

Temporary plugged and abandoned

wells on the Norwegian Continental Shelf 2022



(EXTERNAL/PUBLIC)

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ABSTRACT:

The Petroleum Safety Authority Norway (PSA) is monitoring that the temporary plugging and abandonment activities are performed in a safe and robust way and in compliance with governing standards and regulations. The PSA has since 2011 conducted bi-annual surveys to assess the well integrity categorization of temporary plugged and abandoned wells, time since the well was temporarily abandoned, future activity plans and other specific details. The results are made public using anonymized data based on the 2022 and preceding survey data. There were 227 wells reported and categorized as temporarily plugged and abandoned in 2022. Special emphasis with respect to closer follow-up of the well integrity classification in the "red" and "orange" wells is ongoing.

KEY WORDS:

Plugged and Abandoned wells, P&A, Well Integrity, PSA

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Abbreviations

Abbreviation	means
	NOROG GL117 Recommended Guidelines for Well Integrity
NOROG GETTY	Categorization (2017)
NORSOK D-010	NORSOK D-010 Well Integrity in Drilling and Well Operations; 2021
P&A	Plugged and abandoned
PSA	Petroleum Safety Authority
Green	
Yellow Well integrity category according to NOROG GL117	

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Summary

In the 2022 survey, a total of 227 wells were reported and categorized as temporarily plugged and abandoned. These wells were split into the various well integrity categories and associated color coding in the NOROG GL117 and classifications according to the NORSOK D-010 standard.

The results from the May 2022 survey show the following:

- There were 3 wells categorized as "red"
- There were 14 wells categorized as "orange"
- There were 164 wells classified as "with monitoring"
- There were 63 wells classified as "without monitoring"

The well integrity categorization and classification as temporary plugged and abandoned well are unique and show a snapshot at date of collection in May 2022.

In the well integrity categories "orange" or "red", meaning wells with failures in one or more of the well barriers, there are 13 platform wells and 4 subsea production wells.

For wells classified as "without monitoring" according to NORSOK D-010, there are 16 platform wells, 42 subsea production wells and 5 subsea exploration wells. These have different color coding, but there are 3 "orange" and 1 "red" subsea production wells "without monitoring". A temporary plugged and abandoned well "without monitoring" is a well status where the well is temporary abandoned and where the primary and secondary well barriers are not continuously monitored and routinely tested. These wells will normally have some sort of monitoring but are not continuously monitored and tested.

The survey shows a reduction in the total number of temporary plugged and abandoned wells from 268 in 2020, to 227 in May 2022. Over half of these wells have been permanently plugged and abandoned, which is a considerably higher number than previous years. The number of "orange" and "red" wells is also positively reduced from 24 wells in 2020 to 17 wells in 2022. The survey showed that 80 new wells entered the definition as a temporary plugged and abandoned well, while 121 wells exit the survey data between 2020 and May 2022.

The future activity plans for the 17 "orange" and "red" wells in the 2022 survey show that 5 wells are currently planned to be permanently plugged and abandoned by the end of 2024.

The data collection from the 2022 survey shows that 14 % of the wells (32 out of 227) have been temporary plugged and abandoned without monitoring exceeding the current maximum duration of 2 years for exploration wells and 3 years for production wells.

The 32 temporary plugged and abandoned wells "without monitoring" include:

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- 2 platform wells classified as "without monitoring" have been temporary plugged and abandoned for more than 3 years. One of these is categorized as "orange" and future activity plan is still under evaluation.
- 25 subsea wells classified as "without monitoring" have been temporary plugged and abandoned for more than 3 years. 4 of these wells were temporary plugged before 1.1.2014. Hence, 21 of the temporary plugged and abandoned subsea wells have exceeded the maximum abandonment period of 3 years (ref. current legislation). Out of these, one is classified as "red" and three as "orange". Diagnostic and repair of the "red" subsea production well "without monitoring" is ongoing. Of the three orange subsea wells "without monitoring", 2 wells are planned to be permanently plugged and abandoned and 1 well will have the slot recovered.
- 5 exploration wells classified as "without monitoring" have been temporary plugged and abandoned for more than 2 years. All of them are categorized as "green" by the Operator and 4 of the wells were left as temporary plugged and abandoned wells around 1990 with some remaining work before permanent abandonment.

