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WANO Moscow Center

Analysis of Areas for Improvement of NPP Performance Based on Results of the WANO-MC Peer Reviews in 2017

REPORT

May 2018

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1. Summary of the Peer Review Results

This document presents an analytical overview of areas for improvement (AFI) identified during peer reviews (PR) conducted in 2017 at NPPs of WANO Moscow Center. The report analyses the main issues in AFIs during regular (operating) PRs and gives an overall picture about the pre-startup peer reviews (PSUR), the major causes of AFIs and the nuclear safety culture weaknesses at the reviewed power plants. A general picture about the results of the follow-up peer reviews (FUPR) is also given here.

General

During PRs conducted in 2017, the main governing document used were the WANO PO&C 2013-1, "Performance Objectives and Criteria" for operating nuclear power plants, WANO PO&C 2013-2, WANO Pre-Startup Performance Objectives and Criteria" for pre-startup peer reviews of new plants as well as the "How to Review" documents. During the peer reviews, the status of nuclear safety culture was assessed based on the WANO principles PL 2013-1, "Traits of a Healthy Nuclear Safety Culture".

It should be noted that in 2017 all peer reviews at operating sites in the Moscow Centre were conducted in a four-year-cycle, i.e. the previous PRs were conducted four years before. In 2017, the WANO Moscow Center conducted seven operational PRs and seven follow-up PRs (FUPR).

In 2017, the WANO Moscow Center conducted three pre-startup PRs (PSUR).

This analysis focuses on PR results at operating units with a more general outlook to outcomes during PSURs at new units and giving basic results from FUPRs.

Areas for Improvement at operating plants

In 2017, a total of 78 AFIs were identified by the WANO teams during operating PRs which means 11 in average for the seven reviews. This is less than 14 AFIs per one PR in 2016 (70 AFIs in 5 operating PRs).

One can see that contribution of Maintenance (MA – 12), Organisational Effectiveness (OR – 9) and Radiological Protection (RP – 8) to the number of AFIs is the highest among the review areas. Equipment Reliability (ER – 6), Performance Improvement (PI – 6) and Emergency Preparedness (EP – 5) are of mid-range. Figure 2 below demonstrates the distribution of AFIs by 'major' areas, combined from the PO&C areas by their strong logical and technical relationships.

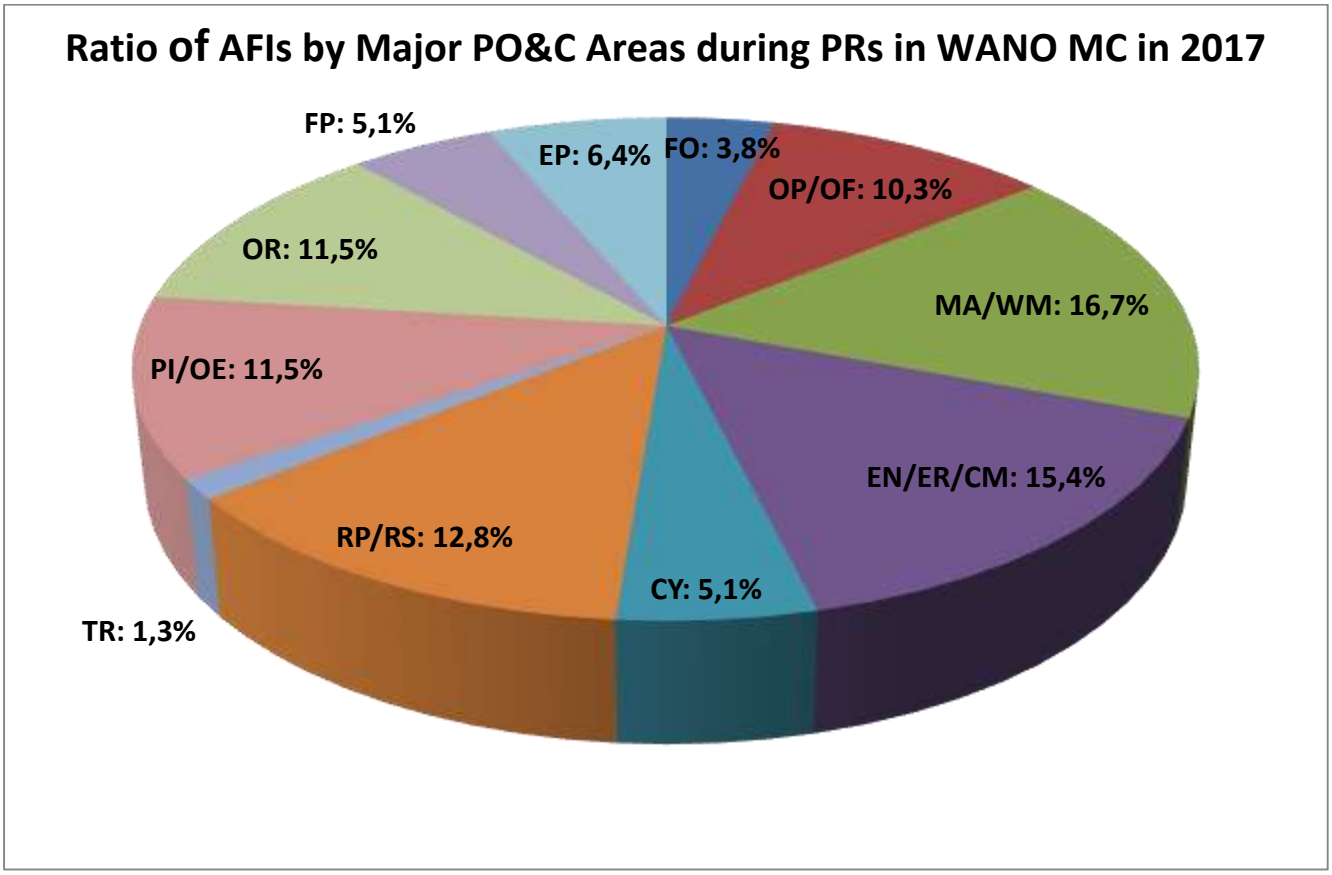

Figure 1: Number of AFIs by major PO&C areas (total 78)

Further on in this report, "main PO&C areas" are mostly meant to include the main functional area and similar cross-functional areas, as follows:

OP – Operations • *OP – Operations* • *OF – Operational Focus*	***CY – Chemistry*** • *CY – Chemistry*	***OR – Organisational Effectiveness*** • *OR – Organisational Effectiveness* • *SC – Safety Culture* • *HU – Human Performance* • *IS – Industrial Safety*
MA – Maintenance • *MA – Maintenance* • *WM – Work Management*	***RP – Radiological Protection*** • *RP – Radiological Protection* • *RS – Radiological Safety*	***FP – Fire Protection*** • *FP – Fire Protection*
EN – Engineering • *EN – Engineering* • *ER – Equipment Reliability* • *CM – Configuration Management*	***PI – Performance Improvement*** • *PI – Performance Improvement* • *OE – Operating Experience*	***EP – Emergency Preparedness*** • *EP – Emergency Preparedness*

The most significant contribution to the number of AFIs is given by the major areas such as Maintenance/Work Management (16.7%), Engineering/Equipment Reliability/Configuration Management (15.4%), Radiological Protection/Radiological Safety (12.8%) and Operations/Operational Focus (10.3%). These major areas cover more than half of all AFIs.

The WANO teams also identified AFIs considered as significant from the safety point of view and were included in the Executive Summaries of the PR reports. In 2017, 27 such AFIs were identified. Figure 2 below indicates their distribution by major PO&C areas.

Repeated/Continuing (R/C) AFIs demonstrate lower levels of success in addressing the weaknesses identified during the previous PR(s). In 2017, 19 such R/C AFIs were identified. The highest number of

three of R/C AFIs were related to the maintenance MA.2 performance objective, two R/C AFIs were identified in Operations OP.2, Equipment Reliability ER.1 and Emergency Preparedness EP.2. Ten other objectives such as Leadership LF.1, Operations Fundamentals OP.1, Human Behavior HU.1 had one R/C AFI each. Unfortunately, the Radiological Protection area had also three R/C AFIs – one in RP.1, RP.3, RP.4 each. The figure in section 2.12 shows distribution of R/C AFIs in 2017.

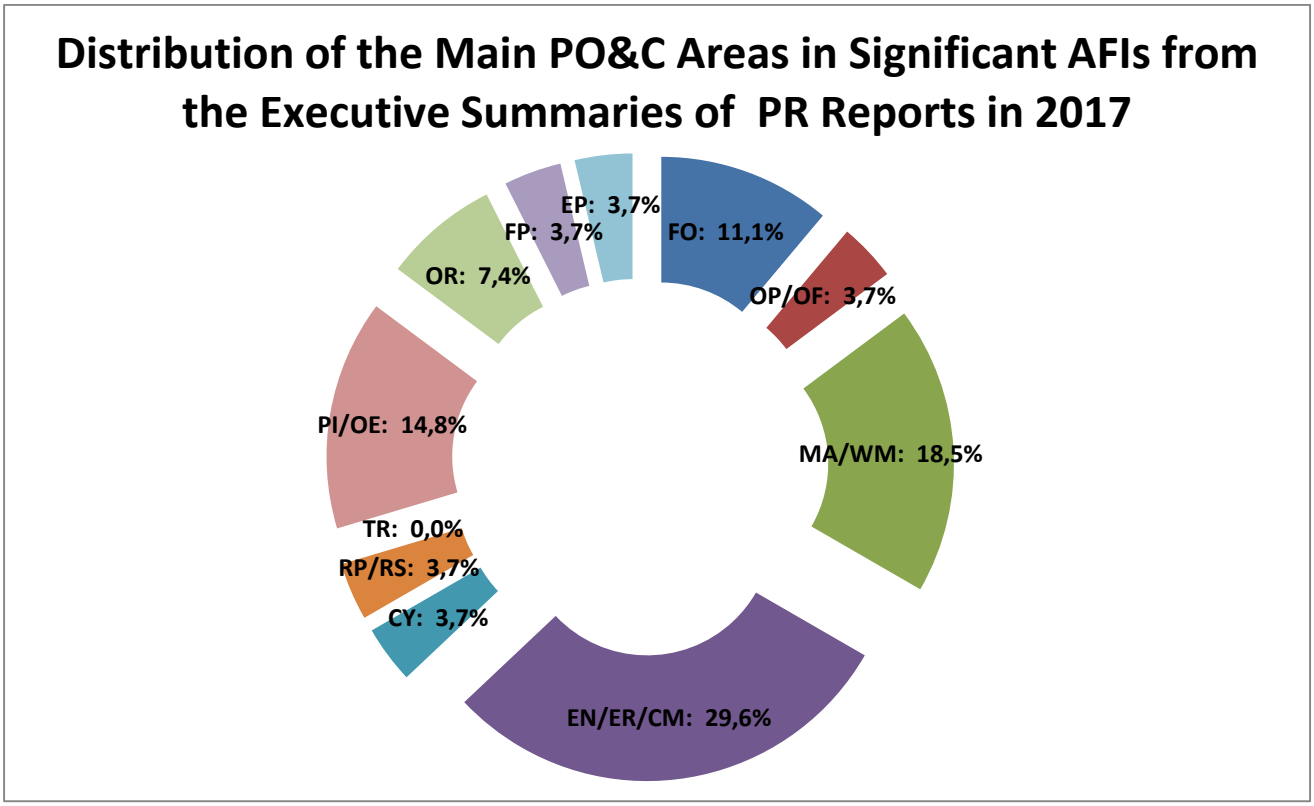

Figure 2: Ratio of significant AFIs by the main PO&C areas

Causes

The causes of AFIs defined together with the PR counterparts during the peer reviews were also evaluated in this study. A classification of causes by ten cause categories was used for analysis of the main AFI causes (see also Table in Section 2.13). The total set of AFI causes shows the following distribution by categories:

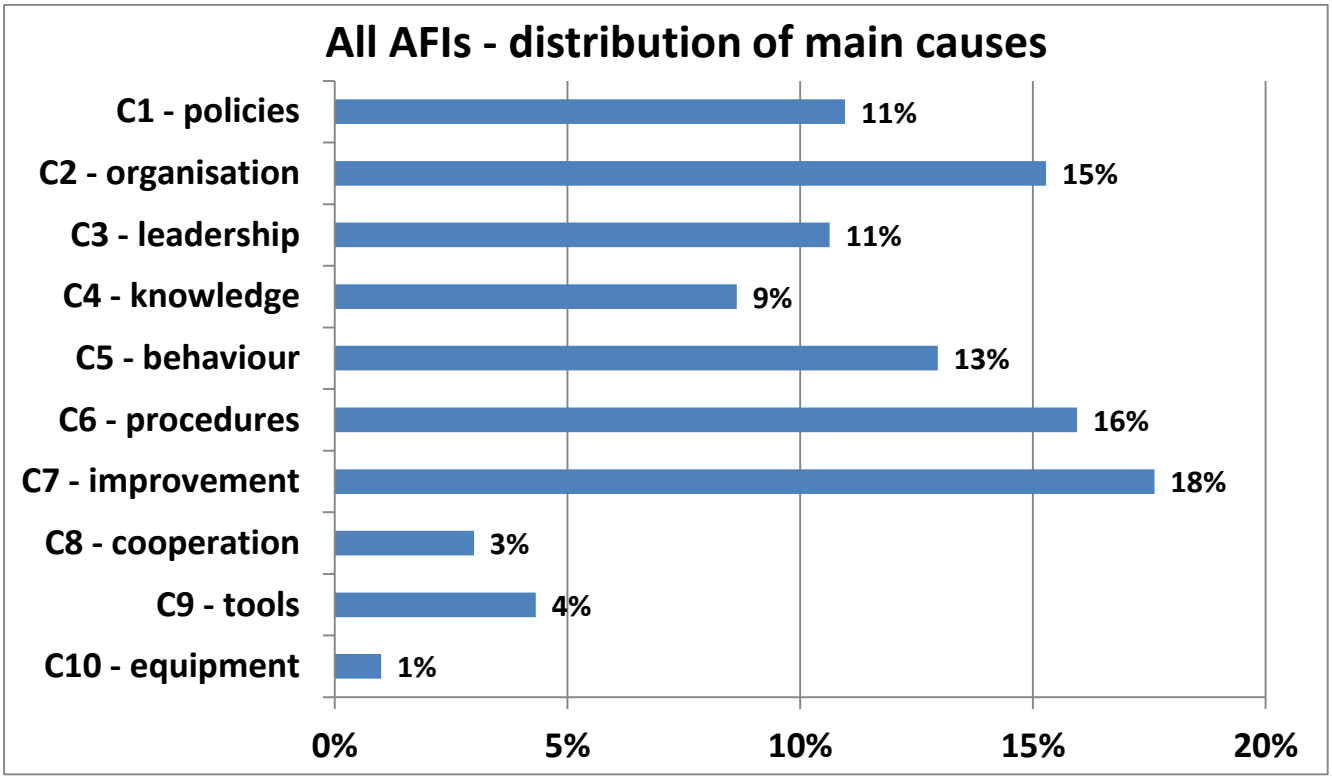

Figure 3: Distribution of AFI causes

The most significant causes contributing to performance weaknesses were:
- missed opportunity to improve performance
- procedure deficiencies, sometimes including missing requirements
- weaknesses in organisation, management and processes.

During follow-up peer-reviews, the results of implementation of corrective actions focusing on the AFIs are assessed. Thus, AFIs receive evaluation in four categories according to the new performance level approximately two years after the main review. In 2017, during seven FUPRs 96 AFIs were assessed out of 98 (during a FUPR the WANO team did not review two AFIs). The results were as follows:

- A – Satisfactory - 67.7%
- B – On Track - 27.1%
- C – At Risk - 6.3%
- D – Unsatisfactory - 0.

Two thirds of the AFI issues were resolved satisfactorily and just 6.3% were at risk (with no unsatisfactory AFIs). The highest number (6) of AFIs rated as On Track – B was in MA.2 – Conduct of Maintenance. The AFIs rated as "C – At Risk" were found in Foundations (Nuclear Professionals), Training, Operational Focus, Radiological Safety, Operating Experience and Emergency Preparedness.

After the plant Nuclear Safety Culture (NSC) self-assessment, during WANO peer reviews, the WANO teams also assess the NSC level according to the WANO principles PL 2013-1 "Traits of a Healthy Nuclear Safety Culture". In 2017, the strongest traits were the WE – Respectful Work Environment about respecting everybody's opinion and the close CO – Safety Communications about open

exchange of safety information. The weakest traits were:

- PI - Problem Identification and Resolution
- QA - Questioning Attitude
- WP - Working Processes

This means that identification of the uncertainties or problems, processing non-compliances and establishing the necessary performance improvement need enhancement at most plants.

2. Analysis results of peer review AFIs of operating plants

Table 2 below demonstrates distribution of all identified 78 AFIs by the PO&C performance objectives. The most frequent performance objective occurred was in maintenance MA.1 and MA.2 both with 6 AFIs in 2017. This confirms importance of and challenges in maintenance despite the continuous efforts to improve in the industry. The Fire Protection (FP.1) and Emergency Preparedness (EP.2) both had 4 AFIs and demonstrate importance of carefully considering these objectives. At the same time, 11 performance objectives did not have AFIs in 2017 at all.

