AUTORITÉ DE SÛRETÉ NUCLÉAIRE
Direction des équipements sous pression nucléaires

FRENCH REPUBLIC

Letter reference:
CODEP-DEP-2023-007194

For the attention of the Director
Nuclear Operation Division
Site Cap Ampère
1, place Pleyel
93282 Saint Denis Cedex

Dijon, 30 March 2023

Subject: Inspection strategy for stress corrosion cracking (SCC) for the years 2023 to 2025

References: **[1]** D455022007005 ind 0 – Strategy for examining the auxiliary MPS lines for the stress corrosion risk – 2023/2025

[2] EDF letter D400822000805 of 12 December 2022

[3] EDF letter D455023001686 of 10 March 2023

[4] Ministerial order of 10 November 1999

[5] CODEP-DEP-2022-053700 - ASN letter of 21 November 2022 – follow-up to the meeting of the Advisory Committees of Experts of 22 and 23 September 2022

[6] EDF letter D400823000043 of 26 January 2023

[7] EDF letter D455023000284 of 29 January 2023

Dear Sir,

In December 2022 you sent me a draft strategy for the inspection and repair of all the reactors with regard to the stress corrosion (SC) risk for the years 2023 to 2025. This strategy followed on from the inspection strategy deployed in 2022.

A new factor has arisen since then with the discovery in early 2023 - out of the 194 inspections carried out until then - of two particularly deep cracks: one caused by stress corrosion[1] and the other

[1] Cracks of which the largest extends over 155 mm (about a quarter of the pipe circumference) with a maximum depth is 23 mm for a pipe wall thickness of 27 mm.

by thermal fatigue[2], both cracks being located on welds that underwent repairs during construction of the reactors.

On 10 March 20123 you sent me a revised inspection strategy for the years 2023 to 2025, taking into account these latest results. This strategy speeds up the inspection of the repaired welds. You thus plan to have inspected, by the end of 2023, more than 90% of the welds that you consider to represent a high-priority repair classification.

ASN takes note of this inspection strategy and considers it your responsibility to implement it as soon as possible. This strategy forms the subject of a series of requests indicated in the appendix to this letter.

Moreover, discussions between our departments are still necessary with regard to the justification of the repaired weld inspection schedule, particularly for the reactors on which several RIS lines are concerned.

ASN considers that the discovery of a thermal fatigue defect among the major defects characterised recently, on a weld on which this damage mode was not expected, requires further analyses. ASN also draws your attention to the importance of the analyses and examinations that must be carried out on the other stainless steel lines of the reactor primary cooling systems, for which you propose an initial action plan to be supplemented by the end of August 2023.

The results of the inspections and complementary expert assessments planned for in 2023 and the years to come are likely to enhance our knowledge of the stress corrosion phenomenon and the factors causing it. This should lead you to continue to consider that your strategy will evolve along with the understanding of the phenomenon, which at this stage cannot be considered complete.

I would ask you to send me a regular review of the implementation of your strategy.

Appendix I to this letter lists my requests for which a reply is expected within ten days.

Appendix II to this letter contains my other requests for which a response with associated schedules is required within two months.

Yours sincerely,

ASN Director General

[2] Crack of which the largest measures 57 mm in length (representing less than 10% of the circumference) with a maximum depth of 12 mm.

Olivier GUPTA

Appendix I to letter CODEP-DEP-2023-007194
Requests to be addressed in priority

1. Justifications provided by EDF for the reactors with repaired welds of category 1 or 2

The defect mechanical strength justifications provided to date do not cover the defects detected near the A3ZR1 welds of the safety injection system hot branch (RIS BC) of Penly reactor 1 and the A10 welds of the safety injection system cold branch 2 (RIS BF2) of Penly reactor 2. These welds are repaired welds of category 1 or 2, according to the classification system proposed in your letter [7]

Thus, the first line of defence which consists in maintaining the integrity of the pipe under the effect of operating situations considered at the design stage is potentially not justified for the repaired welds of category 1 or 2.
In your letter reference [3], you consider that inclusion of the repaired welds does not change the conclusions of the safety analysis conducted in 2022 following the discovery of the first defects.