The 2022 survey also shows that 117 wells are planned to be permanently plugged and abandoned¹ before 2030.

¹ A permanent plugged and abandoned well is a well status where the well is permanently plugged & abandoned with cross-sectional well barriers qualified for eternity towards seabed. The intention is not to re-enter the well. When the last permanent abandonment plug is set inside the surface casing, the function is to isolate the open hole annuli and provide containment of potential contamination to the external environment.

1. Introduction

1.1 Background

Wells are continuously being temporarily plugged and abandoned on the Norwegian Continental Shelf. The Petroleum Safety Authority Norway (PSA) is monitoring that the activities are performed in a safe and robust way and in compliance with governing standards and regulations.

Over the last years, there have been several incidents where temporary plugged and abandoned wells have been re-entered showing leaks in one of the established well barriers. Re-entering temporary plugged wells with leaking well barrier elements can be challenging and well control methods must be implemented.

It is therefore important to establish and continuously update the status of temporary plugged and abandoned wells to ensure that they are properly secured until they are re-entered. When the decision is made that a well is no longer to be used, there is an expectation that a permanent P&A operation is planned and fulfilled within reasonable time. According to the Activities Regulations, exploration wells commenced after January 1st, 2014, shall not be temporary plugged and abandoned beyond two years. For production wells commenced after January 1st, 2014, the hydrocarbon-bearing zones shall be plugged and abandoned permanently within three years if the well is not continuously monitored.

This report presents the well integrity category of temporary plugged and abandoned wells on the Norwegian Continental Shelf in a snapshot from May 2022 and the associated level of risk these wells represent.

1.2 Bi-annual surveys performed by PSA

The PSA has since 2011 conducted bi-annual surveys to assess well integrity categorization of the temporary plugged & abandoned (TP&A) wells. The survey includes the duration of the TP&A period, future activity plans and other specific well integrity information. The data has so far mainly been for internal use, with limited publication in plugging and well integrity forum. The PSA acknowledges that the statistical results are of general interest and decided that the 2022 survey results will be made public (this report). The 2022 results and preceding survey data are anonymized.

The 2022 survey was sent to all operators on the Norwegian Continental Shelf (NCS) in March 2022 requesting specific well data for temporary plugged & abandoned wells. The deadline for submission of the information was May 2nd, 2022, including well integrity categorization according to NOROG GL117 (2017) Guidelines for Well Integrity Categorization.

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1.3 Well integrity categories

The principles for selecting the well integrity category and the associated risk are listed in Table 1.1. Temporarily plugged and abandoned wells are further classified as "with monitoring" or "without monitoring". As per the Activities Regulations § 88, Securing of wells, the duration of the temporary plugging and abandonment period for wells without monitoring is maximum two (2) years for exploration wells and three (3) years for production wells.

Wells in orange and red well integrity categories are specifically addressed in this report, as these wells have higher risk of uncontrolled flow to surface or seabed than wells categorized as green and yellow.

Category	Well barrier 1	Well barrier 2	Risk
Green	Barrier philosophy intact by adherence to company requirements fulfilling the intention of the regulations or if there are only minor well integrity issues not leading to degradation of the well barriers.		No single failure will lead to an unacceptable release of well fluids to surface or to the formation.
Yellow	Intact or degraded, and can fully maintain its function	Intact or degraded, and can fully maintain its function	No single failure will lead to an unacceptable release of well fluids to surface or to the formation.
Orange	Failed	Can fully maintain its function	Single failure may lead to an unacceptable release of well fluids
Red	Failed	Degraded or is not expected to maintain its function	Single failure of the remaining degraded barrier will lead to an unacceptable release of well fluids.

 Table 1.1:
 Well integrity categories as defined in NOROG GL117

1.4 Definition of temporary plugging and abandonment

Temporary plugging and abandonment of wells is a status where the well is plugged with two well barriers and where the intention is that the well will be re-entered within a specified time frame. For some wells left in this state, the well barriers can be continuously monitored and tested. For other wells, however, there is no possibility to monitor and test the well barriers. Table 1.2 lists the NORSOK D-010 definitions of temporary abandonment wells with and without monitoring.