Table 2

PO&C Area	PO&C Performance Objective		AFIs	AFIs
Foundations (FO)	NP.1	Nuclear Professionals	1	3
	LF.1	Leadership	2	
Operations (OP)	OP.1	Operations Fundamentals	2	5
	OP.2	Conduct of Operations	3	
Maintenance (MA)	MA.1	Maintenance Fundamentals	6	12
	MA.2	Conduct of Maintenance	6	
Chemistry (CY)	CY.1	Chemistry Fundamentals	2	4
	CY.2	Chemistry Controls	2	
	CY.3	Effluent Controls		
Engineering (EN)	EN.1	Engineering Fundamentals	3	3
	EN.2	Technical Authority		
Radiological Protection (RP)	RP.1	Radiological Protection Fundamentals	1	8
	RP.2	Radiation Dose Control	3	
	RP.3	Radioactive Contamination Control	3	
	RP.4	Radioactive Material Control	1	
Training (TR)	TR.1	Training	1	1
Operational Focus (OF)	OF.1	Operational Priorities	2	3
	OF.2	Operational Risk	1	
	OF.3	Response to Emergent Operational Challenges		
Work Management (WM)	WM.1	On-Line and Outage Work Management	1	1
	FA.1	Fuelling Activities		
	PM.1	Project Management		
Equipment Reliability (ER)	ER.1	Equipment Performance	3	6
	ER.2	Equipment Failure Prevention	1	
	ER.3	Long-Term Equipment Reliability	1	
	ER.4	Materials Reliability	1	
Configuration Management (CM)	CM.1	Design and Operating Margin Management		3
	CM.2	Operational Configuration Control	1	
	CM.3	Design Change Processes	2	
	CM.4	Nuclear Fuel Management		

PO&C Area	PO&C Performance Objective		AFIs	AFIs
Radiological Safety (RS)	RS.1	Radiological Safety	2	2
Performance Improvement (PI)	PI.1	Performance Monitoring	2	6
	PI.2	Solutions Analysis, Identification and Planning	3	
	PI.3	Solutions Implementation	1	
Operating Experience (OE)	OE.1	Operating Experience	3	3
Organisational Effectiveness (OR)	SC.1	Nuclear Safety Culture		9
	OR.1	Nuclear Organisation Structure and Traits	2	
	OR.2	Manager Fundamentals	1	
	OR.3	Management Systems	2	
	OR.4	Leader and Manager Development		
	OR.5	Independent Oversight		
	HU.1	Human Performance	3	
	IS.1	Industrial Safety	1	
Fire Protection (FP)	FP.1	Fire Protection	4	4
Emergency Preparedness (EP)	EP.1	Emergency Preparedness Leadership	1	5
	EP.2	Emergency Preparedness	4	
	EP.3	Emergency Response		

The distribution of the PO&C areas related to the AFIs defined in 2017 can be seen in the Figure 4 below:

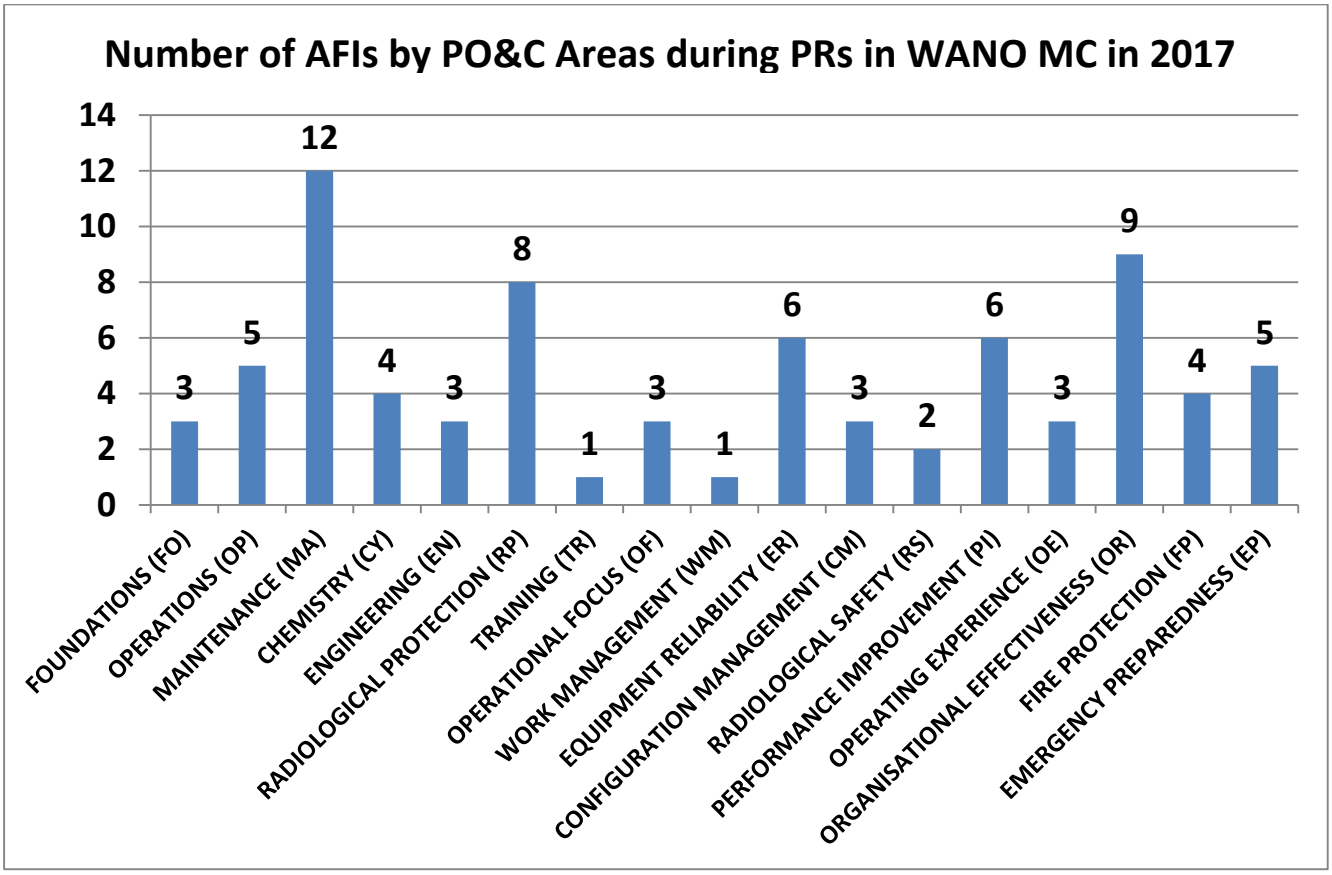

Figure 4: Number of AFIs by PO&C areas at operating plants

Below follows a detailed analysis of the AFIs and their causes by the PO&C areas.

2.1 Foundations (FO)

The Foundations can be considered as a main area, a basis for high level performance of nuclear plants giving information about behavior and commitment to safety of leaders and staff. It combines the NP and LF areas. In 2017, three AFIs were defined in this main PO&C area.

PO code	Performance objective	Number of AFIs
NP.1	**Nuclear Professionals** – Nuclear professionals apply the essential knowledge, skills, behaviours and practices needed to conduct their work safely and reliably.	1

Major deficiencies:

1. **The station employees do not always demonstrate professional behavior and practices to perform work in a safe and reliable manner.**
   - Shortfalls exist in identifying deficiencies, and meeting the ALARA principles and industry safety standards while performing work.
   - The station personnel are not aware of the potential consequences of their incorrect actions.

Examples of significant causes:

- Plant staff does not consider importance to follow expectations and procedures.
- Lack of motivation and manager oversight, coaching…
- Lack of training and communication of requirements.
- Missing requirements in identification of defects/deficiencies.

PO code	Performance objective	Number of AFIs
LF.1	**Leadership** – Leaders, by commitment and example, inspire, motivate and align the organisation to achieve safe and reliable station operations, event-free outages and effective emergency response. They establish and reinforce standards of excellence, based on industry top performance, to continually strive for improvement and intervene to correct performance at early signs of decline.	2

Major deficiencies:

1. **Leaders do not consistently demonstrate the commitment to strive for continuous improvement and to intervene to correct performance at early signs of decline.**
   - Senior leader's expectations for problem identification and resolution have not fully penetrated the organisation with mixed performance seen across departments.
   - Several long-standing issues have not been fully resolved. Leaders are not consistent in coaching, providing feedback, correcting performance or behaviour shortfalls of the staff at all levels.
   - Lack of leader alignment and reinforcement of standards.
2. **Managers do not always demonstrate, by example, their commitment to high standards.**
   - In some cases, station managers demonstrate tolerance to existing weaknesses and do not correct incorrect personnel behaviors.
   - Managers do not always perform tours in the field and task observations thus missing the opportunity to correct incorrect personnel behaviours.
   - Managers do not always pay attention to other departments' deficiencies.

Examples of significant causes:

- Leaders' behaviour in the field are not fully in line with senior managers' expectations.
- Managers do not always demonstrate leadership qualities in day-to-day work.
- Weaknesses in top-down communication of goals and tasks as well as in bottom-up feedback.
- Low effectiveness of managers' work, weak response of leaders to challenges.
- Missing feeling of ownership, low level of motivation.
- Training and coaching are insufficient, conscious acceptance of mistakes, human errors.
- Resistance to changes, lack of self-assessment by leaders.
- Identification of potential risks and setting of counter-measures is weak.
- Insufficient understanding of the importance of leadership and exemplary behavior.
- Insufficient oversight from managers and supervisors, insufficient use of demo tours and checkout tours.
- Not all mid-level managers are trained to leadership, deficiencies in training and promotion of leadership.
- Insufficient personnel awareness of error-prevention tools.
- Shortfalls in the professional selection and professional training.

Conclusions for FO:

All 3 AFIs in Foundations were found as significant in the PR Executive Summaries. In one case, an LF.1-1 AFI was also continuing. The main deficiencies could be categorised as follows:

a) **Leaders do not demonstrate commitment** towards safe work practices, high standards and continuous improvement **by their own example** (2).
b) Workers do not demonstrate professional and safe work practice and behaviour (1).

Distribution of major causes in the FO main area

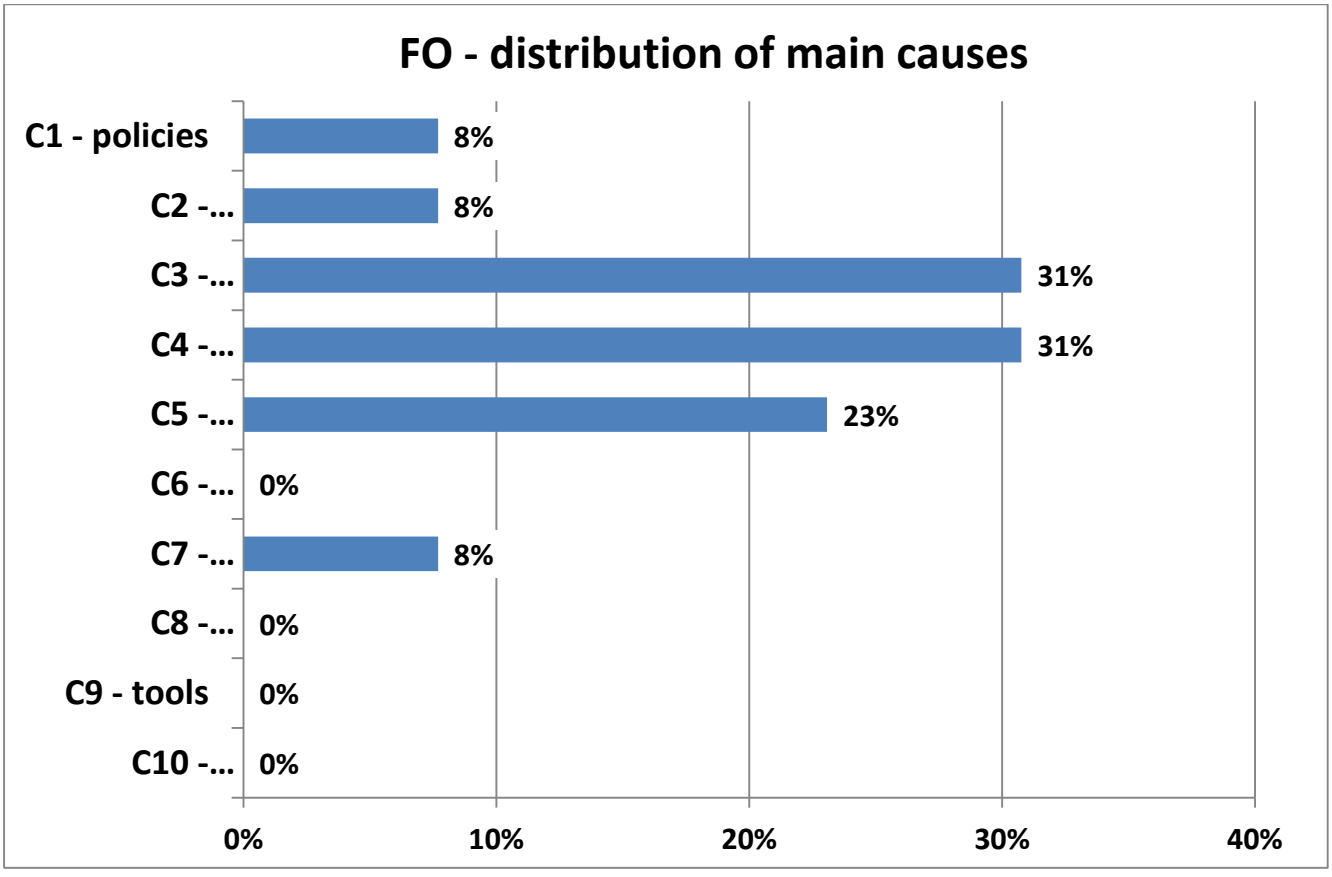

Figure 5: Distribution of FO causes

2.2 Operations (OP)

This OP main area combines 5 AFIs in Operations (OP) functional area and 3 AFIs in Operational Focus (OF) cross-functional. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
OP.1	**Operations Fundamentals** – Operations personnel apply the essential knowledge, skills, behaviours and practices needed to operate the plant safely and reliably.	2

Major deficiencies:

1. **Control Room operators and field operators do not always identify deficiencies on safety-related equipment.**
   - During their rounds, when no one is watching, the field operators do not always report deficiencies on the components belonging to other departments.
   - On some occasions, deficiencies on safety-related equipment are not identified.
   - Deficiencies are not reported on equipment the parameters of which go beyond the allowable limits as shown by the instrumentation.
2. **There are shortfalls in Operations Fundamentals such as procedure use and rigorous plant monitoring.**
   - The plant expectations regarding procedures use requirements do not ensure a rigorous and conservative process while performing plant operations.
   - Operations Fundamentals standards on plant monitoring are not always met, and plant configuration is not closely and online assessed in order to identify potential impact on safety margins.

Examples of significant causes:

- Shortfalls in the questioning attitude during operator rounds.
- Shortfalls in the tools and aids used for operator rounds.
- Deficiencies in operational procedures and their use.
- The number of operational instructions is high.
- The technical (IT) support is not sufficient.
- Training focused on rigorous plant configuration monitoring but shortfalls exist.
- Independent oversight is not sufficient.

PO code	Performance objective	Number of AFIs
OP.2	**Conduct of Operations** – Operations programmes, processes and activities are implemented in a manner that promotes sustained high levels of safe and reliable operation.	3

Major deficiencies:

1. **Equipment operating manuals and operating procedures do not always provide clear and accurate guidance. The plant operating documentation does not cover all the activities performed by the operating personnel.**
   - There are no symptom-based operating procedures and alarm response procedures.
   - Operating procedures do not always clearly define the responsibilities of the involved personnel and do not always provide for the tools and facilities to be used.

- The process of personnel's familiarization with the procedures and instructions should be improved.

2. **The existing process of performing plant evolutions (system lineups) does not always ensure a high level of safety.**
   - The operators do not always use step-by-step procedures for system lineups and plant evolutions, including nuclear safety significant evolutions, sometimes the operators miss steps or actions in the system lineup sheets.
   - Not all procedures and lineup sheets provide clear criteria for the monitoring of parameters and determining the equipment performance.
   - There are shortfalls in the procedures and methods for plant evolutions and system lineups.
3. **Some operational tests and switchovers procedures contain deficiencies. In step-by-step procedures there are steps which include several operations.**
   - There are the discrepancies between equipment marking in the procedures and their labelling in the place.

Examples of significant causes:

- No requirements have been established for the shift engineers and operators to identify deficiencies in the operating instructions and procedures.
- The identified deficiencies in the operating documentations are not always resolved.
- The personnel do not have sufficient qualifications to verify and validate procedures.
- There is no consistent approach to the development of operating procedures and system lineup sheets in the respective departments.
- The Operations managers' expectations are not always properly communicated to the personnel.
- The personnel are not encouraged to suggest changes to improve the existing operating documentation.
- The station does not fully use the best industry practices in the process of performing plant evolutions and system lineups.
- The quality assurance procedures containing detailed requirements for preparation of switchover documents do not fully cover all types of switchovers.
- Personnel involved in procedure development process suffer lack of resources, multiple tasks, extra workload
- Procedure deficiencies are not always detected and reported by the personnel.

PO code	Performance objective	Number of AFIs
OF.1	**Operational Priorities** – Station personnel and programmes are aligned to identify and prioritise the resolution of operational problems.	2

Major deficiencies:

1. **Equipment performance monitoring does not always ensure identification of deficiencies.**
   - There are unidentified deficiencies in the condition of safety-related and safety system equipment.
   - There are deficiencies in the quality, method and documenting of equipment tours.
2. **The station personnel is not always sensitive to identifying and reporting performance issues.**
   - In some cases, the required actions were missed, deficiencies and shortfalls were not reported, attention to the condition of safety-related systems was reduced.

Examples of significant causes:

- Shortfalls in the oversight, tours and task observations performed by managers, and in their leadership training.
- The identified and reported deficiencies are not always addressed, the requirements for resolving the deficiencies are not always defined in the station documentation.
- Lack of questioning attitude during work, tolerance to equipment deficiencies, ineffective equipment monitoring, lack of motivation.
- The requirements of the operating and maintenance procedures are not always met.
- The documentation does not always provide a clear sequence of actions.
- Information on deviations in the performance of safety-related equipment is not always recorded in the procedure.
- Corrective actions on deviations are not always developed.

PO code	Performance objective	Number of AFIs
OF.2	**Operational Risk** – The plant operational risk associated with equipment removed from service or degraded and from planned plant activities, is maintained low. Inadvertent operational events are prevented through planning, preparation, controls, contingencies and communication.	1

Major deficiencies:

1. **There are shortcomings in taking measures to reduce the risks associated with the operation of equipment.**
   - The impact of external factors and defective equipment is not always assessed to reduce the risk of continued operation.
   - Unclear monitoring equipment, a high number of defect tags and incomplete labelling can affect the ability of operators to accurately operate and monitor the plant.

Examples of significant causes:

- The personnel do not consistently assess the risk related to operation of equipment with defect and do not take immediate measures to mitigate risk.
- Operational personnel do not define the value of permitted parameter, inconsistent performance of walk-down inspections.
- Shortfalls in performance of the walk-down inspections by managers in the area of Observation and Coaching of the operational performance evaluation, training of the walk-down inspections by the managers does not include this topic titled Observation and Assessment of the Operation Personnel Performance.
- Defects of unimportant equipment are assigned P4, P5 codes without deadlines defined for defects elimination.
- Huge workload for both the corrective and preventive maintenance.
- When the upgrade is being planned, the priority is given to the critical equipment.