Given that defects with no mechanical explanation have been detected recently, ASN does not agree with your conclusions. The realistic robustness studies provided in 2022 cannot be the sole argument considered to justify keeping reactors with repaired welds of type 1 or 2 in operation until their inspection. Although these studies provide an assessment of the absence of a cliff edge effect in the event double rupture of the RIS (safety injection system) or RRA (residual heat removal system) lines, they do not constitute a safety case.

Additional justificatory elements in this respect are expected of you in the next few days. Technical discussions will continue when these elements are received.

EDF will have to draw the conclusions of these discussions on the reactor inspection schedule, particularly the Nogent 1 and Cruas 2 reactors, which have repaired welds on two RIS BF lines and which are not due to be inspected for several months.

2. Inspection strategy for the RIS and RRA lines

You have drawn up a list of the welds repaired during construction on all the reactor RIS and RRA systems. This work was carried out on the basis of the information available to your national engineering services. During the inspections on the Gravelines 1 reactor, you found a repaired weld which had not been identified as such (your list indicated "data missing" for this weld).

Your investigations found information tracing back this repair in the on-site documentation.

This deviation reveals that, when making the inventory of repaired welds, you were unable to ascertain the history of all the repairs. You have identified all the classified welds for which data are missing and plan conducting additional investigations.

Request 1 : Complete the identification of the repaired welds taking into account the available on-site information and send ASN an updated list of the repaired welds, indicating their classification by category. Adapt your inspection strategy according to the results.

At the end of the additional investigations, if there are no elements confirming the absence of repairs, you plan inspecting them in the same way as category 1 or 2 welds. **I consider that this cautious approach is appropriate for the situation.**

This deviation moreover reveals the sites hold additional data compared with the data used by your national services. It is therefore necessary for you to ensure that the available on-site data do not contain additional information that would lead you find previously unidentified repaired welds.

Request 2 : Propose methods ensuring a high level of confidence in the completeness of the inventory, particularly by using the data available on the sites.

Appendix II to letter CODEP-DEP-2023-007194
Other requests

1. Inspection strategy for the RIS and RRA lines

During the first half of 2022, having no means of inspection considered sufficiently reliable and effective, you removed welds from various reactors in order to conduct expert assessments in the laboratory to characterise the stress corrosion cracking phenomenon. These expert assessments concerned the safety injection system (RIS) and the residual heat removal system (RRA). You used the assessment results and your analysis of the influencing parameters to establish a classification of the susceptibility of the various RIS and RRA system lines to stress corrosion.

Alongside this, you began work to develop a new ultrasound inspection process capable of detecting and measuring the depth of cracks induced by stress corrosion. Although this process is not yet formally qualified, you have provided preliminary elements demonstrating its performance that enable it to be used on the reactors and contribute to the continuation of the stress corrosion monitoring strategy.

ASN underlines the consequential and necessary nature of this work, conducted throughout 2022.

In the second half of the year, this new process enabled you to inspect a set of welds in zones you considered as priorities in order to consolidate the available knowledge. However, process implementation and analysis of the results require significant resources, which limits your inspection capacities with this new process.

In view of the resources required for your ultrasound inspection process and the associated dosimetry, you do not envisage exhaustively inspecting the welds of the lines that could be concerned. Your inspection strategy is thus based on prioritising the inspections according to criteria that you have established.

Based on the results of inspections carried out in 2022 and the geometry of lines, you consider the following susceptibility classification for the RIS and RRA systems according to the reactor types:

- lines considered highly susceptible and susceptible: N4 RIS BF, P'4 RIS BF, N4 RRA BC;
- lines considered slightly susceptible: CPY RRA suction, P4 RIS BF;
- lines considered barely susceptible: the other RIS and RRA lines (no cases detected).