<u>Definitions:</u> Temporarily plugged and abandoned wells are classified as "with monitoring" or "without monitoring" in NORSOK D-010, 10.5.1 as follows:
"Temporary abandonment – with monitoring; Well status where the well is abandoned, and the primary and secondary well barriers are continuously monitored and routinely tested.
"Temporary abandonment – without monitoring *; Well status where the well is temporary abandoned, and the primary and secondary well barriers are <u>not</u> continuously monitored and routinely tested.
A temporary plugged and abandoned well "without monitoring" is a well status where the well is temporary abandoned, and the

*A temporary plugged and abandoned well "without monitoring" is a well status where the well is temporary abandoned, and the primary and secondary well barriers are not continuously monitored and routinely tested. The wells will normally have some sort of monitoring but are not continuously monitored and tested.

2. Statistics

2.1 Well survey

The Petroleum Safety Authority (PSA) issued a request for specific data relating to temporarily plugged & abandoned wells to all operators in March 2022, including:

- Specific well data for all temporary plugged and abandoned wells
- Well barrier schematics for wells in orange and red category
- Risk assessments for wells in orange and red well integrity category

The received data was compiled for further analysis and processing, with focus on orange and red wells. Selected anonymized statistical data is presented in this report, supplemented with observations and discussions based on the well barrier schematics and risk assessments, along with meeting with one operator and data from preceding surveys.

In addition to the well integrity categories and classifications, the wells are sorted by type, platform or subsea, and further grouped into production-, injection- or exploration wells.

2.2 Total number of temporary plugged and abandoned wells in 2022

A total of 227 wells were classified as temporary plugged and abandoned in 2022. Out of these, 63 wells were classified as "without monitoring" and 164 wells were classified as "with monitoring".

Figure 2.1 illustrates how all 227 wells can be split into the various well integrity categories and classifications according to the NOROG GL117 and the NORSOK D-010. The figure shows the distribution of all wells per well integrity category according to NOROG GL117.

In this report, the focus has been divided between the "orange" and "red" wells and the 63 wells "without monitoring". There were 7 wells "without monitoring" and 10 wells "with monitoring" within "orange" and "red" category, hence there were totally 17 wells categorized as "orange" and "red".



Figure 2.1: Temporary plugged and abandoned wells with and without monitoring

2.3 Comparison with previous years

Table 2.1 and Figure 2.2 show temporary plugged & abandoned wells for 2022, compared to the preceding years back to 2011. The reduction in total number of wells from 268 to 227 (-41) compared to 2020 is mainly caused by permanent plugging & abandonment campaigns. The number of orange and red wells is positively reduced with 7 wells compared to 2020.

The activity plans for the 17 orange and red wells in the 2022 survey show:

- 5 wells to be permanently plugged and abandoned
- 2 wells to have slot recovery by reuse of conductor and surface casing
- 2 wells to be repaired
- 1 well to be returned to production
- 1 well to be recompleted

All the above is planned executed by end 2024. The remaining 6 wells are awaiting further diagnostic work before decisions and plans can be made.

Year	Green	Yellow	Orange	Red	All
2022	110	100	14	3	227
2020	122	122	18	6	268
2018	148	110	15	2	275
2016	172	50	41	11	274
2014	154	74	46	8	282
2011	120	56	15	2	193

Table 2.1:	Temporary	/ P&A'd wells	for 2022 cor	mpared to	precedina v	rears

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Figure 2.2: Temporary P&A'd wells for 2022 compared to preceding years

2.4 Changes in number of temporary P&A wells between 2020 and 2022

The well integrity categorization and classification as temporary plugged and abandoned well is unique and a snapshot at date of collection. Figure 2.3 shows the total number of wells in 2020, the reduction (exit) and addition (enter) of wells, and the resulting total number of temporary plugged and abandoned wells for 2022.



Figure 2.3: Changes in number of temporary P&A'd wells between 2020 and 2022

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The survey shows a reduction in the total number of temporary plugged and abandoned wells from 268 in 2020, to 227 in May 2022. 121 of the wells from the 2020 survey are not on the temporary abandoned list for 2022. Over half of these have been permanently abandoned since 2020, a significant improvement from previous periods. 27 wells had the slot recovered and 21 wells were repaired and returned to be producing wells, see Figure 2.4. 80 new wells did, however, enter the definition of a temporary plugged and abandoned well.