Conclusions for OP:

In the main area Operations, one AFI was significant in PR reports and 3 were of repeated/continuing category. The main deficiencies could be categorised as follows:

a) **Weaknesses in walk-downs and monitoring of equipment state (4)**
b) Improper procedure usage (1)
c) Inadequate operational, switchover and test procedures (2)
d) Improper work organisation, weaknesses in risk consideration (2)

Distribution of major causes in the OP main area

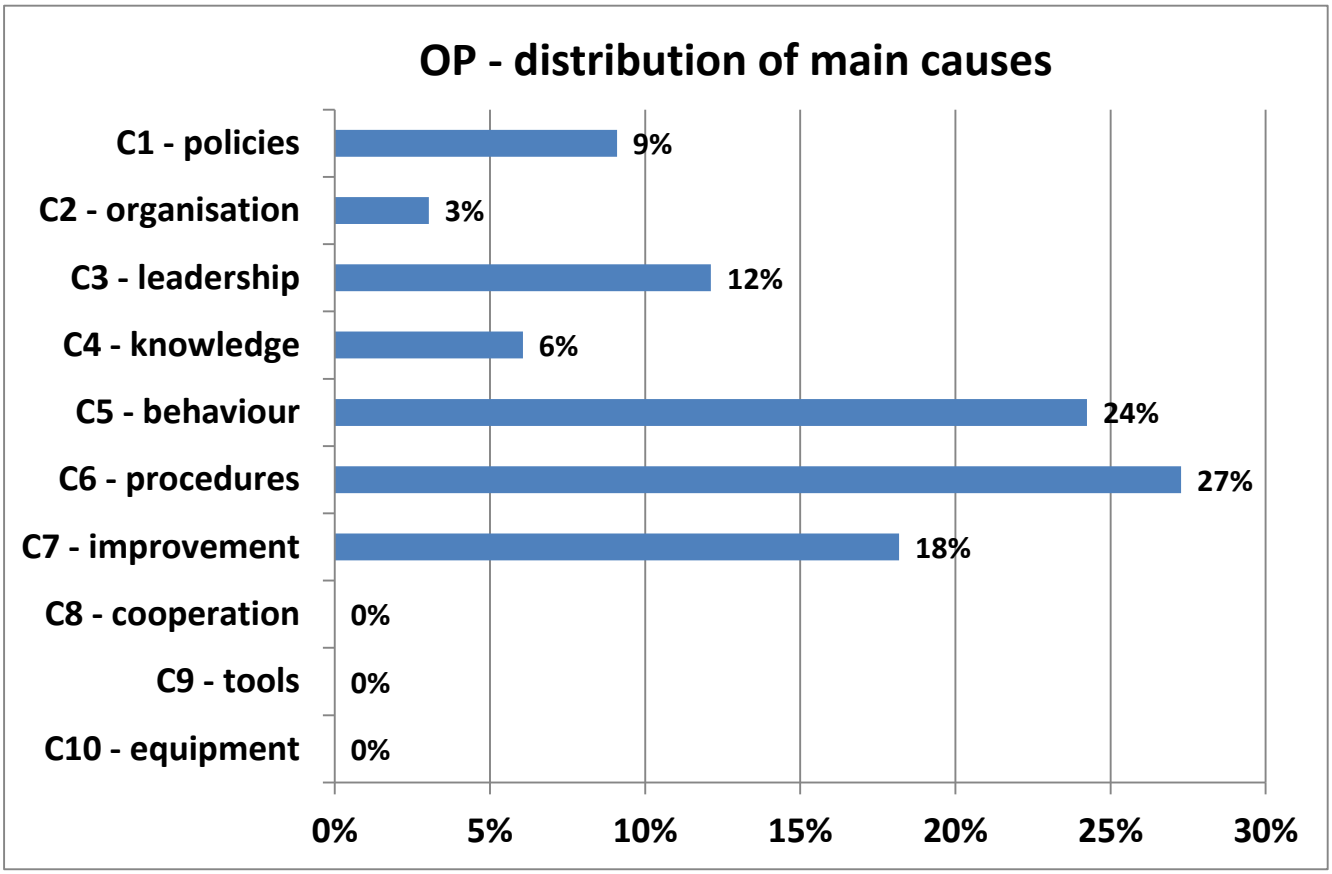

Figure 6: Distribution of OP causes

2.3 Maintenance (MA)

This MA main area combines the functional area Maintenance (MA) as well as the cross-functional area 'Work Management' with objectives WM, FA, PM. In 2017, 12 AFIs in MA functional area and 1 AFI in the WM cross-functional area. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
MA.1	**Maintenance Fundamentals** – Maintenance personnel apply the essential knowledge, skills, behaviours and practices to improve equipment performance, contributing to safe and reliable operation.	6

Major deficiencies:

1. **The maintenance practices exercised by the maintenance personnel do not always meet station expectations.**
   - Insufficient commitment to the use of procedures and correct maintenance methods per the station's expectations and shortfalls in the exiting station procedures can affect the quality of maintenance.
2. **The level of control and oversight of the contractor activities does not ensure that station quality standards for work practices are consistently met.**
   - Improper contractor workers' working practices are not always identified and corrected by supervisors, e.g. deficiencies in using lifting and material handling equipment, tools and working procedures.

- Practical training is missing in some training programs.
- Managers' observation and coaching are not sufficient in the field, including deficiencies in oversight of contractors.

3. **Maintenance personnel do not fully comply with the foreign material exclusion standards.**
   - Insufficient FME controls for safety-related equipment.
4. **Deficiencies in applying adequate maintenance behaviors and practices have the potential to jeopardize equipment reliabilityy.**
   - In some cases, maintenance documentation is not accurate and has not been followed.
   - Deficiencies with tool and lubricant usage, and rigging equipment usage were observed.
5. **Maintenance personnel do not always demonstrate high quality maintenance work practices.**
   - Maintenance personnel do not always follow the requirements of the approved documentation during their work.
   - Maintenance personnel sometimes performs procedure steps from memory and do not always know how and what tools should be used for the work.
   - Personnel sometimes demonstrate weak work practices.
6. **Maintenance personnel do not always apply proper maintenance work practices.**
   - This includes inappropriate personnel and equipment protection, noncompliance with instructions in maintenance work documentation, insufficient maintenance work preparation, inappropriate usage of tools, and insufficient maintenance workers' tool usage skills.

Examples of significant causes:

- Weaknesses developing the station maintenance procedures, their insufficient quality.
- Not strictly adhering to the maintenance documentation and correct established maintenance practices.
- Maintenance personnel do not fully follow the maintenance documentation requirements.
- Inadequate training for the station and contractor maintenance personnel.
- Overconfidence by the personnel in their knowledge.
- Neglected (not reported) problems related to maintenance work practices.
- Insufficient use of the best industry and world maintenance practices.
- Not systematic oversight of the contractors internally and by the NPP staff.
- Insufficient performance and inconsistency of supervision, observation and coaching in the field by managers to correct improper maintenance work practices.
- Requirements on correct application of maintenance equipment, tools and documentation are not specified and detailed.
- Supervisors' knowledge in the oversight in the field is limited.
- Risks during work are not always identified and highlighted.
- Maintenance feed-back is not systematically organised and managed, including from contractors.
- Staff and supervisors do not fully understand the expectations for the FME controls.
- Workers are not provided with sufficient amount of tools and materials to meet the FME standards.
- Use of inappropriate tools, inappropriate or missing expectations and attention of managers.
- Not appropriate activities when rigging, lifting and handling of weights.

PO code	Performance objective	Number of AFIs
MA.2	**Conduct of Maintenance** – Maintenance activities are conducted in a manner that promotes safe and reliable plant operation.	6

Major deficiencies:

1. **The implementation and control of the foreign material exclusion (FME) program is not fully aligned to best industry practices (shortfalls in the FME programme).**
   - Workers do not consistently apply and supervisors do not fully enforce FME rules.
   - Insufficient housekeeping and inefficient FME measures were observed. Plant events related to foreign material intrusions have been continuously increasing in the past 5 years.
2. **Maintenance activities are not always performed in accordance with the station's documentation and technical standards.**
   - Maintenance personnel do not always comply with the technical standards when assembling flange connections and installing/connecting electrical cables.
   - The requirements of the station documentation are not always met during the conduct of maintenance.
3. **Deficiencies in implementation of the foreign material exclusion (FME) policy.**
   - Workers did not strictly follow FME rules.
   - Some deficiencies in the planning, purchasing and training that may adversely impact foreign material intrusion into equipment were observed.
4. **The maintenance practices do not always support safe plant operation.**
   - Maintenance activities are not always performed in accordance with the approved procedures and are not always properly documented.
   - Maintenance personnel do not always review the maintenance documentation and do not always provide their feedback and suggestions to improve the maintenance documentation.
5. **Maintenance managers do not always ensure high quality of the performed maintenance work.**
   - Sometimes maintenance activities are not controlled/supervised in accordance with the approved processes.
   - Not all maintenance procedures meet high quality standards.
   - Deviations from the FME requirements occur during the planning and conduct of maintenance.
   - The layout and tooling of maintenance workshops do not always support safe and reliable conduct of maintenance.
6. **Work documentation accuracy and completeness is not always sufficient to ensure proper work preparation and performance (lack of necessary information or its inaccuracy in maintenance documentation).**
   - Materials, spare parts, tools and reference documents have not fully been completed during work preparation due to some discrepancies or lack of information in documentation.
   - Sometimes prescribed technological steps differ from performed ones or procedures are developed in general form for several types of equipment.
   - Workers do not always use the feedback process to provide feedback on documentation deficiencies.

Examples of significant causes:

- The station is pressed by cost reduction.
- Lack of FME coordinator, roles and authorities of FME coordinator not defined.
- Insufficient task observations, ineffective oversight from managers and supervisors in the field, insufficient training or coaching.
- Insufficient FME training provided for workers
- Insufficient analysis of FME related events, root causes of FME events are not always defined.

- Missing requirements to set up guarded maintenance areas for reactors, turbines and generators
- Insufficient FME equipment and inconvenience to obtain FME equipment
- Contractor workers do not care about the significance of FME.
- Workers do not possess the required knowledge and skills to perform some maintenance tasks.
- Maintenance supervisors and team leaders do not identify major deficiencies in the conduct of maintenance by their staff during their observations, they are overconfident of their workers' abilities and do not reinforce adherence to maintenance procedures.
- Rework cases and events related to equipment performance have not been duly analyzed.
- Workers do not always understand the importance of adhering to procedures and are overconfident of their abilities based on their knowledge.
- Workers do not understand the requirements for the use of maintenance procedures and check lists.
- Maintenance personnel do not always comply with and are not encouraged to meet high standards as regards following step-by-step check lists and procedures.
- Maintenance managers focus on schedule adherence rather than on the conduct of work.
- FME is not implemented in all planning processes, missing ownership of FME activities.
- Challenging outage duration, shortfalls in works scheduling and risk assessment
- Human Error Prevention Tools violations happened.
- Deficiencies in the planning of activities, including those performed in parallel,
- Deficiencies in missing of tools, instruments and personal protective equipment.
- Contractor maintenance workers are not always aware of the specificity of the station equipment.
- Complacency, insufficient reinforcement on the part of line managers.
- Shortfalls in documentation, including related to FME.
- Overconfidence by the staff in their knowledge and skills; maintenance personnel do not fully comply with procedures.
- Insufficient personnel training in work management and preparation.
- Insufficient oversight from managers over the conduct of maintenance and documenting the work performed.
- Insufficient use of error-prevention tools.
- Weaknesses in the technology and tools used by the contractors.
- Workers do not provide feedback on deficiencies of working procedures, lack of motivation.
- Work procedures are not detailed enough. Insufficient control of documentation quality
- Management expectations on importance of document and action compliance are not communicated to workers and are not reinforced.
- Insufficient use of best industrial practices.

PO code	Performance objective	Number of AFIs
WM.1	**On-Line and Outage Work Management** – Work activities are managed during both on-line and outage periods to support safe and reliable operation.	1

Major deficiencies:

1. **Inconsistent or improper implementation of the revised work management process has contributed to an increasing deficiency backlog.**
   - The new work management process coding, because of inadequate training and documentation has resulted in over-evaluation (too conservative) of work deficiencies.

- Initial categorization of deficiencies is not periodically re-evaluated based on the aggregate impacts of deficient equipment and operational condition.
- The station experienced several examples of rework.

Examples of significant causes:

- Omissions in the identification stage, work preparation and material management.
- Increasing backlog of deficiencies.
- No adherence to the work schedule.
- Reduced efficiency in WM process meetings.

Conclusions for MA:

In the main area Maintenance, 5 AFI were significant in PR reports and 3 were of repeated/continuing category. The main deficiencies could be categorised as follows:

a) **Inadequate maintenance practices, lack in use of proper maintenance techniques and procedures (6)**
b) Deficiencies in the oversight of contractors, not sufficient observation by managers (1)
c) Weaknesses in FME practice (3)
d) Weaknesses in work management, organisation, preparation and oversight of maintenance by managers, improper maintenance procedures (3)

Distribution of major causes in the MA main area:

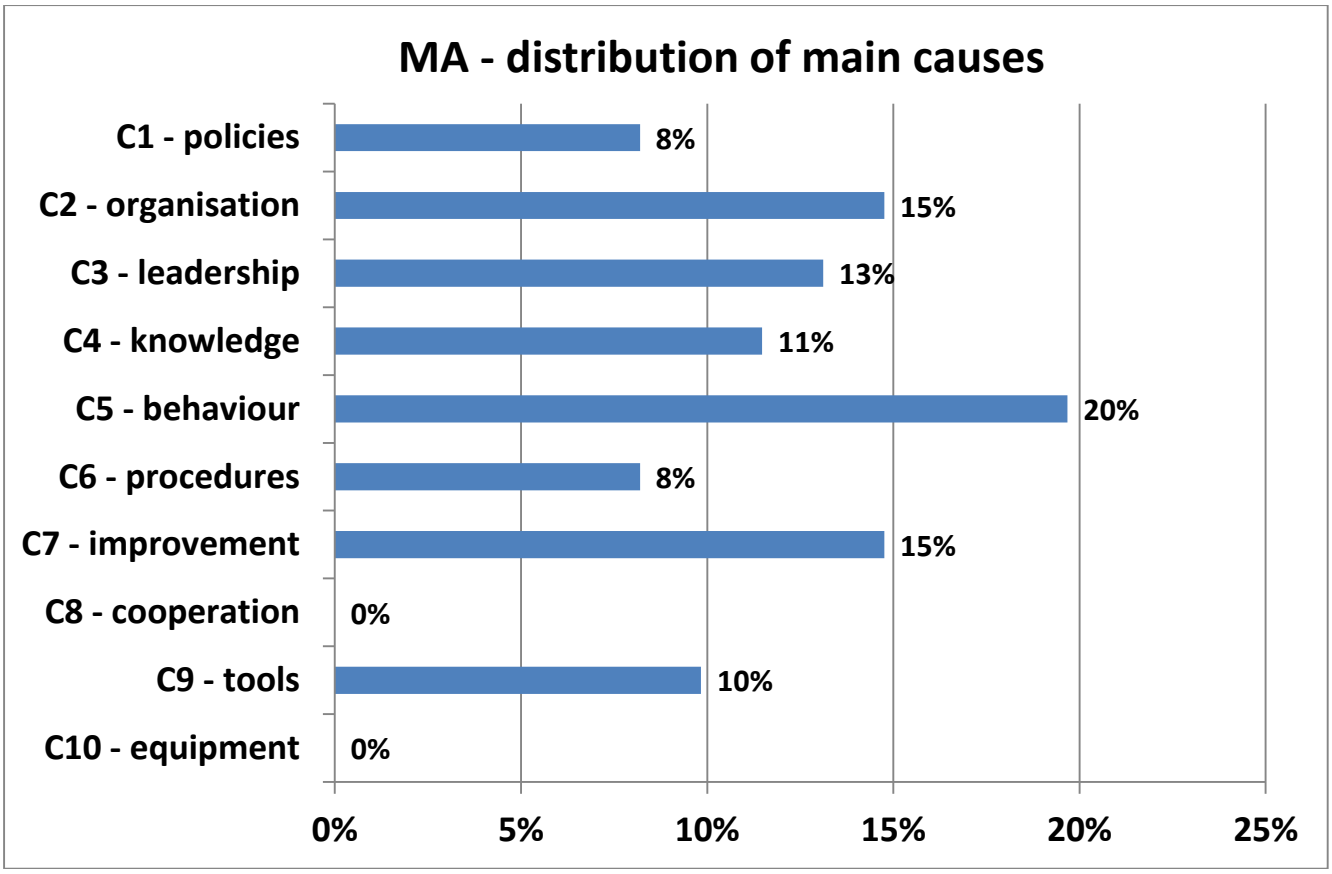

Figure 7: Distribution of MA causes

2.4 Chemistry (CY)

This CY main area is equal to the Chemistry (CY) area and contains 3 objectives. 4 AFIs in the CY functional area were identified in 2017. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
CY.1	**Chemistry Fundamentals** – Chemistry personnel apply the essential knowledge, skills, behaviours and practices needed to implement chemistry activities that support safe and reliable plant operation.	2

Major deficiencies:

1. **The existing practices for monitoring the plant chemistry parameters do not always ensure an effective analysis of the effectiveness of the used methods for the conduct of chemistry and coordination of chemical additions.**
   - On some occasions, the functioning of the online chemistry measurement system is not properly ensured, and the ranges for the monitored parameters are not always accurately established.
   - The actions to be taken in response to chemistry deviations are not always clearly defined.
   - The parameters of the added chemicals are not always monitored.
   - The sampling processes sometimes do not ensure representativeness of samples.
   - Chemicals are not always monitored for quality.
2. **The existing laboratory quality control system with appropriate analytical chemistry method does not always provide the accurate measurement results.**
   - Some devices do not have metrological validation; some calibrations are expired; sometimes measurements are not performed in accordance with measurement range.
   - There are discrepancies in applying chemistry control procedures.

Examples of significant causes:

- Weaknesses in the monitoring, assessment and response during the conduct of maintenance (functioning of the online chemistry measurement system, ranges for the parameters monitoring).
- Shortfalls in the existing procedures and practices for the taking and analyzing samples of the plant process media; weaknesses in the management of chemicals.
- Initial and in-service quality control of chemicals and oils.
- Inconsistent procedure of interface between chemistry and metrology department.
- Insufficient control of chemistry measurements: periodicity, comparison of lab and on-line values.
- Discrepancies in on-line and laboratory chemistry measurement comparison procedures.
- Insufficient requirements for calibration range of on-line measuring device.

PO code	Performance objective	Number of AFIs
CY.2	**Chemistry Controls** – Chemistry personnel maintain proper chemistry conditions during all phases of plant operations.	2

Major deficiencies:

1. **Chemistry procedures do not always ensure effective chemistry control.**
   - Some chemistry procedures do not require preventive actions before the first action level is achieved.
   - Actions to be taken when the chemistry online measurements are out of use are not always clear.
   - Limits for some chemistry parameters are not always established or sometimes the limits are not optimal for the current water chemistry.
2. **The station does not always maintain some chemistry parameters in the specified ranges, including those for the primary circuit and safety-related systems.**
   - For some systems, some chemistry parameters are not measured, their changes are not trended, the station documentation requirements are not complied with, and the criteria for taking corrective actions are not defined.

Examples of significant causes:

- Incomplete chemistry documentation.
- Chemistry procedures are not always clear on what should be done when online measurements. are not working, station relies on the knowledge and experience of the Chemistry Supervisors.
- The station overly relies to the action levels of chemistry parameters.
- Long standing defects on the chemistry online measurements.