You have carried out substantial replacement work on cold branches (BF) of the RIS lines and hot branches (BC) of the RRA lines of the four N4 reactors. You have also started replacement work on the RIS BF lines on several P'4 reactors. This replacement work shall be completed by the end of 2023

for all the other P'4 reactors, with the exception of Cattenom 4, for which you will decide on the repairs to perform according to the results of the inspections planned in 2023[3].

You have also planned, during these replacement operations, to inspect the welds connecting the main primary system lines on the moulded branch connection side on two reactors. Lastly, 2023 should make it possible to capitalise on a set of results of expert assessments of removed line sections so as to improve knowledge of the phenomenon.

For the other RIS and RRA lines, the inspection programme proposed for 2023 to 2025 aims to:

- inspect the lines you consider to have low susceptibility by examining a selection of welds considered most at risk;
- supplement the available information on the lines you consider not susceptible by performing sampling inspections.

This programme will supplement knowledge of the systems in question and will allow the consolidation of the line susceptibility classification, particularly for the lines you consider not susceptible to stress corrosion, which have so far undergone few inspections.

Furthermore, the welding repair operations when initially performed are liable to alter the work hardening of the metal and the residual stresses due to welding. These two parameters influence the onset and, if applicable, the propagation of stress corrosion cracks.

Cracks of significant depth have been discovered on a weld on the RIS BC line of the Penly 1 reactor, despite the fact that it is considered non-susceptible. This case illustrates the fact that a repair is likely to render susceptible a weld situated on a line that is considered non-susceptible to stress corrosion.

You have thus supplemented your strategy with a repaired weld inspection programme [3] which will enable all the repaired welds of the RIS and RRA lines to be inspected, independently of the line on which they are situated. Your programme prioritises the investigations on the types of repairs considered the most at risk, the majority of which will be inspected as of 2023, with the remainder being inspected in the first half of 2024.

[3] The upper sections of the four RIS BF lines of Cattenom 4, which are hotter and therefore considered more susceptible to stress corrosion cracking, were removed for laboratory examination in 2022 and no cracks were found.

For the welds representing a lower risk according to your classification, an inspection will be carried out in the following cases:

- on the reactors at their next ten-yearly outage or maintenance outage;
- on the P'4 reactors that undergo RIS line replacement work;

Repaired welds of this classification, on lines with low susceptibility to stress corrosion (RRA BC for the CPY reactors and RIS BF for the P4 reactors), shall be inspected at their next ten-yearly or maintenance outage, or during a refuelling outage that includes maintenance operations.

This programme will enable more than 90% of the repaired welds to have been inspected by the end of 2024, and the totality by the end of 2025.

I would draw your attention to the fact that your classification of repair types stems from an initial empirical analysis, and might have to evolve according the results of your research work and future inspections.

ASN also notes that the proposed inspection programme, repaired welds excluded, is based on your line susceptibility classification, which has been established primarily in the light of their thermohydraulic behaviour. Nevertheless, it was discovered during the expert assessments and inspections that, taking identical lines, some presented stress corrosion cracks while others did not. This means that other factors influence the occurrence of stress corrosion, without you being able to identify them or accurately quantify their contribution. The continuation of your inspections and expert assessment work is likely to add to knowledge in this area, which could make it necessary to revise your strategy.

On this account you plan to inform ASN of the state of knowledge as and when it is acquired, to make interim reports every six weeks and to draw up a review at the end of the first six months of the year. You will propose any changes to your strategy required in the light of the review, planning for immediate implementation wherever this should this prove necessary.

1.1. <u>Integration of the discovery of thermal fatigue cracks</u>

On 6 March 2023 you reported a significant safety event relating to the discovery of thermal fatigue cracks on the Penly 2 and Cattenom 3 reactors. This phenomenon was not expected on these welds. The two reactors are of the P'4 type (1,300 MWe).