The 2022 survey also shows that 117 wells are planned to be permanently plugged and abandoned before 2030.



Figure 2.4: Well status after exit from temporary plugged abandoned wells in 2020

3. Monitoring

3.1 Regulations

Monitoring of wells, including temporarily plugged and abandoned wells, are described several places in the PSA's regulations:

Section 54 in the Facility Regulation:

 "Christmas trees and wellheads shall be designed such that prudent well control can be performed through recovery, workover and well intervention". The guideline to this section supplements: "all annuli on surface-completed wells and the nearest annulus to flow pipes for production or injection in subseacompleted wells should have pressure monitoring,"

Section 88 Securing of wells in the Activities Regulations:

- "All wells shall be secured before they are abandoned so that well integrity is safeguarded during the time they are abandoned."
- Regarding <u>platform</u> wells, it specifies:
 - "the pressure above the lowermost barrier should be monitored",
 - "it should be possible to monitor the pressure in the annulus and in the production tubing, or as an alternative, in the last casing set."
- For subsea completed wells: "well integrity shall be monitored if the plan is to abandon the wells for more than twelve months." The guideline to the same supplements; "pressure conditions should be monitored or a blind plug should be set just above or below the packer element".

Recollecting the definitions from NOROK D-010, (10.5.1) Temporary abandonment:

- <u>with monitoring:</u> the primary and secondary well barriers are continuously monitored and routinely tested.
- <u>without monitoring</u>²: the primary and secondary well barriers are not continuously monitored and routinely tested.

It is worth noticing that NORSOK D-010 in addition to continuous monitoring prescribes routinely testing which are further described in the Well Barrier Element Acceptance Criteria tables in the standard.

² A temporary plugged and abandoned well "without monitoring" is a well status where the well is temporary abandoned, and the primary and secondary well barriers are not continuously monitored and routinely tested. These wells will normally have some sort of monitoring, but are not continuously monitored and tested.

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3.2 Temporary plugged and abandoned wells with and without monitoring

The distribution of the temporary plugged and abandoned wells per platform, subsea or subsea exploration well type with and without monitoring is shown in Figure 3.1.



Figure 3.1: Type of wells with and without monitoring

A further break-down of the distribution of platform wells per well integrity category, "with monitoring" and "without monitoring" is shown in Figure 3.2.



Figure 3.2: Platform wells, with and without monitoring activities

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Figure 3.3 shows the distribution per well integrity category for subsea wells (including exploration wells).



Figure 3.3: Subsea wells (incl. exploration), with and without monitoring activities

The platform wells "without monitoring" normally have well barriers but without the ability to monitor the pressure between the well barriers.

- The three orange platform wells "without monitoring" have permanent secondary well barriers established with conductor and surface casing intact.
 - One well is prepared for slot recovery, the other two wells have status "as is", meaning that further activities has not been decided.
- The ability to monitor these wells appears to be restricted to monitoring pressure in the well and pressure in the casing annuli.

The two red platform wells "with monitoring" are completed production wells that have never been in production. These wells are anticipated to have their well integrity category changed when the reservoir pressure is further reduced due to production from surrounding wells.

A total of 47 out of 61 subsea production and exploration wells (5) are classified as temporarily plugged and abandoned "without monitoring".

- The majority of the subsea production wells "without monitoring" are categorized as "green" or "yellow", and they have either cement barrier plugs, mechanical plugs or are closed with the down hole safety valve as part of the primary well barrier. Most of the wells have a mechanical plug or XMT as part of the secondary well barrier.
- Diagnostic and repair of the "red" subsea production well "without monitoring" is planned in 2022, and the well is planned to be permanently abandoned by

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2023/2024. The future plans for the three orange subsea wells "without monitoring", are currently that one of them are permanent plugged and abandoned, and one is planned to be permanently plugged and abandoned while one well will have the slot recovered.