Conclusions for CY:

In the main area Chemistry, 1 AFI was significant in PR reports and 1 was of repeated/continuing category. These four main deficiencies could be classified into one category as follows:

a) **Weaknesses in monitoring of chemistry parameters (4)**
b) Inadequate chemistry procedures (2)

Distribution of major causes in the CY main area:

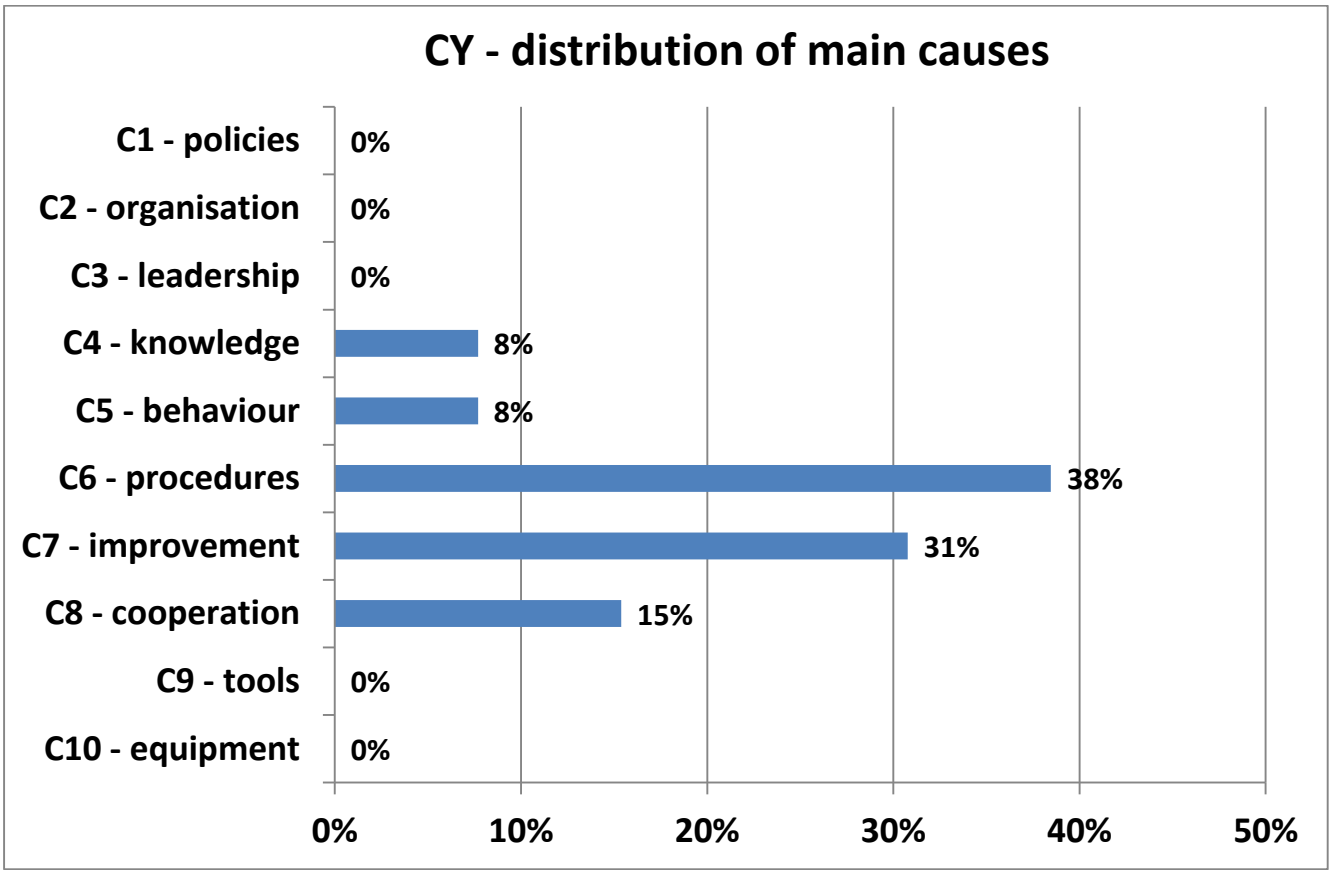

Figure 8: Distribution of CY causes

2.5 Engineering (EN)

This EN main area consists of the Engineering (EN) functional area and the Equipment Reliability (ER) and Configuration Management (CM) cross-functional areas where 12 AFIs were identified in 2017 (3 + 6 + 3 respectively). Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
EN.1	**Engineering Fundamentals** – Engineering personnel apply the essential knowledge, skills, behaviours and practices needed to ensure equipment performs as required, the plant is maintained within design requirements, margins are controlled and the plant is operated safely and reliably.	3

Major deficiencies:

1. **Engineers do not always perform thorough, critical reviews of work performed by external organisations.**
   - For instance, safety analyses sometimes were accepted by the plant engineers with significant deficiencies.
   - Evaluation of equipment condition was not always verified in comprehensive manner.
   - Lack of questioning attitude from plant engineers to the results provided by contractors sometimes contributed to incorrect technical conclusions at management level.

2. **The station engineering departments do not always find optimal solutions to ensure timely prevention of events and long-term equipment reliability.**
   - Technical solutions and compensatory measures do not always include a comprehensive engineering assessment and analysis of potential risks.
3. **Engineers do not always consistently analyze the actual equipment conditions and performance to identify operational issues and develop timely technical solutions to resolve those issues.**
   - The consequences of existing problems on safety-related systems are not always evaluated and correctly prioritized in line with their significance.
   - As a result, long-standing issues are not always considered in developing the station documentation.
   - Contributing are shortfalls in the existing system performance analysis processes.

Examples of significant causes:

- Too much trust to the contractors, lack of questioning attitude, requirements on critical review of the work performed by external organisations not clearly and completely established.
- Organisational changes have not been finished yet.
- Increased scope and number of engineering activities, work overload.
- Weaknesses in the existing procedures.
- The overall scope of engineering analyses is not effectively coordinated.
- Insufficient training on decision-making.
- Shortfalls in the equipment performance analysis process.
- Shortfalls in the analysis of the working documentation as regards assessment of potential risk.
- Critical knowledge transfer..

PO code	Performance objective	Number of AFIs
ER.1	**Equipment Performance** – High levels of reliability are achieved for equipment that supports nuclear safety, plant reliability and emergency response capability.	3

Major deficiencies:

1. **The practices of monitoring the condition of cables and electrical equipment is not sufficiently effective.**
   - The team found uninsulated and unlabeled cables, overloaded cable trays, deviations from the design in securing the cables, unsealed cable penetrations, compromised integrity of fire protective devices in the cable lines.
   - Personnel do not always identify deficiencies on electrical equipment.
2. **A high number of deficiencies on critical components of safety systems exist and there is a potential that their accumulation increases the vulnerability to a safety system failure (b)**
   - The deficiencies include several that affect the reliability of EDG, Auxiliary Emergency Feed Water System and Safety Injection System, etc.
   - Main causes of the problem are insufficient work management engagement, inconsistent equipment walk down and observation weakness, critical spare parts management and long-term equipment reliability strategy shortfalls.
3. **High reliability of safety systems is not always consistently maintained.**
   - Equipment configuration changes sometimes affect equipment availability and operability.
   - Also, there are weaknesses in evaluating the equipment performance and condition.

Examples of significant causes:

- Shortfalls in the equipment upgrade projects that involve cable installation/disassembly.
- Shortfalls in the observation of the cabling activities including during equipment upgrades.
- Not using check lists or round sheets during walkdowns.
- Weaknesses in the questioning attitude towards equipment walkdowns as regards identification of deficiencies; insufficient personnel knowledge.
- Managers do not reinforce their expectations.
- Long-lasting deficiencies accumulating with upcoming new deficiencies.
- Inconsistent engineering engagement in the work management process with the plant procedure.
- Weaknesses in walk-down and observation.
- Equipment long-term reliability management did not prevent the failure of critical equipment.
- Spare parts of some critical equipment are not available on site.
- Incorrect prioritization during equipment operation and maintenance.
- Insufficient self-assessment and monitoring of safety system equipment performance.
- Inconsistent use of error-prevention tools; procedures are not consistently followed.
- Procedures and instructions are not correct.
- Shortfalls in the modification/upgrade projects; insufficient analysis of modifications.

PO code	Performance objective	Number of AFIs
ER.2	**Equipment Failure Prevention** – Preventive and predictive maintenance and performance monitoring are used to prevent failures of equipment important to safety, reliability and emergency response.	1

Major deficiencies:

1. **The equipment performance assessment and monitoring process does not always make it possible to identify degradation and significant deficiencies on equipment important to safe and reliable plant operation.**
   - Adverse trends and deviations from expected values are not fully documented and analyzed.
   - Sometimes equipment is operating with zero reliability margins.

Examples of significant causes:

- Shortfalls in documenting and analyzing reliability margins, performance deviations and adverse trends.
- Shortfalls in the use of information systems to computerize the analysis of equipment performance data and changes.

PO code	Performance objective	Number of AFIs
ER.3	**Long-Term Equipment Reliability** – Equipment is managed to maintain long-term equipment reliability.	1

Major deficiencies:

1. **The activities to maintain availability and reliability of safety-related systems are not always performed in a timely manner.**
   - In some cases, the personnel do not realize the potential threat to equipment reliability and disregard the parameters that go beyond the established limits.
   - Chemistry is not sufficiently monitored.

- Complacency towards equipment performance.

Examples of significant causes:

- The station configuration change management process is not sufficiently centralized.
- Shortfalls in the procurement process for supplies and materials.
- Insufficient training of engineers in procurement.
- Priority of price over other factors affects the quality of purchased spare parts and materials.

PO code	Performance objective	Number of AFIs
ER.4	**Materials Reliability** – Activities are implemented to preserve materials and components in a manner that supports long-term, reliable plant operation.	1

Major deficiencies:

1. **High chemistry standards and requirements are not always met to ensure materials reliability for long-term plant operation.**
   - In some cases, long-standing deviations are observed in chemistry parameters of the condensate/feedwater system and auxiliary systems.
   - These deviations are not always analyzed for their effect on the formation of corrosion products and on the materials and radioactivity of the primary circuit.

Examples of significant causes:

- Early chemistry deviations are not fully trended and assessed.
- Corrective actions that have been taken are not sufficiently analyzed for their effectiveness.

PO code	Performance objective	Number of AFIs
CM.2	**Operational Configuration Control** – Plant operation, maintenance and testing activities are conducted in a manner consistent with the licensing and design bases and maintain configuration control.	1

Major deficiencies:

1. **Operating procedures and system operation manuals do not always provide clear and precise guidance for equipment operation and maintenance.**
   - Shortfalls in the system lineup sheets; missing procedures or procedures incorrectly referred to; specific operator actions are not described; no precise guidance as to the parameters monitoring scope.
   - Maintenance documentation is not always detailed and updated; the procedural requirements are not always specific.

Examples of significant causes:

- Shortfalls in the operating documentation; procedures do not provide accurate guidance for the scope of parameters monitoring, for limiting criteria and personnel actions.
- Insufficient numbers of workers capable of developing and analyzing documentation.
- Shortfalls in verification and validation of maintenance documentation.

PO code	Performance objective	Number of AFIs
CM.3	**Design Change Processes** – Changes to plant configuration, design and licensing bases are evaluated, controlled, tested and implemented while consistency is maintained among the physical plant configuration, design and licensing requirements and the documented plant configuration.	2

Major deficiencies:

1. **Station personnel have not in all cases fully evaluated, tested and monitored some plant modifications.**
   - Information related to plant configuration is not always collected and assessed for impact to the design basis.
2. **Plant configuration changes are not always developed and implemented with consideration of their effect on safety and potential risk of equipment failure.**
   - Some changes (including temporary modifications) are implemented without a proper technical justification, documentation of results and in-situ labeling.
   - Contributing is missing analysis of temporary configurations and modifications.

Examples of significant causes:

- Procedure deficiencies.
- Insufficient training, underestimated critical knowledge transfer process for retiring engineers.
- Lack of external experience exchange or benchmarking focused on configuration and design basis.
- Lack of leadership in configuration and design basis potential problem identification.

Conclusions for EN:

In the main area Engineering, 8 AFIs were significant in PR reports and 3 were of repeated/continuing category out of 12. In two cases, AFIs of ER.1 were both significant and repeated/continuing. The 12 deficiencies could be classified into the following categories:

a) Inadequate review of work performed by external organisations (1)

b) Weaknesses in development of solutions for equipment reliability and for modifications as well as in managing issues and deficiencies (3)

c) Lack in systematic monitoring of equipment status, collection and analysis of reliability data and deficiencies (4)

d) Weaknesses in risk management in configuration management, planning, implementation and tracking of modifications (4)

e) Inadequate conditions (e.g. chemistry) procedures (e.g. ops, maintenance) for managing high equipment reliability (2)

Distribution of major causes in the EN main area:

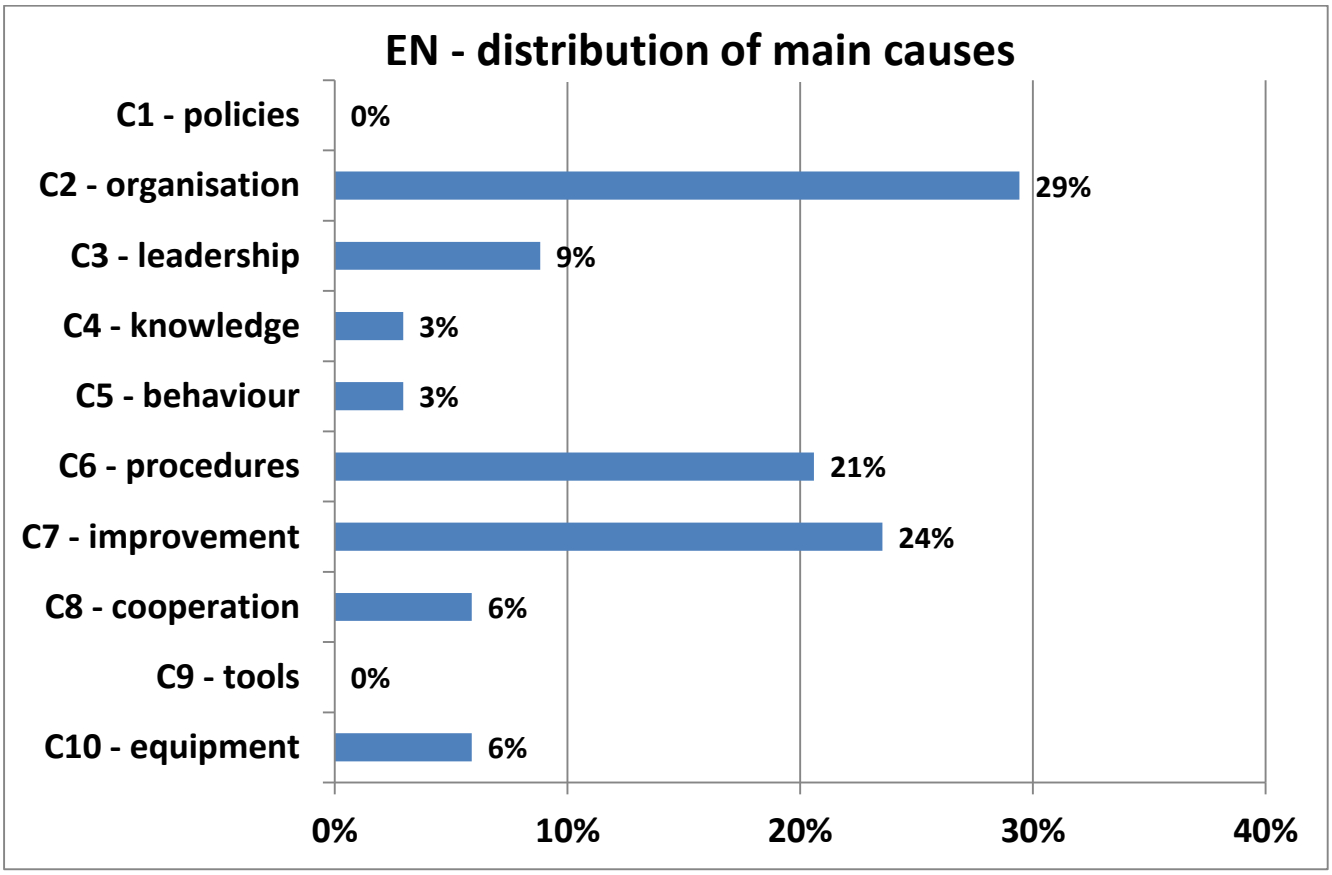

Figure 9: Distribution of EN causes

2.6 Radiological Protection (RP)

This RP main area consists of the Radiological Protection (RP) functional area and the Radiological Safety (RS) cross-functional area which had total 10 AFIs (8 + 2 respectively) in 2017. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
RP.1	**Radiological Protection Fundamentals** – Personnel who perform radiological protection activities apply the essential knowledge, skills, behaviours and practices needed to implement those activities such that worker and public health and safety are protected.	1

Major deficiencies:

1. **Personnel do not always use diverse controls and barriers to prevent unplanned exposure.**
   - Incorrect fencing of hot spots; the inspection frequency for those areas is not established; the source characteristics are not always posted on the fences of those hot spots.
   - The process of categorizing an area as a hot spot is not sufficiently formalized.
   - A root cause analysis is not always performed for increased radiation levels because there is not specific station requirement to establish a duration for the hot spots.

Examples of significant causes:

- Shortfalls in the procedures for hot spots management and for management of used decontamination solutions.

- Shortfalls in the analysis of issues and root causes as to why hot spots occur.
- Insufficient use of best industry practices for hot spots management.

PO code	Performance objective	Number of AFIs
RP.2	**Radiation Dose Control** – Individual dose and collective radiation dose are measured accurately and are maintained as low as reasonably achievable.	3

Major deficiencies:

1. **The existing processes for radiation dose control and reduction are not always effectively implemented.**
   - Shortfalls in radiation work planning.
   - Some processes are not sufficiently formalized.
   - Actions to reduce exposure dosed are not fully analyzed for adequacy and effectiveness.
2. **There are shortfalls in the system of administrative and physical barriers for hot spots.**
   - Accounting for hot spots is not arranged; hot spots are not always and not fully labeled, fenced off and shielded.
   - Low-background areas are not labeled.
   - Personnel does not always respond to hot spots. This results in high collective dose which has an upward trend.
3. **The existing practices for the use of individual dosimeters results in inaccurate measurement of individual external exposure doses; whereas the established dose limits for specific activities, individuals and teams are not conservative.**
   - Incorrect use (wearing) of individual dosimeters resulting in the possibility of incorrect dose measurements for individual radiation types.
   - The approach used to establish the dosimeter alarm actuation thresholds does not ensure that the personnel is promptly alerted to unexpected or changing radiological situation.
   - The established levels of exposure in the radiologically controlled area are not optimized.
   - Many workers do not have online or direct-reading dosimeters does not allow to respond to worsening radiological situation in a timely manner.