The thermal fatigue cracks were detected on the lines situated on the cold branch of the safety injection system (RIS) during inspections for stress corrosion. The reactors where shut down at the time.

At this stage, you note that the investigations conducted on the other P'4 reactors have not revealed the simultaneous presence on a given weld of cracks linked to both stress corrosion and thermal fatigue phenomena. Likewise, no detected crack shows a mixed propagation mode.

I consider that the discovery of these two fatigue cracks implies carrying out a detailed analysis of the causes and that you must update your maintenance programme accordingly.

Request 3 : Provide an analysis of the causes of the occurrence of fatigue cracks. More specifically, without your analysis being limited to the following elements:

- **perform the fatigue propagation calculations taking into account the hypotheses of thermal stratification of the lines, and check whether the results are consistent with the dimensions of the observed defects;**
- **transmit the planned thermal fatigue investigation programme, detail the actions concerning the removed lines of the Cattenom 3 and Penly 2 reactors, including in the standard pipe sections;**
- **identify the range of occurrence of thermal fatigue and stress corrosion cracking and any ranges of mixed occurrence.**

Adapt your inspection strategy according to the results of the studies.

1.2. Observations concerning selection of the inspected welds on the RIS and RRA lines

You consider the RIS BF lines of the P4 reactors to have low susceptibility to stress corrosion.

According to your studies, weld A13 presents the highest stresses therefore you propose inspecting this weld on all the reactor lines. Given that the examinations carried out so far have not revealed any systematic stress corrosion on this weld, ASN considers that this approach must be supplemented by inspecting at least two welds per line in order to have greater assurance of detecting the phenomenon.

In addition to this weld, all the repaired welds on the sections where the temperature is sufficient to allow the damage mode to occur (welds A5 to A14) shall be inspected.

For the Paluel 3 reactor you plan to inspect one additional weld.

The Paluel 2 and Saint-Alban 2 reactors have FSIs (*fiches de suivi d'indication* - indication tracking sheets) rated P2[4] for the A13 welds and shall be inspected in 2024 and 2025. A refuelling outage is planned for the Saint-Alban 2 reactor in 2024.

Request 4 : Inspect at least two welds per line on the RIS BF systems of the P4 reactors.

Request 5 : During the 2024 outage, inspect the A13 weld of the Saint-Alban 2 reactor RIS BF system which shows an indication.

[4] Indication tracking sheet: re-reading the reports on the earlier weld inspections led EDF to consider that these welds present indications that can be attributed to stress corrosion cracks, but their re-inspection is was not a priority.

1.3. Inspection strategy for the repaired welds on the RIS and RRA lines

You plan to inspect all the repaired welds of the RIS and RRA systems by the end of 2025. Some welds have been prioritised in order to inspect them in the 2023/2025 programme.

You plan to perform an interim assessment of the available technical elements by July 15 2023 at the latest.

Request 6 : Continue your research work to assess the influence of the different repair classifications on the stress corrosion risk, and submit a schedule for this work.
If necessary, you will review your inspection strategy to take account of the development of knowledge on the impact of the repairs without waiting for this interim assessment.

1.4. Inspection extension strategy if indications are found on the RIS and RRA lines

If indications are discovered:

- on the lines considered to have low susceptibility, you plan a limited extension for indications exceeding 2 mm in height:
  - Case of the RRA BC lines of the CPY reactors: extension to A2 (initial inspection of A5 and M4);
  - Case of the RIS BF lines of the P4 reactors : extension to A10 (initial inspection of A13);
- for lines considered non-susceptible, you plan an inspection extension in the following three cases:
  - an indication greater than 3x20 mm (excluding uncertainties) is discovered;
  - a change in an indication (length or height) is observed during monitoring;
  - stress corrosion is revealed by the destructive expert examination.

