Introduction
When welds and materials are inspected, the results are usually a judgement of signals from ultrasonic or eddy current examinations. Scratches, tool marks and other geometrical indications can therefore cause severe problems for these traditional surface techniques and may even cause unnecessary repair work with economical impact.

However, a technique which can give a direct picture of a surface breaking defect can also be offered. This two part silicone polymers technique is called “Moulding VT” (VT stands for Visual Testing).

Initial work with polymer moulding compounds was undertaken during the 1980’s and resulted in systems being developed for underwater inspections of North Sea oil installations and nuclear submarines. The application area has since been extended for examination and inspection in the following fields:

- Surface metrology
- Crack investigation
- Microstructure assessment
- Fracture surfaces
- Remote surface inspection
- Hole surfaces (threads, drill holes, corrosion pit, etc.)

Moulding VT is a fast and simple technique for detection of surface breaking defects. It is a visual technique applying a 2-component silicone mix to the component to be inspected. After curing, the mix is removed from the surface and inspected in a microscope, detecting defects down to 1.5 mm length. This fast, flexible, and reliable moulding technique has been a cost effective part of FORCE Technology’s inspection program since 2002.
Examples of use
Especially underwater components (e.g. in nuclear reactor vessels) can be inspected with this technique. The technique can furthermore be a good supplement to other inspection techniques, like ultrasonic and eddy current, because it delivers a direct picture of the surface.

The moulding technique is based on a two part silicone compound. When the two parts are mixed together a chemical reaction is started.

This chemical reaction is dependent on the temperature and the amount of hardener component. When the chemical reaction is started the mass can be applied on the component to be inspected and after a certain time (the curing time) the compound has cured and can hereafter be removed from the component.

The mould has now generated a copy of the surface and with very large accuracy the surface can be mapped with a microscope, which can reveal the surface breaking defects, if any.

Applications
Typical areas of application are as follows:
- Welds
- Surfaces
- Special geometries which are difficult for other inspection types
- Underwater components
- All components which can be directly (manually) accessed or where a special tool can be constructed for use (especially for underwater components).

Typical sensitivity, accuracy, etc.
- Ideal conditions: Cracks down to 1 μm in width and 0.5 mm in length
- Normal conditions: Cracks down to 3 μm in width and 1.5 mm in length
- Directions: Defects located in all directions can be detected
- Component temperature: +15°C to +50°C (higher or lower temperatures are possible but requires special constructed silicone polymers).

Inspection of J-groove welds in the reactor pressure vessel from the inside (wet inspection):
The tool is developed and fitted to the inside surface of the reactor wall and can be equipped with moulding forms adapted to the different sizes of the J-groove welds. The tool is capable of making moulds of the entire weld in one inspection.
**Inspection of cooling outlet nozzle areas (wet inspection):**

This tool is developed and fitted for an area below the cooling outlet nozzle in a pressure water reactor and can be equipped with 3 different moulding forms for 3 different locations.

The tool is centered inside the nozzle and surveillance cameras secure that the tool is placed as required.

The construction of the tool can be changed to fit other dimensions and/or inspection areas.

**Inspection of bottom nozzle welds:**

For inspection of the bottom nozzle welds without removing all the internals in a reactor, this tool is constructed to pass by/through the grid/core to access the bottom nozzles below. Depending on the size of the nozzles, 3-4 mouldings shall be performed to inspect an entire weld.

**Inspection of the inside of the main re-circulation system:**

When the pipes are emptied for water, this tool can be inserted through the pump housing and make inspection of a designated area inside the main re-circulation pipe system.

**Inspection of scram nozzles:**

The tool is developed and fitted to the scram nozzle. The tool is capable of making moulds of the entire scram nozzle in one inspection.
**Inspection of reactor vessel head penetrations:**
The tool is developed and fitted to the reactor vessel head penetration. The penetration has a larger diameter at the inspection place compared to the piece of pipe where the mould shall be removed through. This requires that the moulding shall be able to be elongated in order to pass by the smaller diameter.

This has been solved by a special construction of the mould, which allow it to be elongated without loosing the shape. The tool is capable of making moulds of the entire pipe in the area of interest in one inspection. During test of the tool, a plexiglas mock-up was used, giving the possibility to see the moulding process.

**Advantages with the moulding VT technique:**
- It has a high resolution (down to 1 μm in width) at ideal conditions
- Small detection target (minimum 1.5 mm long defects can easily be detected)
- Picture the real surface and can therefore support explanations of defect cause
- It complements the UT and ET inspections made previously and can give further explanations to defect signals obtained with ultrasonic and eddy current examinations
- The high separation and detection ability makes it possible to separate and distinguish between even very small defects
- All the silicone products we use are chemically approved in the Swedish NPP
- Difficult geometries can be inspected
- Remote and manual application depending on accessibility
- Moulding in water is possible and has been performed with very good results.

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