The 5 exploration wells "without monitoring" shows that 4 of these wells have been temporary plugged and abandoned prior to 1.1.2014 with reservoir plugged. One well has been permanently abandoned except from wellhead not being cut below seabed and removed.

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4. Duration of temporary P&A period

4.1 Regulations

The Activities Regulations Section 88, Securing of wells, states:

- "For subsea-completed wells, well integrity shall be monitored if the plan is to abandon the wells for more than twelve months."
- "Exploration wells commenced after 1.1.2014 shall not be temporarily abandoned beyond two (2) years."
- "In production wells abandoned after 1.1.2014, hydrocarbon-bearing zones shall be plugged and abandoned permanently within three (3) years if the well is not continuously monitored"
- "It shall be possible to check well integrity in the event of reconnection on temporarily abandoned wells."

4.2 Duration of temporary plugged and abandonment period, all wells

The data collection from the 2022 survey shows that 56 % of the wells have been temporarily plugged and abandoned for more than 3 years. Out of these, 4 wells are categorized as orange and 1 is categorized red.

Figure 4.1 shows the number of wells and the duration from the time that the wells were temporarily plugged & abandoned before May 2022 cut-off date. The 9 wells in the 20+ years category are 4 subsea exploration wells and 5 platform productions wells – all with green or yellow well integrity category.



Figure 4.1: Wells and durations of the temporary P&A periods

4.3 Duration of temporary P&A period for wells without monitoring

The data collection from the 2022 survey shows that 14 % of the wells (32 out of 227) have been temporary plugged and abandoned without monitoring for more than the maximum duration specified in the regulatory requirements applicable from 2014. (2 years for exploration wells and 3 years for production wells).

Out of the 166 temporary plugged and abandoned platform wells, there are 16 wells without monitoring. Figure 4.2 shows the duration these have been temporary plugged and abandoned. Two of these wells have been temporarily P&A'd for more than 3 years and hence exceeding the limitation in the regulation. Three platform wells have orange well integrity category. The plan for the orange platform wells exceeding the 3-year limit is not stated by the operator.



Figure 4.2: Temporary P&A periods – platform wells without monitoring

The duration of the 42 temporary P&A'd subsea production wells without monitoring is shown in Figure 4.3. Of these, 25 wells have been temporary plugged and abandoned for more than three years. Four of these wells were temporary P&A'd before 1.1.2014. The remaining 21 wells have exceeded the maximum period of three (3) years as stated in the Activities Regulation. 20 of these wells belongs to a field, where the platform has been onshore for upgrade since 2016, and the plan is to return the wells to production in 2022. Three subsea production wells have well integrity category orange and one have red category. Three of these wells will be permanently plugged and abandoned and one well will have the slot recovered.



Figure 4.3: Temporary P&A periods – subsea production wells w/o monitoring

The temporary plugging and abandonment duration of the 5 exploration wells without monitoring is shown in Figure 4.4. All of them have exceeded the maximum period of two years for exploration wells. Four of them were P&A'd more than 20 years ago and hence not covered by the 2-year maximum duration from the Activities Regulations. All the wells have well integrity category "green" according to the operator's own classification.



Figure 4.4: Temporary P&A periods – subsea exploration wells without monitoring

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5. Activity plans

5.1 Regulations

In the Activities Regulations section 81 and its guideline, it is stated that for wells that are to be temporarily plugged back, the programme should describe:

- a) plans for future use of the well,
- b) securing of the wellhead,
- c) planned location inspections and their frequency,
- d) an evaluation of well integrity seen in the context of the design life for the barriers, cf. also Section 88.

This implies, that a new well program shall be prepared for wells that have not been put to use according to the original plan, or that have been temporarily plugged back for three years. (Two years for exploration wells, ref. section 4.1).

5.2 Activity plans for orange and red wells

The future plans for temporary plugged and abandoned orange and red wells, including estimated year of execution of the planned activities are shown in Figure 5.1. For 6 of the wells, plans have not yet been submitted (indicated as "as is" in the figure). 4 wells will be recompleted, returned to operation, or repaired within 2022. For two of the wells, a slot recovery is planned within 2023 and 5 of the wells will be permanently plugged and abandoned. 3 wells will be or are permanently plugged in 2022, 1 in 2023/2024 and for 1 well, the operator has not specified a date.