The aim of this programme is to detect the presence of stress corrosion cracking on the various systems, **considered in principle to have low susceptibility or to be non-susceptible.** The discovery of an indication of more than 2 mm attributable to stress corrosion on a line would be liable to call into question your conclusions concerning the SC susceptibility of that line.

In this case, your proposed inspection extension - limited in some cases to a single weld - seems insufficient in view of the objective of detecting all cracks that could jeopardise the integrity of the line concerned.

Request 7 : for all these lines, whether considered to have low susceptibility or be non-susceptible, if an indication exceeding 2 mm in height is discovered:

- **extend the reactor inspections in order to verify the susceptibility classification of the line;**

- **if the susceptibility is confirmed, extend the inspections to guarantee the absence of defects prejudicial to the integrity of the equipment.**

Should the susceptibility classification of a line be called into question, the inspection strategy for all the reactors concerned shall be adapted as soon as possible.

1.5. Unanalysable zones of the RIS and RRA welds

When analysing the data acquired by the ultrasound inspection process, some zones may be classified as unanalysable. This may be due to difficulties relating to the surface of the line or the structure of the material in itself.

Susceptible lines

The future inspections on these lines are the "point zero" inspections and the inspections planned on Cattenom 4 and the M13 welds of the RRA BC lines of the N4 plant series.

You propose considering the presence of unanalysable zones (ZNA) of length exceeding 80 mm as a deviation. However, you do not propose any methods of addressing the deviation.

Request 8 : detail the actions implemented further to a "zero point" inspection revealing ZNAs of more than 25% (cumulative length on the two edges of the weld with respect to the circumference), to guarantee in-service monitoring that will give the required level of assurance.

If the inspections on a susceptible line that is not a zero point reveal a ZNA exceeding 25% (cumulative length on the two edges of the weld with respect to the circumference), carry out complementary inspections or a specific analysis to confirm the absence of prejudicial defects.

Low susceptibility or non-susceptible lines

One of the aims of the inspections planned over the 2023/2025 period is to confirm the susceptibility classification of these lines. The sampling rate must therefore be sufficiently high to provide a robust confirmation of this susceptibility analysis.

For these lines, you consider that if a ZNA exceeds 25% (**cumulative length on the two edges of the weld with respect to the circumference**), a deviation must be opened. However, no additional action is planned.

You propose a six-monthly review to assess whether or not the ZNA level calls into question the objectives of the strategy.

Request 9 : If the ZNA level found in the inspections carried out in the first half of 2023 calls into question the achievement of the objectives, present a complementary inspection programme at the six-monthly review that enables them to be achieved.

If a ZNA level exceeds 50% (cumulative length on the two edges of the weld with respect to the circumference), conduct another inspection on an equivalent weld during the ongoing outage of the same reactor or perform complementary inspections.

Impact of the ZNAs when there is an indication of measurable height (greater than 2 mm)

Lastly, I would draw your attention to the fact that there are no criteria for extending the ZNAs if an indication exceeding 2 mm in height is detected, in order to conclude on the way to address the indication. This aspect will therefore be addressed on a case-by-case basis, and may necessitate the performance of additional inspections or replacement of the weld.

Case of repaired welds

Request 10 : In the case of the repaired welds, analyse the adequacy of the coverage of the inspections case by case, particularly with respect to the position of the repairs and, where necessary, perform additional inspections or replace the weld.

Improved ultrasound acquisition procedure

On some welds it has been possible to reduce the ZNAs by carryout out an acquisition on an additional index (distance with respect to the weld axis) or by using an additional acquisition frequency.

Request 11 : Assess the benefit of preventively performing ultrasonic inspection systematically with acquisition of an additional index and/or an additional frequency, particular for the repaired welds.

1.6. Geometrical conformity of the lines and their supports

The position and nature of the line supports constitute input data for the load estimates resulting from the line flexibility studies. You have indicated that verifications of the conformity of the supports are conducted during the ten-yearly outages, which have been completed for the 1300 MWe reactors and are in progress for the 900 MWe reactors. You have discovered no significant deviations to date.