Examples of significant causes:

- Shortfalls in the questioning attitude towards the review of existing documentation.
- Shortfalls in the radiation control procedure for hot spots and management of hot spots.
- Analytical information is not provided when collective dose reports are submitted.
- Allocation of roles and responsibilities is not sufficiently formalized.
- Tolerance to hot spots.
- Insufficient fencing and shielding of hot spots; insufficient supplies of protective devices.
- The RP personnel are not aware that this type of dosimeter is supposed to be worn without casing.
- Absence of a warning setpoint in the dosimeters; insufficient number of direct-reading dosimeters.
- No conservative approach is used while establishing the exposure levels; no requirements in the station and regulatory documentation.

PO code	Performance objective	Number of AFIs
RP.3	**Radioactive Contamination Control** – Radioactive contamination is controlled to prevent the spread of contamination to personnel, areas and equipment.	3

Major deficiencies:

1. **There are weaknesses in behavior and manners in terms of potential contamination spreading and inconsistent use of PPE.**
   - Improper worker practices and inaccurate contamination monitoring were identified in the RCA.
2. **Radioactive contamination controls are not always adequate and effective.**
   - There are shortfalls in the radioactive contamination controls at the borders of areas of various dose rate levels, in the administrative barriers and personnel behaviors.
3. **Measures to contain and prevent the spread of contamination are not taken in all areas with actual or potential contamination and/or airborne releases.**
   - Some doors at the borders between the zones are not tight because they are not properly sealed or adjusted.
   - Some flap valves are not correctly adjusted.
   - Some barriers are defective at the borders of areas/rooms; not repairing those barriers promptly may lead to the spread of radioactive contamination.

Examples of significant causes:

- Workers do not always strictly adhere to the guidelines in conducting work in RCA.
- Managers do not use effective communication, instruction and coaching of field workers in RCA to correct behavior and work practices on the spot in all cases.
- Workers are not sufficiently trained in practical skills.
- Inadequate investigation of possible contamination at the exit of RCA to hot change area.
- Obsolete instrumentation, insufficient inventory of forced radiation monitoring instruments.
- Shortfalls in the process for individual and small items radiation monitoring.
- Station procedures do not provide requirements for operation of flap valves.
- Work has not been completed to upgrade (retrofit) the low-level radioactive waste storage facility per international standards.
- Deficiencies in the condition of contamination spread barriers on the way from semi-occupied areas are reported with delays.
- Deficiencies are not addressed for a long time.

PO code	Performance objective	Number of AFIs
RP.4	**Radioactive Material Control** – Radioactive material controls are implemented to protect the health and safety of workers and the public.	1

Major deficiencies:

1. **There are shortfalls in the station process for solid radioactive waste management.**
   - The work is not always planned and performed to minimize generation of solid radioactive waste.
   - There are weaknesses in the collection, sorting, stock-taking of solid radioactive waste and in ensuring integrity of the containers and the use of sorbents.

Examples of significant causes:

- The existing procedures for the collection and sorting of low-level and intermediate-level radioactive waste does not allow to clearly segregate clean and dirty waste.
- Work has not been completed to upgrade the intermediate-level radioactive waste storage facility.
- There shortfalls in the station processes to reduce solid radioactive waste.

PO code	Performance objective	Number of AFIs
RS.1	**Radiological Safety** – Station leaders and workers are aligned to minimise dose, reduce source term and implement controls for radioactive contamination and materials.	2

Major deficiencies:

1. **Actions to minimize exposure doses have not been fully developed and implemented.**
   - There shortfalls in the analysis of collective dose, and in the planning and implementation of actions to reduce dose.
2. **Some workers do not strictly comply with station standards for radiation protection**
   - Some gaps in the implementation of the procedure requirements and following the contamination and exposure prevention expectations were observed in the Radiological Controlled Area (RCA).

Examples of significant causes:

- Insufficient attention of managers at various levels to radiological safety as a priority.
- Shortfalls in the analysis and implementation of actions to reduce doses.
- Shortfalls in implementation of actions to reduced dosed.
- Inadequate use of radiological protection equipment and radiological safety posters.

Conclusions for RP:

In the main area Radiation Protection, 1 AFI was significant in PR reports and 3 were of repeated/continuing category out of 10. In one case, an AFI of RP.1 was both significant and repeated/continuing. The 10 deficiencies could be classified into the following categories:

a) Inadequate efforts to control of high dose zones and to prevent radiation spreading (4)

b) Weaknesses in planning and analysis of dose loads (2)

c) Improper plant practice in adequate measuring and reducing staff dose exposure, lack in following rad protection standards (3)

d) Weaknesses in procedure for managing radioactive wastes (1)

Distribution of major causes in the RP main area:

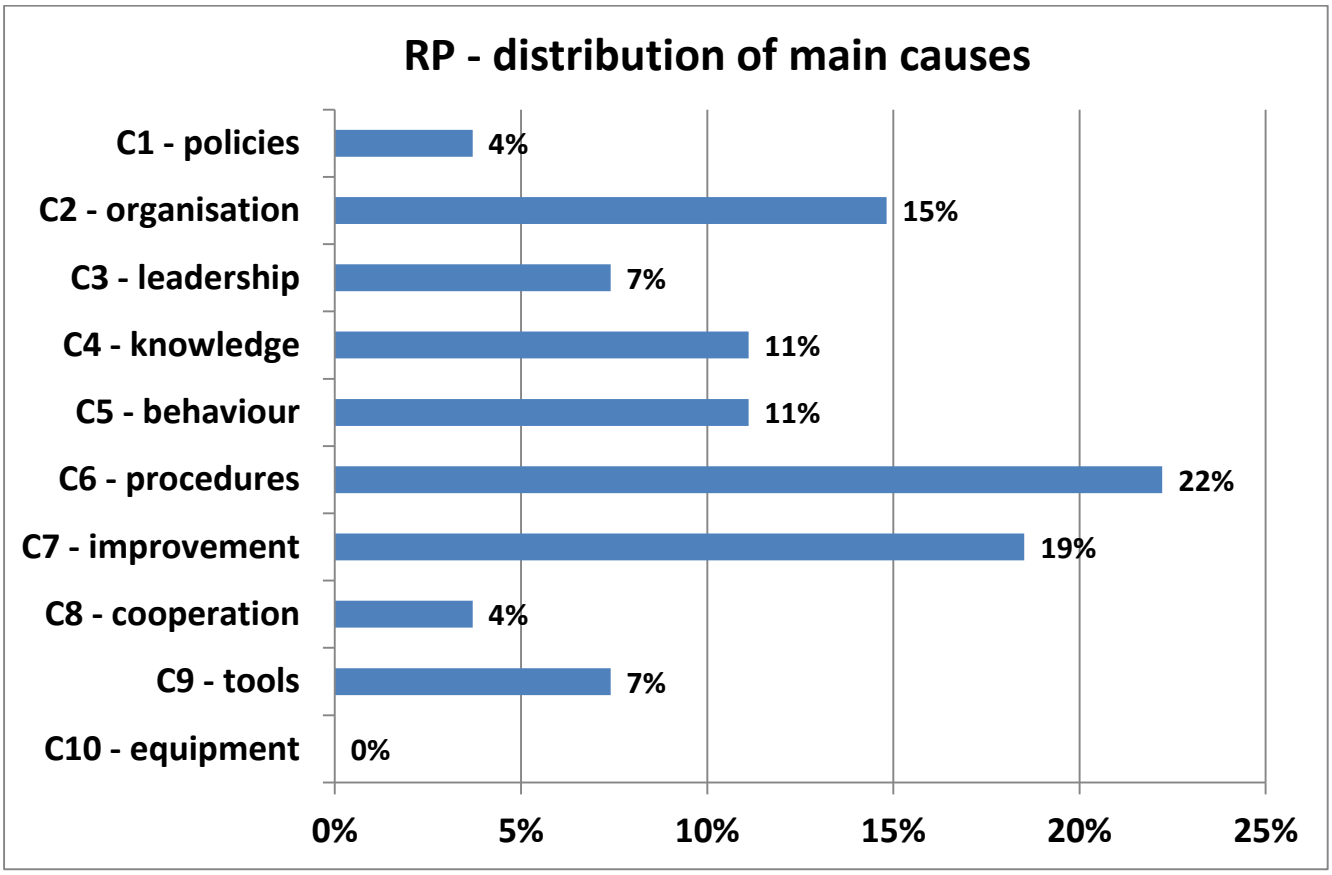

Figure 10: Distribution of RP causes

2.7 Training (TR)

This TR main area is equal to the similar Training functional area and had 1 AFI in 2017 as it can be seen below.

PO code	Performance objective	Number of AFIs
TR.1	**Training** – A systematic approach to training is used to provide highly skilled and knowledgeable personnel for safe and reliable operations and to improve performance.	1

Major deficiencies:

1. **Training needs are not fully identified and analyzed to include important topics in the initial and refresher training programs.**
   - Responsibilities for identification of training needs are not clearly allocated between the departments concerned and the training department.
   - The initial and refresher training programs do not fully reflect the topics of severe accident management, emergency preparedness and modification management.
   - Emergency drills on the full-scope simulator do not consider the events that have occurred at the station.

Examples of significant causes:

- Shortfalls in the identification of training needs; department managers do not pay sufficient attention to personnel knowledge improvement.

- The annual scope of training does not consider the events that have happened at the station.

Conclusions for TR:

In the area of Training, the only AFI was neither significant nor repeated/continuing. The deficiencies could be classified into the following category:

a) Weaknesses in planning of training (1)

Distribution of major causes in the TR main area:

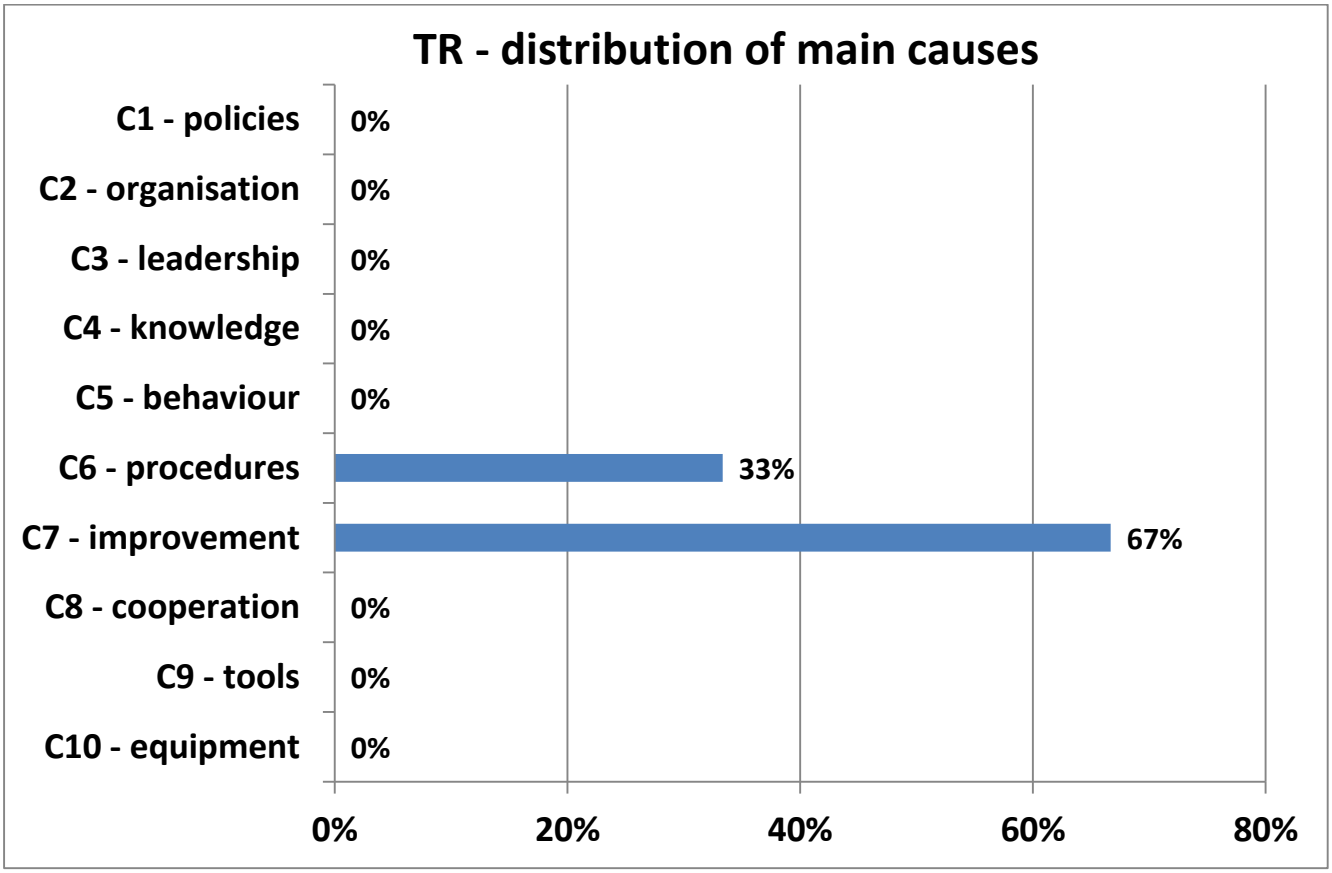

Figure 11: Distribution of TR causes

2.8 Performance Improvement (PI)

This PI main area consists of the Performance Improvement (PI) and the Operating Experience (OE) cross-functional areas which had total 9 AFIs (6 + 3 respectively) in 2017. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
PI.1	**Performance Monitoring** – Performance monitoring activities are used to identify gaps between current levels of performance and desired management and industry standards.	2

Major deficiencies:

1. **The station does not fully use the performance improvement opportunities.**
   - Some managers and workers do not demonstrate personal commitment and ownership for early identification and prevention of deviations and deficiencies.

- The station does not pay sufficient attention to identification, analysis, trending and repeatability of deviations and defects that can affect plant safety and reliability.
- The performance monitoring process does not fully promote continuous improvement.
- The effectiveness analysis of the use of operating experience does not always meet its goal to identify and resolve performance deficiencies.
- The corrective actions resulting from event investigations do not always preclude recurrence of the events.

2. **Performance monitoring activities are not always used to identify gaps between current performance and desired management and industry standards.**
   - Missing performance indicators, incorrect reaction to performance indicators, not fully comprehensive codes list and deficiencies in reporting of problems.
   - Missed opportunities to improve and inaccurate trends.

Examples of significant causes:

- Deficiencies in the documentation that specifies tours and walkdowns.
- Some managers and workers do not have sufficient ownership of the plant equipment.
- The station tours and walkdown program does not apply to all station departments.
- The station documentation does not specify the required scope of self-assessment of the operating experience program effectiveness.
- Shortfalls in the training as regards event investigation reports.
- Inadequate monitoring of the effectiveness of programs or processes, the limit levels of indicators in the comfort zone are not always reviewed and analyzed.
- Currently used system of codes for coding of condition reports is broad but not comprehensive.
- Non-compliance with management expectations for reporting of non-conformities into the plant information system, management expectations are not fully reflected in the documentation.

PO code	Performance objective	Number of AFIs
PI.2	**Solutions Analysis, Identification and Planning** – A consistent and deliberate approach is used to investigate problems and plan actions to improve performance.	3

Major deficiencies:

1. **The station has not fully implemented some elements of the continuous improvement model to support desired improvements in performance.**
   - The elements include identification, reporting and resolution of issues and ongoing assessments of performance (e.g. observation, self-assessment, trending, prioritization).
   - Gaps in the implementation of the continuous improvement model elements challenge successful implementation of activities needed to improve station performance.

2. **There are some weaknesses in the event cause analysis process and corrective action development.**
   - Root cause, apparent cause and minor apparent cause analyses are sometimes not timely.
   - Corrective actions are not always developed sufficiently based on the cause analysis.
   - This could contribute to recurring events.

3. **Events are not always analysed to improve plant performance.**
   - Deficiencies in performing of root cause analyses (low fruitfulness of root cause analyses of not repeated events in Category 2 and events in Category 3, incorrect root cause, missing extent of cause) may lead to recurrent events.

Examples of significant causes:

- The Continuous Improvement Programme is still under development, not completed yet.
- Leadership engagement is limited due to other activities, reinforcement of expectations is limited, checks, walk-downs by managers sometimes they are not conducted.
- Gaps in communication and cooperation between departments are visible, work "in islands", narrow focus on department perspective and performance.
- Extra workload.
- Untimeliness of evaluations of expert from plant departments involved in analyzing.
- Insufficient quality of produced evaluations due to extra workload and lack of management oversight and lack of adherence to procedures.
- The established procedure of analysis of non-recurrent events allows different interpretations of the expected results from the analysis.
- There is no regulation of the procedure for work of the independent commission for summary review of recurrent events.

PO code	Performance objective	Number of AFIs
PI.3	**Solutions Implementation** – Actions to address identified gaps are specific, actionable, measurable and timely, to improve performance.	1

Major deficiencies:

1. **Corrective actions are not always developed with consideration of their sufficiency, timeliness and effectiveness.**
   - The repeat event analysis does not identify the reason why the implemented corrective actions did not preclude the recurrence of the event.
   - Adequacy of corrective actions is not always assessed during their development.
   - Development of corrective actions with no consideration of all the established effectiveness criteria may cause the problem to remain unresolved and recur.

Examples of significant causes:

- Deficiencies in the quality control for event investigation; completeness of identification of the root causes and adequacy of corrective actions is not always ensured and monitored.
- Absence in the procedures of practical guidance to assess the effectiveness of corrective actions and absence of assessment criteria.
- Shortfalls in the training of personnel participating in investigating the root causes of events.

PO code	Performance objective	Number of AFIs
OE.1	**Operating Experience** – Internal and industry operating experience is shared and used to prevent events and improve equipment, worker and station performance.	3

Major deficiencies:

1. **External operating experience is not always systematically applied in the station programs and processes.**
   - The station event investigation process does not always consider external/international operating experience.
   - Selection of information on external events is not performed in a systematic manner.
   - Some key programs and processes such as training and pre-job briefings, do not include international operating experience.

- Insufficient use of external operating experience can result in similar events at the station.

2. **External operating experience is not sufficiently used by the plant.**
   - External operating experience process is mostly focused on learning from national OE, international events often are not used for analysis and corrective action development.
   - Station staff is unfamiliar with the available database that lists all relevant international operating experience.

3. **The opportunities for the use of operating experience are not fully used to preclude significant events.**
   - The internal operating experience program is not fully tracked as regards completeness of identification and reporting of deficiencies, rework, lessons learned from human errors and some external operating experience.
   - Opportunities are missed to identify common problems based on the trend analysis results from various events, and to address those problems in a timely manner.
   - The station does not pay sufficient attention to identification of potential problems and development of proactive actions based on the accumulated internal and industry operating experience.

