service bridge and thereby enable parallel inspections. The cameras have a remote controlled pan, tilt and zoom lens.

## About Visual Inspection

Every time an inspection is performed on a weld or a component, some kind of visual inspection is performed as well.

In most cases the inspection includes checking that it is welded, location of welds and/or limitations and access. In some cases, the visual inspection is more difficult, i.e. when the inspection is performed under water in areas inaccessible to man. Such components can be the internals of the reactor pressure vessel.

In spite that this is an advanced inspection method, it is still fast and relatively easy to perform. It can be mobilised in short time for urgent inspections. Furthermore, it is flexible and the cameras can be attached to different tools in order to inspect components that are hidden. This makes it a very cost effective and attractive inspection method.

## Inspection system

The signal is transmitted to a control container via a combined shielded cable, one for the colour signal and another for the intensity signal. This ensures maintenance of a high quality image signal.

In the control container, information such as item designation and the actual camera position can be added to the image before it is displayed on a monitor and possibly recorded on DVD recording media.

At the beginning of an inspection the operator supplies the item designation, and the position of the camera is continually supplied by the control system, if required.

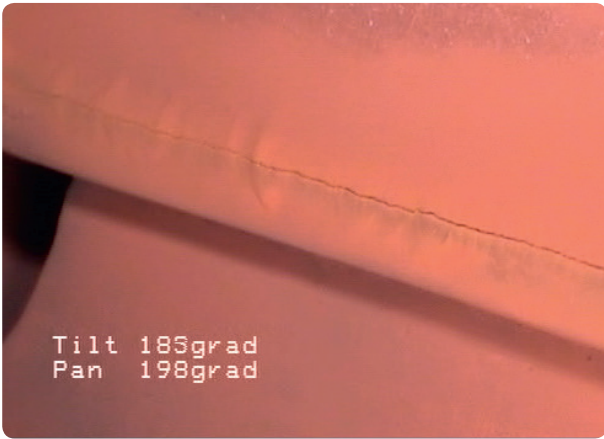
Single image frames of special interest (including the information added to the image) can be stored in a digital format on hard-disk for documentation and print-out purposes.

Storage of images to hard-disk and DVDs are carried out as a real-time function. More than 55 hours recording are easily stored on hard-disks.

## Applications

Typical areas of application are as follows:

- All components in the reactor pressure vessel and the surrounding pools
- Welds
- Surfaces



Visual Inspection of a component with a crack in the weld.



#### Large camera (K1)

Optical zoom:	18 x
Digital zoom:	4 x
Total magnification ratio:	72 x
Width:	145 mm
Pan:	360° (±180°)
Tilt:	270° (±135°)

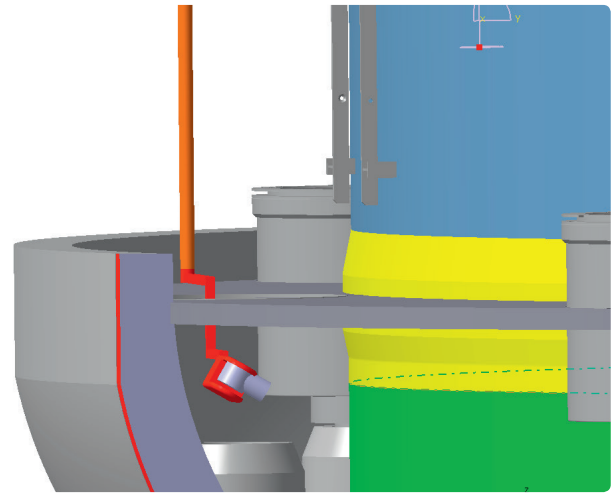
#### Set-up of the VT system

FORCE Technologys two types of cameras have been qualified for visual inspection of reactor vessel internals at the Swedish Nuclear Power Plants. The VT equipment is manually manipulated and controlled from the customer's service bridge, but the cameras can be mounted on a mini-submarine or other automatically controlled manipulators.

The VT system is a chain of components, containing a radiation resistant camera with built in halogen light and the necessary auxiliary steering and fixing tools. The camera is connected to a camera control unit. The operator on the service bridge has a small video monitor for orientation means.

#### Special tools for inspection

If special tools are necessary in order to get access to a components, they can be manufactured prior to the inspection.



Access study and theoretical testing of tools. Prior to an inspection it is very advantageous to look at models of the component in order to look at access and make estimations for possible helping tools.



#### Small camera (K2)

Optical zoom:	10 x
Digital zoom:	4 x
Total magnification ratio:	40 x
Width:	48 mm
Pan:	With a Pan unit attached to the camera 360°
Tilt: (mirror angle)	Mirror inside camera gives a tilt of 0° - 59°

#### Preparation of Visual Inspection

Visual inspections in the reactor vessel should be prepared for well ahead of the actual inspection. Access studies can ease the inspection, as no surprises arise during the in-service inspection.

Therefore drawings, pictures from previous inspections or other available information about the component to be inspected are necessary to ensure a good quality result.

#### Component reference list

- Control rod guide tubes
- Nozzle to shell welds
- Welds in core grid
- Level measuring nozzles
- Welds in steam separator
- Welds in pump deck
- Core shroud welds
- Core shroud support welds
- Feed water nozzles
- Moisture separator welds

#### For further information please contact

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