Request 12 : Provide a summary of the actions undertaken to verify the conformity of the geometry of the lines and their supports for the RIS and RRA systems of all the reactors with respect to the hypotheses used in the line flexibility calculations (in particular the position of the fixed points).

If there is no verification of support conformity when examining whether to maintain an indication of height exceeding 2 mm "as is", carry out a verification of conformity with respect to the calculation hypotheses during the ongoing outage.

1.7. Taking the stratified state into consideration in the mechanical loads

In the 2023/2025 strategy, the standard loads estimate is used to justify the welds selected for in-service monitoring. These stress estimates are based on the flexibility studies of the regulatory reference files. These studies do not necessarily consider a stratified situation.

According to your new analysis carried out in the light of the stress corrosion defects observed, the studies of the P'4 reactor RIS BF lines should postulate a stratified condition. Complementary calculations are planned by end of March 2023.

More specifically, in view of the thermal fatigue defects recently discovered on the P'4 reactors, it is necessary to update the wear factor calculations of these lines taking stratification into consideration.

Request 13 : Transmit the conclusions of the mechanical strength studies for the P'4 reactor RIS BF lines.

Update the wear factors for the P'4 reactor RIS BF lines taking the environmental effects into account.

If necessary, adapt the inspection strategy according to the results of the studies.

1.8. Knowledge of the loads in the RIS and RRA lines – Instrumentation of the lines

It is necessary to know the distribution of temperature and thermohydraulic phenomena (vortex for example) in the lines in order to evaluate the mechanical loads, assess the stress corrosion risk, and underpin the inspection strategy. By letter of 26 January 2023 [6], you state that an R&D programme is under way to further the understanding of the physical phenomena and that the first stage consists in defining the actions to take based on an analysis of the available data, the current understanding of the phenomena and the digital simulation capabilities.

At the same time, you plan installing temperature measurement strips on the replaced RIS and RRA lines of the Civaux, Chooz and Penly NPP reactors. These devices will provide confirmation of the extent of the cold zones when they retract at the end of an operating cycle.

Request 14 : Transmit the details of the R&D programme and the associated time frames.

Transmit the objectives of installing the temperature measurement strips, the conditions of implementation and the associated time frames.

Propose a programme for installing temperature measurement strips as soon as possible on at least one reactor of each type in order to verify certain hypotheses used in the SC susceptibility classification of the lines (particularly the absence of high temperatures in the low line sections).

2. Strategy for the austenitic steel zones other than the RIS and RRA lines

Based on existing knowledge, you consider that the other austenitic steel lines of the main primary system do not present the same susceptibility to the stress corrosion risk as the RIS and RRA lines.
You have nevertheless initiated actions and you plan transmitting by 31 August 2023 a dedicated investigation programme that will take the presence of repaired welds into account.

ASN takes note of this position and considers it necessary to undertake inspections to consolidate your current conclusions with regard to the susceptibility of these lines. This is particularly the case for the repaired welds on these lines, in view of the discovery of defects of significant depth on the RIS hot branch line of the Penly 1 reactor.

2.1. Main primary system branches

You plan performing penetrant inspections on fifteen elbows removed during steam generator replacement operations. Completion of these inspections is planned for mid-2024.

Request 15 : Transmit the results of the penetrant inspections and your interim conclusions as and when they are obtained.

2.2. Lines of 6 inches diameter or less

At present, no specific analysis has been carried out to evaluate the stress corrosion susceptibility of lines of 6 inches diameter or less. You have nevertheless stated that the analysis of prior expert assessments has not revealed any stress corrosion. You plan performing complementary expert assessments on these lines. You also plan to conduct an expert assessment on a section of the RCV (chemical and volume control system) of the Fessenheim reactor 1 in the second half of 2023.

You indicate that an adaptation of the improved ultrasonic inspection process is in progress for the 6-inch diameter pipes and should be available in September 2023. Radiographic and eddy current inspection processes for small diameter pipes are also under development with availability targeted for the end of 2023.