Examples of significant causes:

- The station and utility procedures do not require to use international operating experience while investigating station events.
- Not clear expectations regarding the activity of department OE/CAP coordinators.
- Not following the written procedures concerning external OE process, extra workload of personnel, lack of management oversight of OE process.
- Missing methodology to incorporate external OE information into training program, SAT (Systematic Approach to Training) project has not been finished.
- Internal and external operating experience is not properly tracked.
- No one is responsible for analyzing the applicability of preliminary event reports and developing preventive actions.
- There is no collective discussion of the proposed corrective actions; an opportunity is missed to identify common issues from the event trending results.
- No analytical methods are in place to identify performance problems; no indicators are obtained from the analysis of significant events.

Conclusions for PI:

In the main area Performance Improvement, 4 AFIs were significant in PR reports and 1 was of repeated/continuing category. The 9 deficiencies could be classified into the following categories:

a) Lack of commitment of plant staff and managers to performance improvement tolerating issues and deficiencies (1)

b) Weaknesses in monitoring and identification of deficiencies (2)

c) Gaps in analysis of weaknesses in plant performance, including comparison with best industry practice (6)

d) Inadequate definition, execution and tracking of corrective actions (2)

Distribution of major causes in the PI main area:

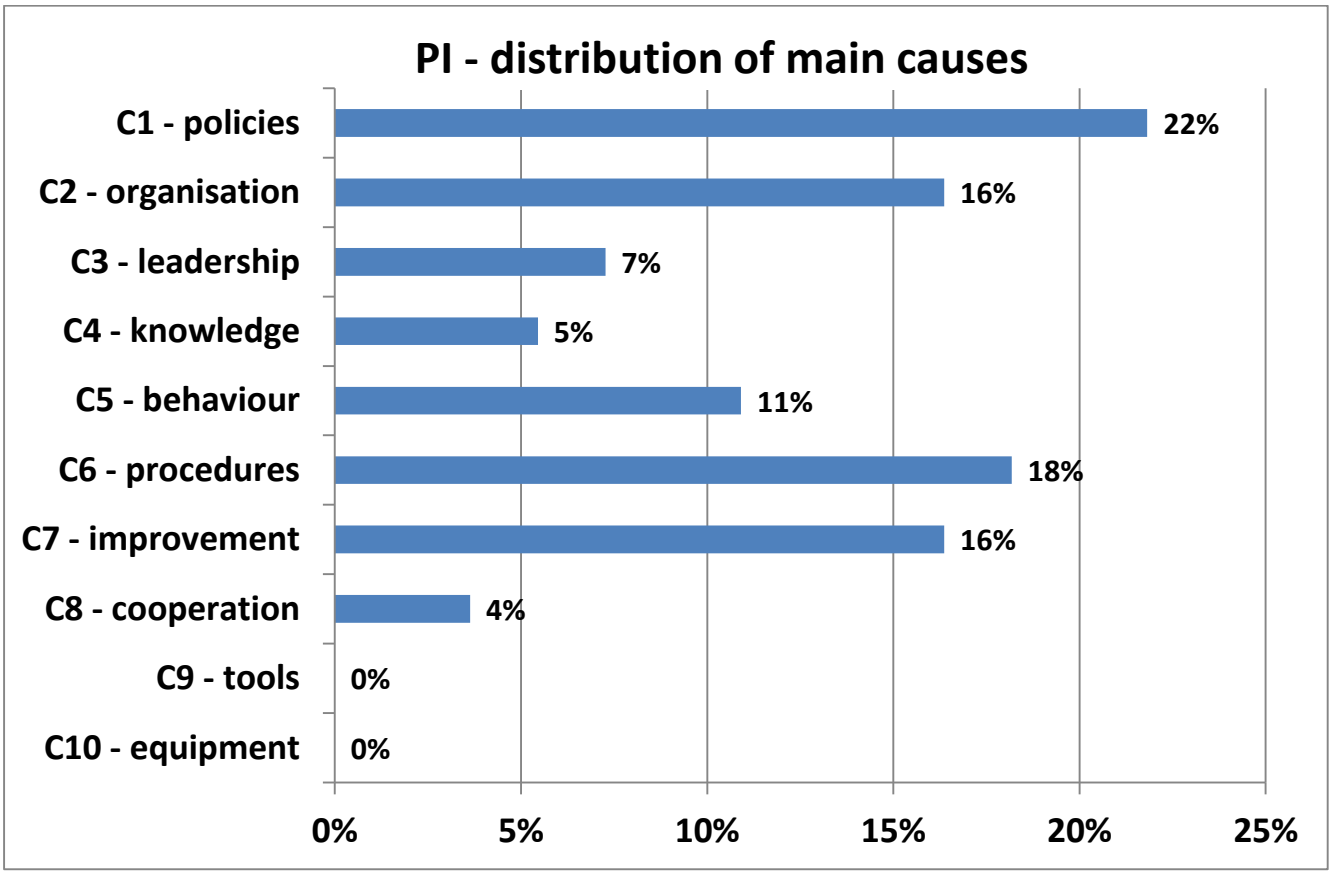

Figure 12: Distribution of PI causes

2.9 Organisational Effectiveness (OR)

This OR main area consists of the following cross-functional areas and objectives: Safety Culture (SC), Organisational Effectiveness (OR), Human Performance (HU) and Industrial Safety (IS). A total number of 9 AFIs (0+5+3+1 respectively) were defined for the OR main area in 2017. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
OR.1	**Nuclear Organisation Structure and Traits** – Responsibility, authority and accountability for nuclear safety and nuclear plant operations are defined clearly, understood thoroughly and implemented effectively. Employees strive continuously to improve performance and exhibit high levels of integrity, accountability and engagement.	2

Major deficiencies:

1. **The existing task observation program does not always promote questioning attitude of workers towards the consequences of their actions.**
   - In some cases, managers conducting field observations do not identify and correct minor behavioral deviations of their staff.
   - Personnel behaviors are not always corrected.
   - The results of task observations are not always effectively analyzed and used.

2. **Roles and responsibilities for the plant safe operation are not always clearly defined.**
   - In some cases roles and responsibilities are not clearly allocated among departments and managers.

Examples of significant causes:

- Personnel do not always follow the established task observation process.
- Insufficient oversight over the task observation process from the management.
- Shortfalls in the process of documenting coupled observations; insufficient analysis (measurability) of the observation results.
- Shortfalls in the measures taken to establish or modify the organizational structure.
- Departmental role descriptions are not updated effectively.

PO code	Performance objective	Number of AFIs
OR.2	**Manager Fundamentals** – Managers control and coordinate station activities and staff the organisation to achieve safe, reliable station operation, event-free outage performance and effective emergency response.	1

Major deficiencies:

1. **Station managers do not always identify and analyze deficiencies and do not always correct personnel behaviors.**
   - In some cases, managers focus on equipment failures rather than on personnel errors.

Examples of significant causes:

- Managers are not aware of the existing problems.
- For events less significant than reportable, the real root causes related to human performance are not determined.
- Managers do not coach their workers, do not use feedback and do not discuss human errors with the workers.

PO code	Performance objective	Number of AFIs
OR.3	**Management Systems** – Management systems are defined clearly, resourced appropriately and implemented effectively to support the vision and goals of the organisation and facilitate the effective integration of risk management.	2

Major deficiencies:

1. **Self-assessment is not always effectively used as a tool to analyze weaknesses and to develop and track corrective actions in a comprehensive and systematic manner.**
   - Some self-assessment reports did not include a problem analysis, suggestions and performance indicators.
   - Corrective actions were developed not for all issues.
   - Shortfalls in self-assessments do not promote identification of performance improvement possibilities in this area.
2. **The station self-assessment program is not developed and implemented accordingly.**
   - There are not clearly defined responsibilities and self-assessment mandatory parts such as good performance, gaps to excellence or proposals for corrective actions.

- It is a missed opportunity to improve station performance, by comparing actual performance to established targets and management expectations, performance of other high-performing organisations, industry standards of excellence and regulatory requirements.

Examples of significant causes:

- Insufficient methodological support for departments in conducting self-assessments.
- Deficiencies in the analysis of self-assessment effectiveness and corrective actions.
- Development and implementation of station level self-assessment program was delayed due to plant management and staff involvement in activities related to unit relicensing.
- The systematic approach is not comprehensive enough.
- Self-assessment system is not sufficiently integrated into the station improvement system.

PO code	Performance objective	Number of AFIs
HU.1	**Human Performance** – Human performance standards and expected behaviours are defined, established and incorporated in an organisation's programmes, processes and training. Leaders reinforce the standards and behaviours to reduce the likelihood for human error and to achieve sustainable, event-free operations.	3

Major deficiencies:

1. **Human error reduction tools are not used consistently at the NPP.**
   - Human performance tools such as pre-job-brief, self and peer checking, and three-way-communication are not always performed in a rigorous manner.
2. **The existing practices of conducting pre-job briefings do not always meet the established station management standards and expectations.**
   - Deviations from the established process for conducting pre-job briefs (PJB) such as not using PJB check lists, conducting PJBs from memory, omitting mentioning of internal and external operating experience, not documenting the PJB items.
   - PJBs are not always provided to all personnel participating in the job.
   -
3. **Station error prevention tools program has not fully been developed at the station (d)**
   - There are neither clearly defined responsibilities regarding error prevention tools, nor responsible person at the station.
   - No document governing area of error prevention tools is applied at the station.
   - Some of error prevention tools are deployed at the station, but not systematically. Shortcomings in the error prevention tools program may increase risks of human errors.

Examples of significant causes:

- A consistent training programme for error prevention tools (EPT) has not been implemented yet
- Lack of observation and coaching and EPT reinforcement from the side of management.
- Workers application of standards and requirements are not sufficient.
- Insufficient visualisation and promotion of EPT to enhance internal communication.
- Personnel underestimate the importance of PJB check lists.
- Personnel overestimate their abilities to conduct PJBs.
- The procedure does not require to have a PJB check list during the conduct of PJB.
- Personnel underestimate the importance of personal presence during the PJB.
- The contents of the PJB check list does not fully correspond to the job to be done.
- System lineup sheets do not specify which PJB check list should be used for this job.

- There is insufficient scope and effectiveness for training of the error prevention tools.
- Management has underestimated the potential of this system as a means of improving performance of station.
- Insufficient visualization of error-prevention tools (posters, booklets, reminders, TV screens).

PO code	Performance objective	Number of AFIs
IS.1	**Industrial Safety** – High standards are maintained for industrial work practices and the work environment to achieve high levels of personnel safety.	1

Major deficiencies:

1. **Station personnel do not always use personal protective equipment.**

Examples of significant causes:

- Personnel working in the RCA are not provided with hard hats, there is no such requirement in the station documentation.
- Station personnel do not realize the importance of using personal protective equipment.
- Insufficient oversight from the managers of how the personnel follow the industrial safety rules.

Conclusions for OR:

In the main area Organisational Effectiveness, 4 AFIs were significant in PR reports and 1 was of repeated/continuing category. The 9 deficiencies could be classified into the following categories:

a) **Ineffective manager in-the-field programme with weaknesses in correcting improper behaviour and in coaching, including use of PPEs (3)**

b) Improper definition of some responsibilities between organisational units/managers (1)

c) Ineffective or incomplete self-assessment programme (2)

d) **Weaknesses in use of human error prevention tools, including pre-job briefs (3)**

Distribution of major causes in the OR main area:

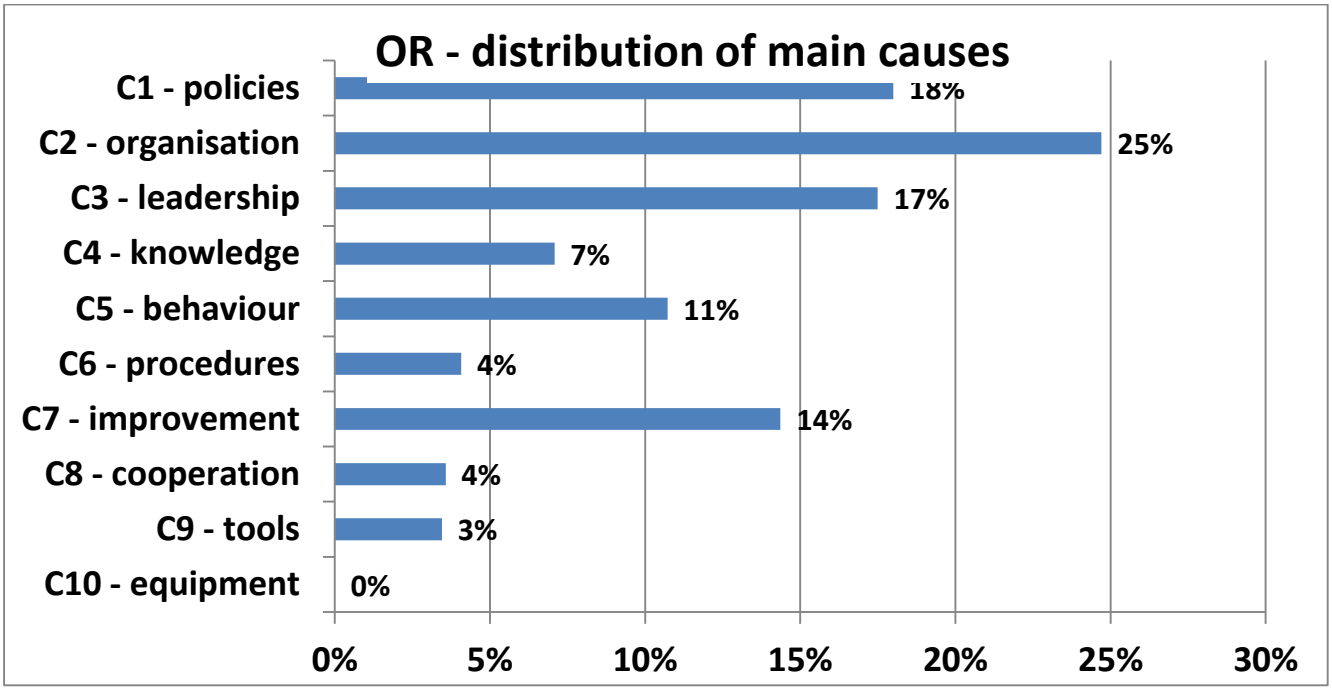

Figure 13: Distribution of OR causes

2.10 Fire Protection (FP)

This FP main area is identical to the cross-functional area Fire Protection (FP) with one objective where 4 AFIs were defined in 2017. The main issues were as follows:

PO code	Performance objective	Number of AFIs
FP.1	**Fire Protection** – The fire protection programme is implemented to provide a high degree of protection to the plant and personnel by preventing, detecting, controlling and extinguishing fires. Design features and programme controls protect structures, systems and components to prevent significant plant damage and operational challenges and maintain safe shutdown capability.	4

Major deficiencies:

1. **Some shortfalls exist in fire prevention measures at the plant.**
   - Fire hazardous work such as hot work sometimes is not strictly monitored.
   - Sometimes temporary electric equipment is not fully disconnected from its power supplies after work.
   - Sometimes fire loads such as temporary storage of inflammable material are not fully controlled.
2. **There are shortfalls in the fire protections systems.**
   - Design solutions implemented for some active and passive fire protection systems do not ensure detection, containment and suppression of fires.
3. **Some combustible materials in the plant are not assessed to minimise the potential for fire ignition and spread (a)**
   - Unauthorised combustible materials, such as wooden boxes and oil soaked matting, were observed throughout the power block.
   - Transient combustibles stored in plant areas that have not been assessed and can increase the potential for fire ignition and fire spread.
4. **Some passive fire protection elements do not ensure physical segregation and containment to minimize fire spread and protect important plant equipment.**
   - Some fire and anti-smoke doors have defects and are not always kept closed.
   - In some cases, fire protective coating is flaked on ventilation systems and metal supports in fire-hazardous areas.
   - Some cable routes are not provided with fire girdles and labeling.

Examples of significant causes:

- Contract workers don't always strictly adhere to the plant expectations and requirements for the conduct of hot work.
- Field inspectors sometimes don't question deficiencies in the field.
- The requirement to disconnect power supply to temporary electric equipment used in the production buildings at the plant is not strictly followed and checked by the inspectors.
- Contractor workers do not always follow plant requirements for temporary material storage
- Shortfalls exist in work management process, contractors' work places are not strictly checked.
- The implemented design solutions for fire protection systems are obsolete. Fire protection components are physically worn due to aging.
- Aging and obsolescence of the passive fire protection systems and components.
- Problems in the functioning of newly-installed fire detecting hardware and wiring with the old detectors.

- The equipment upgrade process is too lengthy due to the procurement and supply complications.
- The Chief Engineer's fire protection responsibilities are not delegated in the job descriptions of his deputies.
- Weaknesses in the corporate process for laydown and storage does of temporary and permanent storage to be assessed for fire risk.
- Staff knowledge and awareness of the laydown and storage approval process is inadequate
- No consistent method and specific tracking of oil leaks and their contribution to fire risk, personnel do not always know the plant expectations how to handle oil absorbent pads
- The operators do not consistently identify deficiencies in the condition of the passive fire protection systems, they do not have sufficient ownership of those systems.
- The station documentation does not fully describe the requirements for keeping passive fire protection components available and operable.