Figure 5.1: Activity plans for red and orange wells

The colors in Figure 5.1 refers to the well integrity categories as listed in Table 1.1. Orange color means failed primary barrier, but secondary barrier can fully maintain its function. Red color means failed primary barrier and secondary barrier is degraded or is not expected to maintain its function.

6. Well barrier schematics, risk assessments and well integrity categorization

As part of the survey the operators were asked to provide well barrier schematics and associated well integrity risk assessments for the orange and red wells. These were further assessed to understand the defined well barriers and the reasons for characterization of the well integrity category. The following observations and comments are made:

Well barrier schematics:

- Well barriers schematics follows the guidance in NORSOK D-010 and appears to be kept updated.
- They contain overwhelming additional information and comments, which require a close study of the content.
- In many cases, it was unclear whether a well barrier element was accepted or had failed (e.g., a detected leak or casing cement bonding not acceptable). A "traffic light" system for status of the well barrier elements will make it easier to quickly see which elements are not compliant or partially compliant with NORSOK D-010 or operator's requirements.
- Several wells have multiple boreholes and sidetracks that are permanently plugged & abandoned, but still connected to existing wellbore. These wellbores should therefore have well barrier schematics to assist with understanding the total risk of leak to surface or seabed.
- Some of the well barrier schematics did have the well integrity category clearly visible which is very beneficial for a reviewer. However, in some cases it is very difficult to see or understand the reasons for selecting the well integrity category and the connection to the belonging risk assessment.

Risk assessments:

- Almost all wells with a well integrity issue had associated risk assessments.
- In many of the risk assessments, the risk of uncontrolled flow from a source of inflow or from several sources were specifically assessed.

Well integrity categorization:

- It appears that the well integrity categorizations follow the guideline in NOROG GL117
- Many of the wells in red and orange category have well barrier elements which are not compliant with NORSOK D-010
- Annulus cement in combination with in-situ formation are the well barrier elements that in most cases appear to not be compliant with NORSOK D-010 requirements
- The decision basis for determining the well integrity category based upon well barriers status and risk rating was absent in the submitted material.
- Because NOROG GL 117 allows the use of risk assessments with mitigating actions to evaluate well integrity category and re-categorize wells, this makes it very difficult to compare wells alike.

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A. Requested well data

Below is the list of data as requested by PSA from the operators for the 2022 survey:

- 1 Operator name
- 2 Field
- 3 Well ID
- 4 Well type
- 5 Water depth
- 6 Date of T.P&A
- 7 Primary well barrier element
- 8 Verification of primary well barrier envelope
- 9 Secondary well barrier element
- 10 Verification of secondary well barrier envelope
- 11 Well integrity status as per NOROG GL117, Rev.6
- 12 Risk assessment done according to NORSOK D-010, chap. 5.4
- 13 Temporarily plugged with monitoring/surveillance
- 14 Compensating measures for wells without monitoring/surveillance?
- 15 Comments to well barrier status and verification method
- 16 Future plans for the well
- 17 Time for execution of plans (MM/YYYY)
- 18 Compensating measures for subsea wells without monitoring/surveillance?
- 19 Methane leaks (from seabed?) around wellhead
- 20 Comments to compensating measure around methane leaks
- 21 Number of years the well has been temporarily plugged since 2014
- 22 Comments other important information

B. Framework requirements to temporary abandonment

The framework that relates to temporary abandonment of wells include:

Regulation	Guideline
Activities Regulations §81, Well Programme	<u>RE § 81:</u>
Prior to starting well activities, a programme shall be prepared that describes the individual activities to be carried out and the equipment to be used. The programme shall be updated as mentioned in Section 20, second subsection litera b.	In order to fulfil the requirement relating to the programme as mentioned in the first subsection, the NORSOK D-010 standard, Chapters 5.3, 5.7, 5.11 and 10.3 should be used in the area of health, working environment and safety.
	programme should also describe
	 a) plans for future use of the well, b) securing of the wellhead, c) planned location inspections and their frequency, d) an evaluation of well integrity seen in the context of the design life for the barriers, cf. also Section 88.
	The updating as mentioned in the second subsection, implies, for example, that a new programme shall be prepared for wells that have not been put to use according to the original plan, or that have been temporarily plugged back for three years.
Activities Regulations § 88, Securing of wells	<u>RE § 88:</u>
All wells shall be secured before they are abandoned so that well integrity is safeguarded during the time they are abandoned. For subsea-completed wells, well integrity shall be monitored if the plan is to abandon the wells for more than twelve months. Exploration wells commenced after 1.1.2014 shall not be temporarily abandoned beyond two (2) years. In production wells abandoned after 1.1.2014, hydrocarbon-bearing zones shall be plugged and abandoned permanently within three (3) years if the well is not continuously monitored. It shall be possible to check well integrity in the event of reconnection on temporarily abandoned wells. All wells shall be secured before they are abandoned so that well integrity is safeguarded during the time they are abandoned.	To fulfil the requirement relating to securing as mentioned in the first subsection, the NORSOK D-010 standard, Chapter 10 should be used. The monitoring as mentioned in the first subsection, should be carried out by monitoring the pressure above the lowermost barrier. In order to control the well integrity as mentioned in the second subsection, one should, inter alia, be able to monitor pressure conditions or set a blind plug just above or below the packer element. For surface-completed wells, it should be possible to monitor the pressure in the annulus and in the production tubing, or as an alternative, in the last casing set. For subsea-completed wells, it should be possible to monitor the pressure in the production tubing and in the production annulus.
Facility regulations § 48, Well barriers	<u>RE §48:</u>
When a production well is temporarily abandoned without a completion string, at least two qualified and independent barriers shall be present. When a well is temporarily or permanently abandoned, the barriers shall be designed such that they consider well integrity for the longest period of time the well is expected to be abandoned. When plugging wells, it shall be possible to cut the casings without harming the surroundings.	No further description relating the quoted text

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NORSOK D-010:2021 - temporary abandonment with or without monitoring

The NORSOK D-010 Well Integrity in Drilling and Well Operations; 2021, describes requirements and guidelines for well barriers and their performance criteria for temporary abandonment.

The standard describes <u>temporary abandonment – with monitoring</u> (10.5.1) as a "*Well status, where the well is abandoned and the primary and secondary well barriers are continuously monitored and routinely tested. There is no maximum abandonment period.* The requirement and guidelines for routine testing and monitoring is stated in the Well Barrier Elements Acceptance tables.

Reversely, for <u>temporarily abandoned well without monitoring</u>, the "maximum abandonment period, shall be three (3) years." For subsea wells in this category, it stated that "a program for visual observation shall be established. The frequency shall be substantiated by a risk assessment and shall not exceed one (1) year".

NOROG GL117 (2017) Recommended Guideline for Well Integrity

The PSA regulations require that *"the barrier status shall be tested, verified and documented"* when handing over wells and refers to NOROG GL11, which focuses on:

- Known leaks through components that can be leak tested. Examples:
 - Downhole safety valves or deep-set plug
 - Production tree emergency shut-down valves and annulus valves
 - Tubing hanger and internal wellhead seals
 - Completion and casing string
 - Production packer
- Compliance with NORSOK D-010 acceptance criteria for casing (annulus) cement
- Behavior of sustained casing/ annulus pressure
- Risk assessments with mitigating actions to evaluate well barriers and recategorize wells

In addition to the above, it describes a well integrity categorization system, which has been used on the Norwegian Continental Shelf for many years for wells that are not permanently abandoned. The categories are as follows:

Category	Principle
Red	One barrier failure and the other is degraded/not verified, or leak to surface
Orange	One barrier failure and the other is intact, or a single failure may lead to leak to surface
Yellow	One barrier degraded, the other is intact
Green	Healthy well - no or minor issue

Source: NOROG GL117

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NOROG GL117 allows change in the well integrity category based on risk of "unacceptable release of fluids" to surface. This statement was included in the 2017 revision: "4.2.2; *The responsible operator may use risk assessments with mitigating actions to evaluate well barriers and re-categorize wells accordingly.*"

Because operators use their own risk assessment models with different probability, consequence, and acceptance criteria, one operator's orange well may have different risk than another operator's orange well.