Although some systems may be available as of 2023, you do not plan deploying them before 2025.

Request 16 : Complete the development of the new non-destructive inspection means a quickly as possible.

In the investigation programme to be developed by 31 August 2023, integrate the performance of inspections before 2025.

On the CP0 and CPY reactors, the high pressure and low pressure safety injection is ensured by 6-inch diameter lines which are therefore of particular interest with regard to reactor safety. You have planned to identify and classify the repaired welds of the pressuriser surge line and the primary branches in priority, and then to carry out this work on the lines of less than 6 inches diameter.

Request 17 : For the 6-inch diameter safety injection pipes of the CP0 and CPY reactors:

- **transmit the identification and classification of the repaired welds;**
- **list the welds inspected under your maintenance programme and the date of the last inspection, specify the means of inspection used and detail any indications detected.**

2.3. Pressuriser surge lines (PSL)

You have inspected two welds of the Civaux 2 reactor pressuriser surge line, which did not reveal any indication exceeding 3 mm in height (design-basis indication performance claimed for this system). You plan performing these inspections on another reactor which has not yet been identified.

There is little information available on these lines, which present the highest operating temperature of the primary cooling system of the reactors. Moreover, these lines are likely to feature repaired welds due to their complex geometry.

You have started an assessment of the stresses present in the surge lines of the various reactors, the conclusions of which are expected in April 2023. These calculations will allow values to be compared between all the reactor configurations against a common baseline.

The identification and classification of the repaired welds is expected for the end of March 2023. Your dedicated investigation programme is expected for 31 August 2023.

Your strategy at present plans for inspections to be performed on just one additional reactor in 2023, which seems insufficient.

Request 18 : Present the conclusions of the stress assessment studies and the list of repaired welds with their classification.

Consider reinforcing, as of now, the inspection programme planned for 2023 on the PSLs of the nuclear fleet reactors.

2.4. Extension of the inspections

Request 19 : Detail the planned methods of extending inspections to the zones in austenitic steel other than the RIS and RRA lines in the investigation programmes expected for 31 August 2023, should the inspections reveal indications that could be attributed to these defects.

3. Performance of "point zero" (initial) inspections following replacement of the RIS and RRA lines

Following the production of a new weld, it is planned to conduct an initial, or "point zero", inspection which will serve as a reference for the subsequent inspections.

You propose postponing some "point zero" inspections for the welds replaced in 2022 and 2023 in order to deploy the resources on inspections deemed to have higher priority.

I note that you will provide a schedule for these inspections by 20 June 2023.

Furthermore, for the performance of this "point zero" inspection for in-service monitoring of the welds of the replaced lines, you propose postponing the analysis of the data in order to prioritise use of the resources for other types of inspections.

ASN considers this proposal admissible for the inspections performed in 2023. This analysis shall be carried out at the latest before the next outage of the reactor.

4. Strategy for maintaining indications as is

The deployment of your inspection strategy is liable to lead to the detection of indications. According to the provisions of order [4], cracks must be eliminated except in cases with specific and appropriate justifications. Subject to these justifications, maintaining welds with indications as is for a given length of time can be envisaged. The conditions under which ASN is liable to accept maintaining the welds as is over a cycle are detailed in paragraph 4.3 of this letter.

With regard to the hypothesis of maintaining welds as is over more than one cycle, the complexity of the stress corrosion phenomenon and the study of its propagation kinetics obliges me to consult the Advisory Committee for Nuclear Pressure Equipment. A session for this purpose is scheduled for 25 and 26 May 2023. You will be informed of ASN's position on this subject after this session.

4.1. Lines susceptible to stress corrosion

You plan to replace the stress corrosion-susceptible sections of the RIS BF lines of all the P'4 reactors except the Cattenom 4 reactor.