Conclusions for FP:

In the main area Fire Protection, 1 AFI was significant in PR reports and 1 was of repeated/continuing category. The 4 deficiencies could be classified into the following categories:

a) **Examples of extra fire loads, including fire hazardous works (2)**

b) Weaknesses of active and passive fire and smoke prevention systems, including doors (2)

Distribution of major causes in the FP main area:

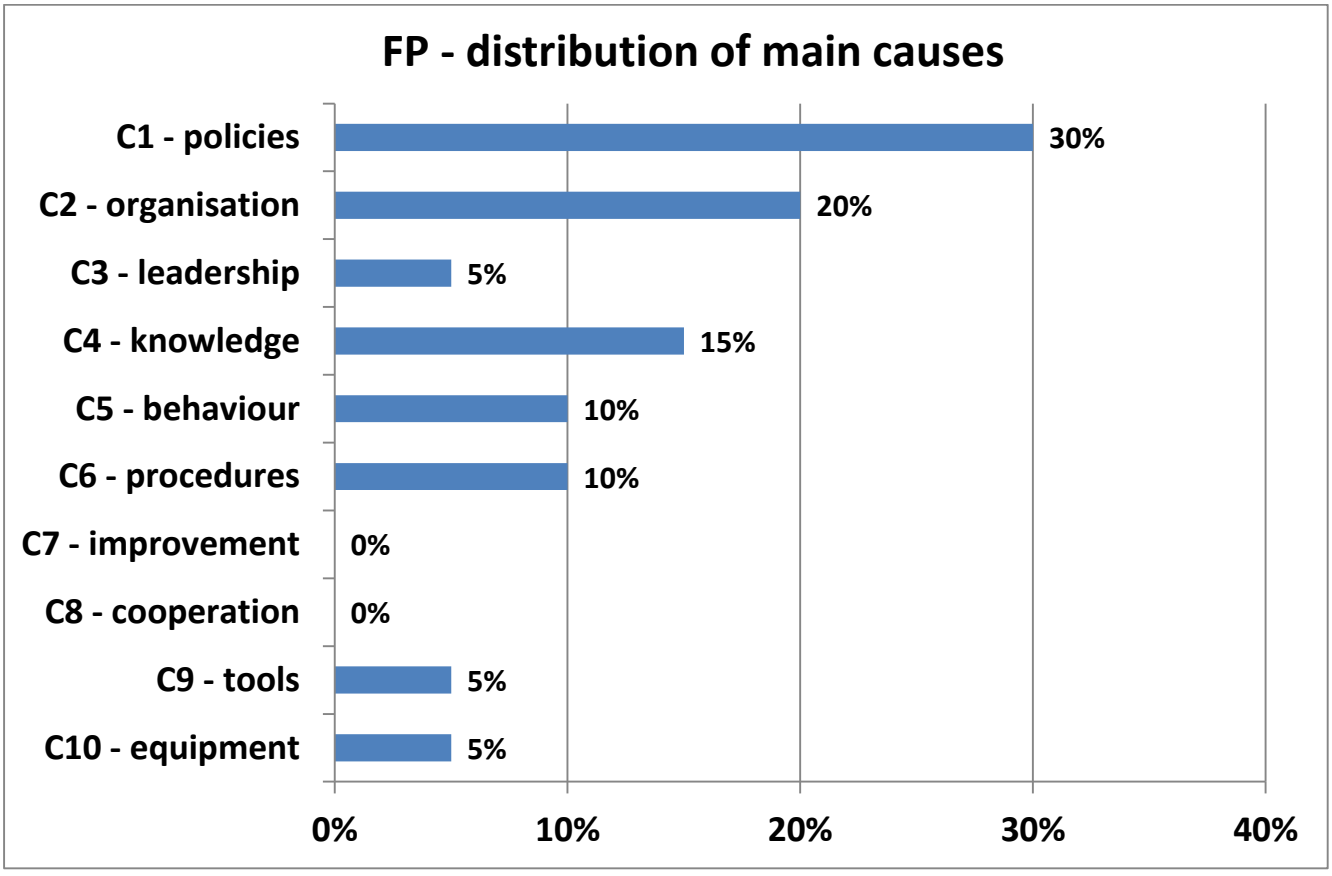

Figure 14: Distribution of FP causes

2.11 Emergency Preparedness (EP)

This EP main area is equal to the cross-functional area Emergency Preparedness (EP) with three objectives. In 2017, 5 AFIs were defined. Their distribution by objectives is as follows:

PO code	Performance objective	Number of AFIs
EP.1	**Emergency Preparedness Leadership** – Leaders align the organisation to prepare for and respond to emergencies, mitigate plant damage and protect the health and safety of on-site personnel and the public.	1

Major deficiencies:

1. **Organizational shortfalls do not make it possible to effectively ensure the station's emergency preparedness.**
   - Emergency preparedness activities are not always assessed for effectiveness.
   - Not all emergency preparedness shortfalls are considered in corrective actions.
   - Walkdowns by emergency preparedness managers are not always performed in a comprehensive and high-quality manner.

Examples of significant causes:

- Shortfalls in the conduct of internal self-assessments by the department.
- During the assessments of the emergency preparedness performance, insufficient focus is given on internal analyses.
- Corrective actions are postponed.
- Shortfalls in providing supplies for the station emergency response activities.
- Shortfalls in the development of documentation.

PO code	Performance objective	Number of AFIs
EP.2	**Emergency Preparedness** – Personnel, plans, procedures, facilities and equipment are tested and maintained ready to respond to emergencies, from minor events to severe accidents.	4

Major deficiencies:

1. **The existing condition and availability of emergency facilities and procedures do not fully support the readiness to respond to emergencies.**
   - There are shortfalls in documentation, radiological and medical monitoring, and communications at the emergency facilities.
   - The quality and completeness of emergency procedures do not fully ensure reliability and availability of emergency response equipment.
   - Deficiencies in the condition of emergency facilities and procedures may reduce the level of emergency preparedness.
2. **There are shortfalls in the condition and completeness of the emergency preparedness facilities and equipment.**
   - There are weaknesses as regards supplies and equipment for the Emergency Control Centre, as well as Shelters Nos. 1 and 3 as regards ventilation and radiological monitoring.
   - Weaknesses during the tests of emergency equipment and facilities.
   - Shortfalls related to support systems for emergency facilities and buildings.
3. **The existing severe accident management program has weaknesses in terms of procedures, documentation, training.**
   - Shortfalls in allocating responsibilities and scope of knowledge including during the operation of emergency equipment.
   - There is no owner of the emergency preparedness process.

4. Not all of post Fukushima corrective measures are fully implemented (a) (b)

Examples of significant causes:

- Insufficient quality of documentation and procedures.
- Insufficient accounting for personnel in the shelters after emergency declaration.
- Monitoring of radiological situation as radioactive cloud is moving.
- Absence of cross-country vehicles to get to destinations without roads.
- During the assessments of the emergency preparedness performance, insufficient focus is given to internal analyses.
- Corrective actions are postponed.
- Shortfalls in providing supplies for the station emergency response activities.
- There are shortfalls in the implementation of the severe accident management program. There is no coordinator or owner for the SAM program. SAM program effectiveness is not assessed.
- Ineffective interaction among departments, no clear allocation of responsibilities for emergency preparedness.

Conclusions for EP:

In the main area Emergency Preparedness, 1 AFI was significant in PR reports and 2 were of repeated/continuing category. The 5 deficiencies could be classified into the following categories:

a) **Weaknesses in EP organisation and management, including assessment, documentation and training (4)**

b) Inadequate status and completeness of technical facilities and equipment, including incomplete Post-Fukushima measures (3)

Distribution of major causes in the EP main area:

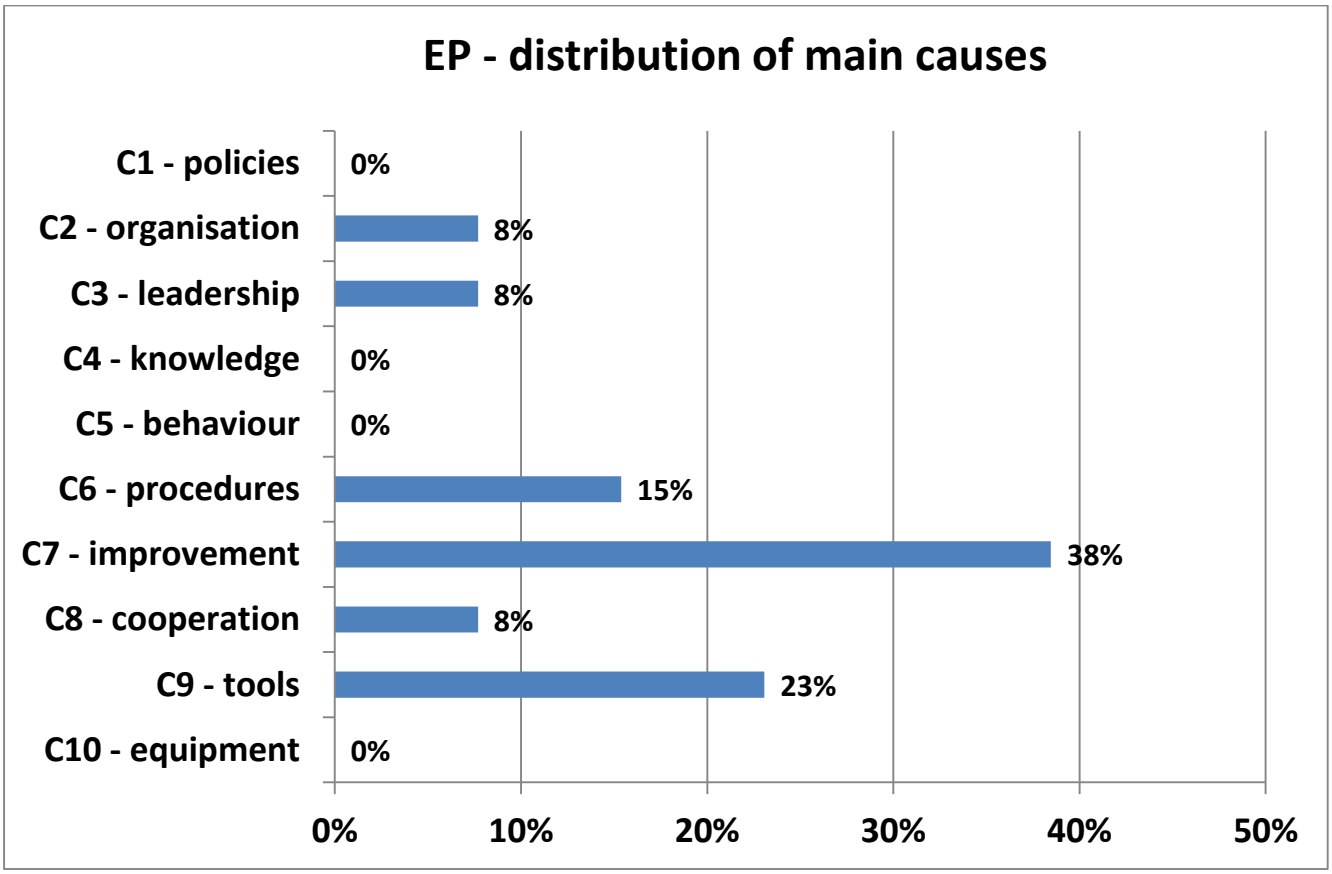

Figure 15: Distribution of EP causes

2.12 Significant and Repeated/Continuing AFIs

The distribution of 27 significant AFIs, given in the PR reports Executive Summaries, is shown in the Figure 16 below:

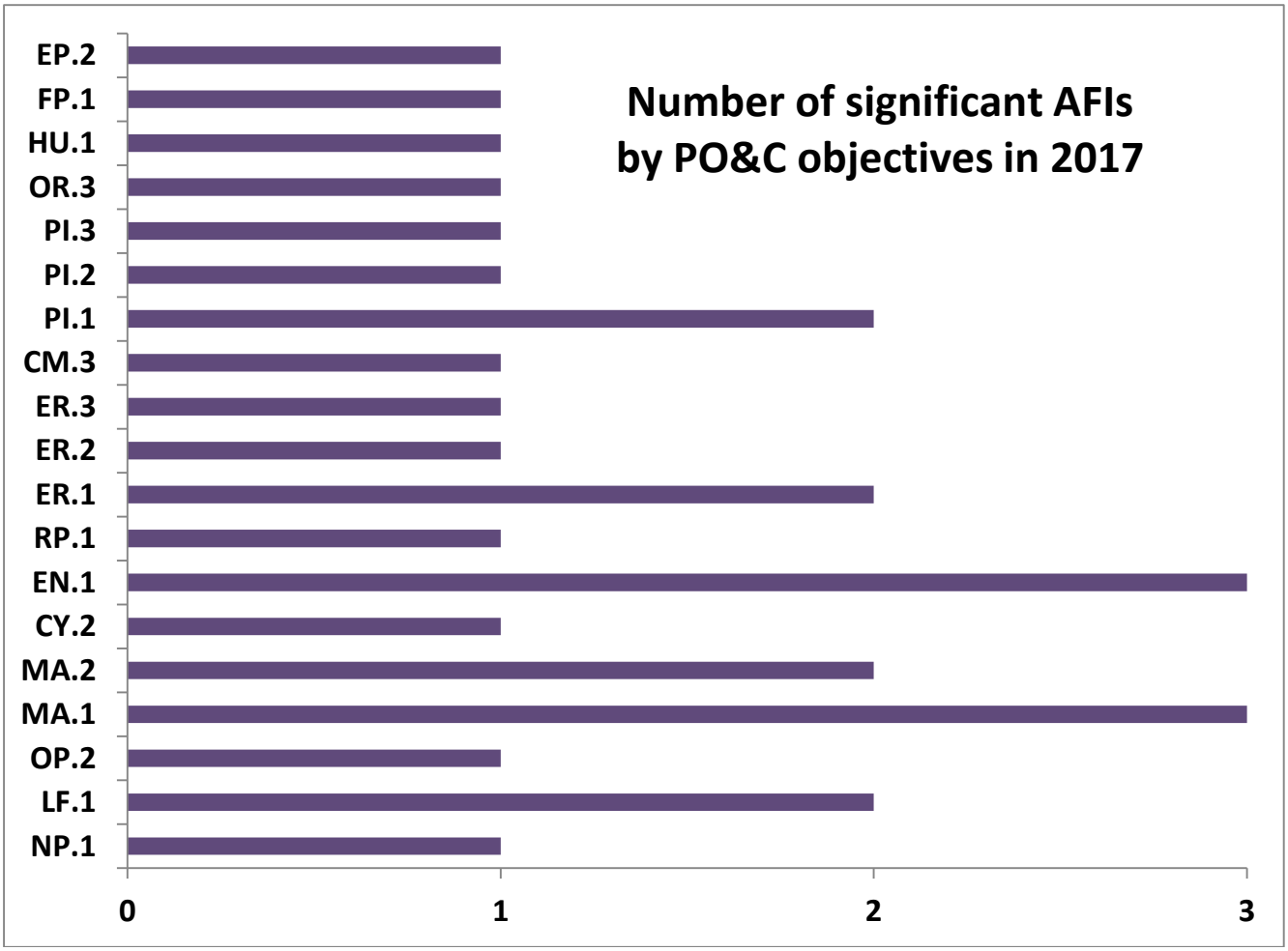

Figure 16: Number of significant AFIs by the PO&C objectives

The highest contribution in the significant AFIs are given by the MA.1 and EN.1 objectives (3 AFIs each), while the LF.1, MA.2, ER.1 and PI.1 objectives had 2 AFIs each in 2017. The first set sometimes demonstrates low standards to maintenance and engineering work practices. The objectives with 2 significant AFIs are related to demonstration of leadership, FME and documentation, monitoring of equipment and cable state, performance monitoring. Unfortunately, the 2 significant AFIs in ER.1 were also of repeated/continuing type. Distribution of significant AFIs by the main PO&C areas can be seen in Figure 17 where also the Engineering (EN), Maintenance (MA) and performance Improvement (PI) main areas give the highest contribution. This confirms consistency between the significant AFIs and the most frequent AFIs.

The distribution of 19 repeat/continuing (R/C) AFIs, is shown in the Figure 17 below:

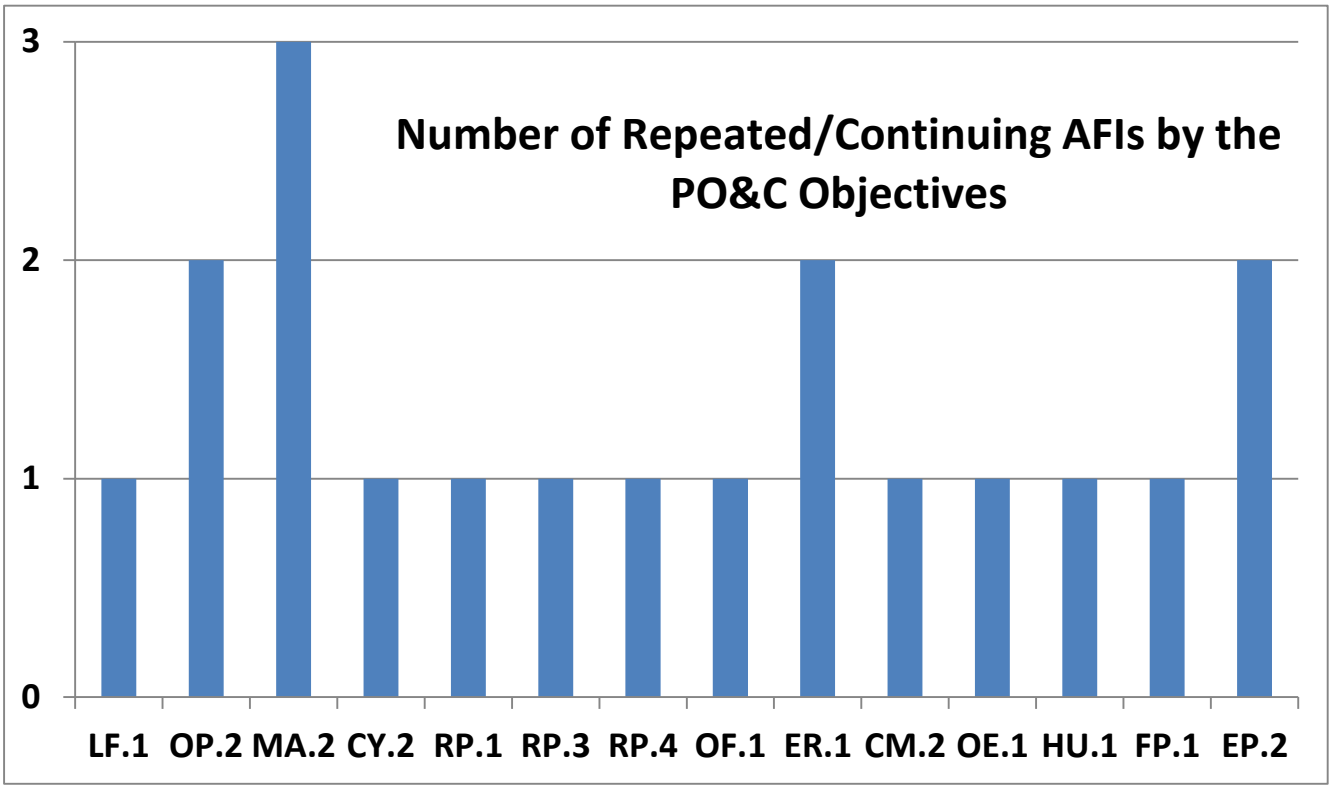

Figure 17: Repeat/Continuing AFIs in 2017

As it was given in the summary in Chapter 1, in 2017 the most challenging areas to resolve previous AFIs were maintenance (3*MA.2), radiation protection (RP.1, RP.3, RP.4), operations and its fundamentals (OF.1, 2*OP.2), equipment reliability (2*ER.1) and emergency preparedness (2*EP.2).

In one case, four AFIs in MA.2, CY.2, RP.4, EP.2 were both of significant and repeated/continuing category. This happened during one peer review at one particular plant which means really challenging to solve these important issues for long time repeatedly for that plant.

