
Recommended practice Well integrity strategy – out of zone injection

27 April 2021

FOREWORD

After discussion in the Well Integrity Forum (WIF), the decision was taken to establish a recommended practice for well integrity strategy – out of zone injection.

The manager drilling is responsible for the practice.

Norwegian Oil and Gas Association
Vassbotnen 1, NO-4313 Sandnes
P O Box 8065
NO-4068 Stavanger, Norway
Tel: +47 51 84 65 00
Website: www.norskoljeoggass.no
E-mail: firmapost@norog.no

CONTENTS

1	INTRODUCTION:.....	3
2	METHODS FOR IDENTIFYING INJECTION INTEGRITY.....	3
3	OCCURRENCE OF OUT OF ZONE INJECTION.....	4

1 INTRODUCTION:

This document proposes mitigating measures and alternatives or methods to identify out of zone injection. The document can be viewed as a best practice towards NORSOK D-010 8.7.4 Injection / disposal wells, and applies for injection wells under the following situations:

- Well has been exposed to maximum injection pressure over a longer period, and it is suspected that either reservoir cap rock and/or formation at injection packer have been exposed to injection pressure surpassing their physical strengths
- Well is planned for injecting above formation integrity requirements, but a deviation is planned, and the material can be used as a basis for additional mitigations to support the deviation

Indications of out of zone injection could be a drop in injection pressure coupled with an increase in injectivity. If this does occur, further investigations should be initiated.

Downhole well monitoring should be used when available to confirm and/or verify injection point. This is more precise than the topside parameters.

2 METHODS FOR IDENTIFYING INJECTION INTEGRITY

In the event where the well has been exposed to injection pressure above formation strength limitations over a longer period, the following methods can be used to gather information about the out of zone injection. The methods will also be applicable as compensation actions in a deviation for planned injection above formation integrity limits. Comparison with baseline measurements is essential for most of the actions. They include:

- Review injection trend for the last period (days, weeks, months) and confirm:
 - Injection pressure vs. cap rock strength over time
 - How long has the well been injecting at this pressure?
- Fall-off test. A fall-off test response at overburden depth can be distinguished from a reservoir response when compared with baseline
- Perform step rate test. Compare with baseline
- Life of Field Seismic (LoFS) can inform of any change in the area when compared with baseline
- Perform a temperature survey. In case of a leak, the formation in the overburden will cool down and this will be reflected in the temperature log by showing a sudden decrease in the temperature profile compared to the rest of the well when compared with baseline
- Evaluate well investigation:
 - Spinner/MLT log (downhole volume measurements on injected water per intervals)
 - Topside water rates vs. downhole water rates (any issues topside that have not been identified or verified)
- Confirm reservoir capacity (reservoir mass balance or void age replacement ratio (VRR)) over time. How much water is the reservoir taking in that area?

3 OCCURRENCE OF OUT OF ZONE INJECTION

In the event where out of zone injection has been identified, additional mitigating actions with an agreed frequency should be established. Examples of mitigating actions include:

- Evaluate to shut-in well
- Review injection trend for the last period (days, weeks, months) and confirm:
 - Injection pressure vs. cap rock strength over time
 - How long has the well been injecting at this pressure?
- Review and evaluate and reservoir capacity (VRR)
- How old is the well? What is the well integrity diagnosis of the well with regards to mechanical barriers? Any barrier or component weaknesses? Identify shallowest injection point
- Any cement issues on the well? Or suspicious on cement barriers?
- Perform a step rate test. Compare with baseline
- Evaluate well investigation:
 - Temperature log profile
 - Spinner/MLT log (downhole volume measurements on injected water per intervals)
 - Topside water rates vs. downhole water rates (any issues topside that have not been identified or verified)
 - LoFS or seismic
 - ROV inspection to verify seabed integrity
 - Review nearby wells and check for the following:
 - Any downhole or surface temperature anomalies in outer annuli and/or reservoir?
 - Any changes on mass balance (Voidage ratio recovery)?
 - How far are the nearby wells (Ratio of injection)?
 - Any Pressure anomalies observed in outer annuli?

It is recommended to document the analysis and findings.