For this reactor, you propose inspecting the A13 and M14 welds (A14 and M15 for loop 4) and the repaired welds of the RIS BF lines.

You say that you will open a deviation processing file if any indications are discovered.

Request 20 : If indications are discovered, you will conduct an in-depth analysis to determine the associated risk of the presence and development of stress corrosion. You will more specifically state your position regarding the need to repair the stress corrosion-susceptible zones of this reactor.

Likewise, it is planned to inspect the M13 welds not removed from the RRA BC system of the N4 reactors, and to open a deviation processing file if any indications are discovered.

ASN considers that this proposal does not call for any comment.

4.2. Low susceptibility or non-susceptible lines

You state that if an indication is discovered, you will deal with the case through a deviation processing file which may propose maintaining the indication as is subject to appropriate justifications.

ASN considers that this proposal does not call for any comment.

4.3. Factors to consider for the justification of maintaining as is pending examination by the Advisory Committee for Nuclear Pressure Equipment

The justifications for the possible to maintaining of indications as is are based on the results of the non-destructive examinations, the defect propagation kinetics and the studies of the mechanical strength of a weld affected by a defect.

Non-destructive examinations (NDE)

ASN considers it acceptable, pending process qualification, to adopt your claimed performance levels, namely the integration of an increase in the measurement result obtained from the examination of 1.1 mm.

As indicated in the paragraph relative to ZNAs, ASN considers that if an indication is discovered, it is impossible to define, a priori, a maximum ZNA level that confirms the adequacy of the inspection performed. This point will be examined on a case-by-case basis, and may necessitate the performance of additional inspections or replacement of the weld.

Kinetics of stress corrosion defect propagation

For all the defects, whatever the line concerned by the indication, you propose adopting stress corrosion crack propagation rate of 0.5 mm/year. This hypothesis is based in particular on the results of digital simulations.

However, a propagation rate of 0.5mm/year does not explain the extension of the deep crack observed on weld A3Z weld of the Penly 1 reactor RIS BC system. Moreover, at a preceding session, the Advisory Committee of Experts recommended considering this propagation rate with caution.

ASN's examination of the elements provided to support this propagation rate is not finished, but has led to initial complementary information requests. The results of this examination will be presented at the meeting of the Advisory Committee for Nuclear Pressure Equipment planned in May 2023.

In the interim, ASN considers it necessary in the examination of the deviation processing files to adopt a sufficiently conservative propagation rate to cover the uncertainties regarding knowledge of the phenomenon and its modelling.

Request 21 : Postulate in the deviation processing files a stress corrosion propagation rate of at least 1 mm/year for all welds, whether they have been repaired or not.

You have started an R&D programme to enhance knowledge and better identify the propagation ranges of stress corrosion and fatigue respectively.

Pending the results, if a defect is detected in a zone sensitive to thermal fatigue, you propose analysing both modes of propagation in order to retain the fastest rate of propagation.

This approach is acceptable at this stage of the examination given that, out of a large number of assessed welds, no "mixed" propagation has been observed to date.

Mechanical aspects:

Further to the presentation to the Advisory Committee of Experts on 22 September 2022 [5], as part of the files to justify maintaining stress corrosion-related indications on the RIS or RRA as is, you carry out fracture mechanics computations by separating the crack initiation and crack instability calculations.

The calculation hypotheses (selection of welds, material properties, transients, calculation optimisation, etc.) are currently being analysed by IRSN and will be presented at the Advisory Group's meeting of 25 and 26 May 2023.

4.4. Indications detected during the "point zero" inspections

You state that during the "point zero" inspection, the discovery of small-sized indications, or exceptionally exceeding a height of 2 mm, cannot be excluded.

If any indications are detected, you propose opening a deviation processing file.

The presence of a planar welding defect could accelerate the initiation and propagation of stress corrosion cracks. Maintaining such a defect in service is to be avoided. In the event of maintaining in service, even for a limited period of time, the defect must be subject to specific monitoring.