2.13 AFI causes

In 2017 during the peer review AFIs at the operating plants, 301 causes were identified for the 78 AFIs – a little less than 4 per AFI in average. Important, that causes and contributors were defined/developed basically by the plant counterparts with the WANO team members' support. In this study, the causes were classified into ten categories to find more common and deep weaknesses. The following table gives the cause categories where AFI causes were classified and also those main PO&C areas for each cause where the ratio of the given cause category was the highest:

Cause Code	Cause description	Highest in
C1	Policies: requirements, expectations, standards and priorities are not established or not clearly defined, weak utility support	FP (30%)
C2	Organisation: deficiencies in processes, management, work conditions, control of plant and contractors' activities	EN (29%)
C3	Insufficient management control, observation and coaching of their staff, expectations are not reinforced, gaps in feedback	FO (31%)

Cause Code	Cause description	Highest in
C4	Insufficient personnel knowledge and skills related to deficiencies in training, qualifications or communication of expectations	FO (31%)
C5	Inadequate behavior of plant staff: complacency, lack of motivation, ownership, consideration of risks, missed procedures and requirements adherence	OP (24%)
C6	Procedures are not developed or deficiencies exist in quality and completeness of the current procedures	CY (38%)
C7	Missed opportunity to improve performance, use of operating experience, weaknesses in identifying issues, problem analysis and corrective action plan	TR (67%)
C8	Deficiencies in cooperation and communication, department interactions, team work, narrow view on problems, lack of responsibility for the entire plant	CY (15%)
C9	Missing or inadequate technical equipment, tools and facilities, weaknesses in material control	EP (23%)
C10	Equipment aging with inadequate management of long term operation, weaknesses in design or ergonomics	EN (6%)

Distribution of all AFI causes given in the PR reports can be seen in the figure below:

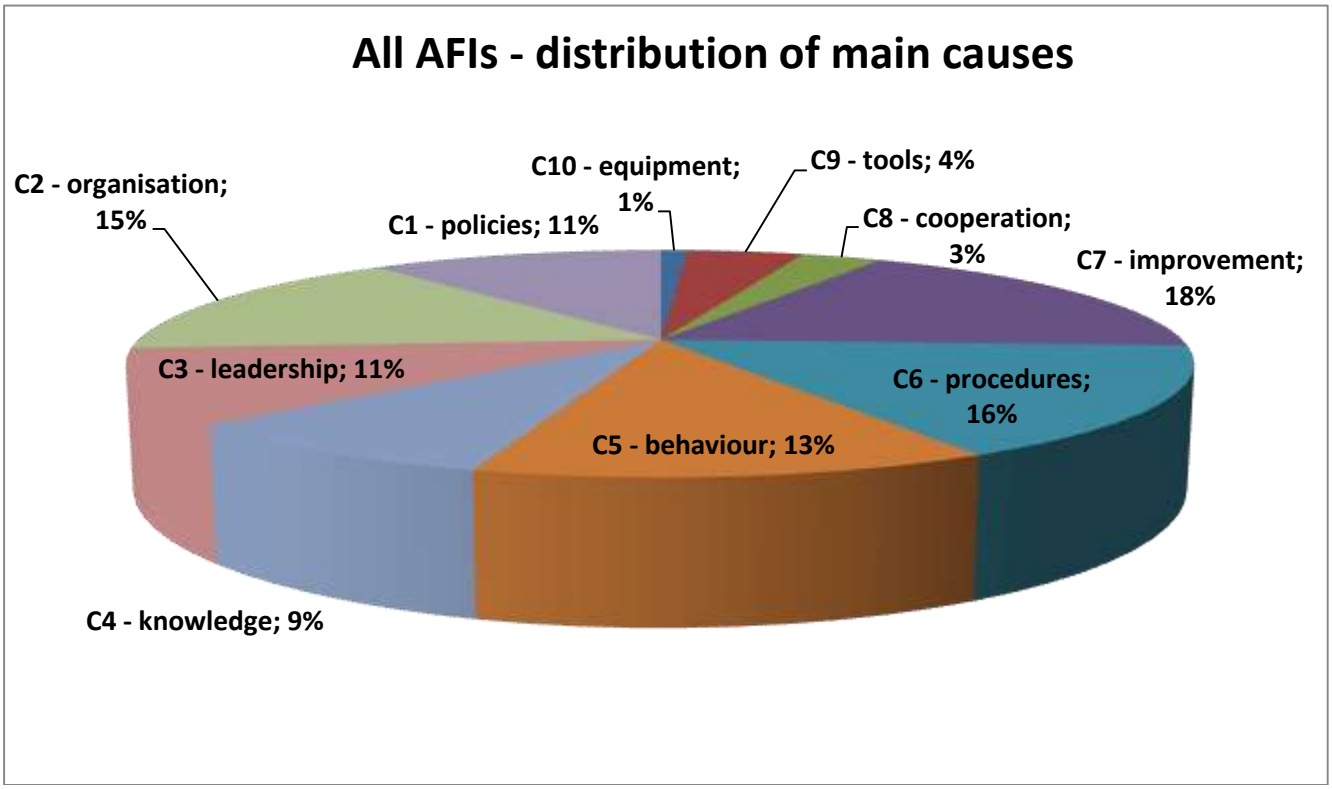

Figure 18: AFI causes in 2017

The most significant causes contributing to performance weaknesses (AFIs) were:
- missed opportunity to improve performance (C7)
- procedure deficiencies, sometimes missing requirements (C6)
- weaknesses in organisation, management and processes (C2).

The following causes visibly contributed to AFI weaknesses as well:
- inadequate staff behavior (C5)
- unclear or not communicated policies, expectations, standards and priorities (C1)
- insufficient management control (C3).

2.14 Status of Nuclear Safety Culture (NSC)

During peer reviews, the WANO team members assess the level of the nuclear safety culture (NSC) in accordance with the WANO Principles PL 2013-1 'Traits of a Healthy Nuclear Safety Culture'. The table below represents the results of NSC assessments related to the traits based on the peer review assessments in 2017. The following assessment levels were used for the analysis of traits: (strongest - +2, strong - +1, weak - -1, very weak - -2, weakest - -3). The results in the table represents NSC assessment in all operating PRs in 2017.

Traits of a Healthy Nuclear Safety Culture	Scores	Order
PA - Personal Accountability	4	3.
QA - Questioning Attitude	-14	**9.**
CO – Safety Communication	6	2.
LA - Leadership Accountability	-2	7.
DM – Decision-Making	1	4.
WE – Respectful Work Environment	9	1.
CL - Continuous Learning	0	5.
PI - Problem Identification and Resolution	-18	**10.**
RC – Environment for Raising concerns	0	5.
WP - Working Processes	-5	**8.**

Consequently, the strongest NSC traits were WE (Respectful Work Environment) and CO (Safety Communication) which reflects open exchange of information about issues and problems inside the organisations. The weakest traits were as follows: PI (Problem Identification and Resolution), QA (Questioning Attitude) and WP (Working Processes). These weaknesses point at issues in questioning the unknown, identification of problems and willingness to improve processes. This is consistent with the most frequent cause of AFIs (missed opportunity to improve performance) and demonstrates a visible room for improvement in the PI and OE area.

3. Assessment results of the pre-startup peer review AFIs

In 2017, the WANO MC conducted three pre-startup peer reviews (PSUR) using the PO&C 2013-2 WANO Pre-startup Performance Objectives and Criteria with 49 objectives in 13 areas. During these three PSUR reviews, 26 (10+6+10) AFIs were defined by the WANO teams. Distribution of PSUR AFIs by the PO&C 2013-2 areas can be seen in the following figure:

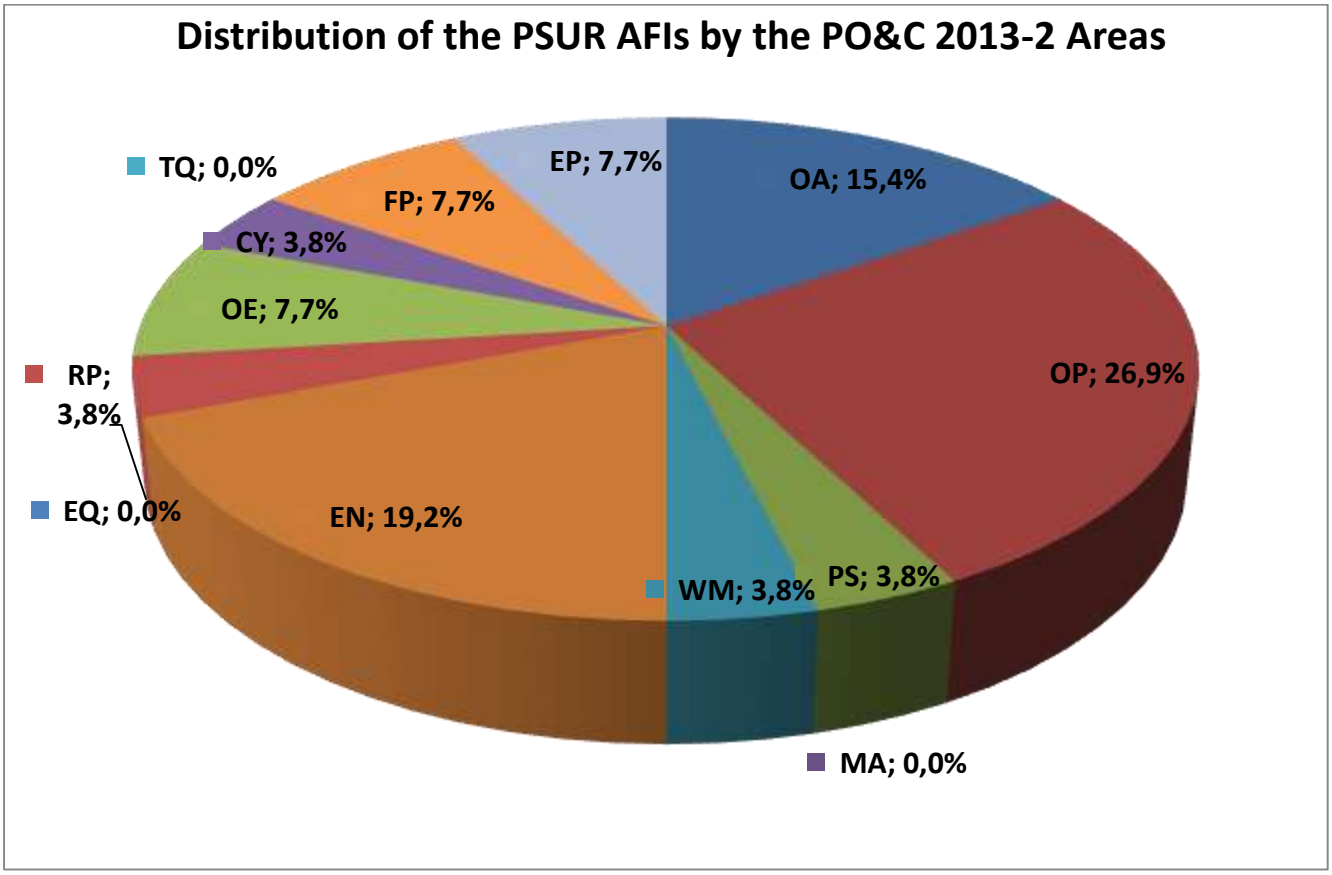

Table 19: Distribution of pre-startup AFIs by the PO&C 2013-2 areas

It is visible that three areas – Operations, Engineering and Organisation and Administration – provides the highest contribution to PSUR weaknesses, more that 60% total. This is understandable: readiness of a new nuclear unit to safe operation largely depends on organisational and management factors, proper structure and responsibilities, management commitment and staff knowledge to operations conditions as well as engineering management. Emergency preparedness, fire protection and use of operating experience had also mentionable weaknesses.

AFIs required to be resolved before start-up of a new unit are called 'start-up related' (SUR). During the three PSURs, 9 AFIs were start-up related in 5 PO&C areas as follows:

No.	SU Related AFI (Objective)	Number
1	OR.1 - Organisational Structure and Responsibilities	2
2	OP.1 - Operations Management and Leadership	1
3	OP.3 - Operator Knowledge and Skills	2
4	EN.5 - Reactor Engineering and Fuel Management	2
5	FP.1 - Fire Protection Management and Leadership	2

The SUR weaknesses strongly confirm the importance of proper organisation, processes and responsibilities, management commitment and oversight, knowledge of staff, foreign material exclusion for nuclear fuel.

The causes more relate to organization, management and human weaknesses such as:

- More attention to construction works, lack of resources, delay in technology installation
- Insufficient coordination, cooperation, communication between organizations
- Not clear expectations, lack of management oversight, more commitment to construction and commissioning milestones thus delay in change/turn-over to operation
- Staff behaviour weaknesses, not completed mindset change from construction to operation, lack of ownership, housekeeping and FME weaknesses

- Gaps in or incomplete procedures, lacks in their adherence
- Gaps is knowledge to new technologies, design, incomplete training and preparedness of staff and management to manage and operate
- Weak use of external experience for new units, understanding of differences of the new design
- Weaknesses in problem identification and corrective action plan.

4. Assessment of the follow-up peer reviews

During follow-up peer-reviews, results of implementation of corrective actions focusing on the AFIs are assessed. Thus, AFIs receive evaluation in four categories according to the new performance level approximately two years after the main review. In 2017, during seven FUPRs 96 AFIs were assessed out of 98 (during a FUPR the WANO team did not review two AFIs). The performance results can be seen in the following figure:

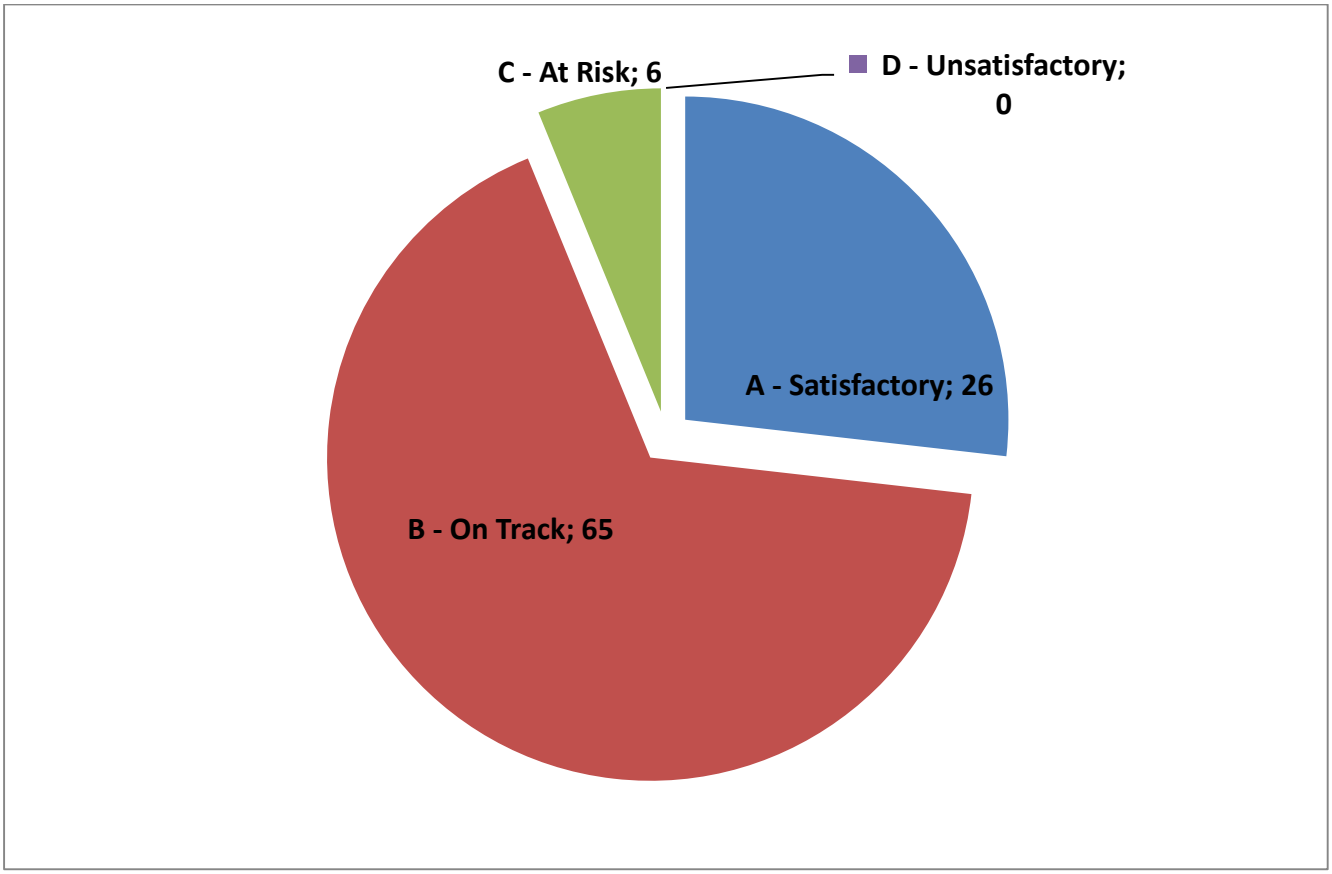

Table 20: Distribution of AFIs by implementation categories of corrective measures

More than two third of AFIs were classified as A – Satisfactory, more than a forth as B – On Track. Areas with highest number of AFIs rated as "B" were MA, OR, PI. The six areas with AFIs rated as "C" were of OF(NP), TR, OF, RS, OE and EP. Thus, these areas had more challenging issues (AFIs) to solve.

5. Conclusions

The overview of AFIs and their causes for operating plants, newly commissioned units as well as state of AFIs during follow-up reviews is presented by WANO Moscow Center in this document to identify significant common issues and direction of member support. Results of peer reviews, precise definition of areas for improvement are significantly depends on the plants' understanding of the peer review goals and principles as well as their open attitude.

The main issues from the analysis of AFIs during peer reviews of operating plants were:

- Leaders do not demonstrate commitment towards safe work practices by their own example.
- Weaknesses in walk-downs and monitoring of equipment state.
- Inadequate maintenance practices.
- Weaknesses in monitoring of chemistry parameters.
- Lack in systematic monitoring of equipment status, collection and analysis of reliability data.
- Weaknesses in risk management in configuration management, planning, implementation and tracking of modifications.
- Inadequate efforts to control of high dose zones and to prevent radiation spreading.
- Improper plant practice in adequate measuring and reducing staff dose exposure, lack in following rad protection standards.
- Weaknesses in planning of training.
- Gaps in analysis of performance weaknesses, including comparison with best industry practice
- Ineffective manager in-the-field programme with weaknesses in correcting improper behaviour and in coaching, including use of PPEs.
- Weaknesses in use of human error prevention tools, including pre-job briefs.
- Examples of extra fire loads, including fire hazardous works.
- Weaknesses in EP organisation and management, assessment, documentation and training.

The most frequent significant AFIs were MA, EN/ER, PI and LF related. The repeat/continuing AFIs were MA, OP, ER and EP related.

Among causes the following common factors are visible:

- Missed opportunity of performance improvement.
- Deficiencies in processes, managers' reinforcement and oversight.
- Inadequate behavior of plant staff, insufficient knowledge.
- Missing, incomplete procedures or their low quality.

According to the WANO teams, the weakest nuclear safety traits were as follows:

- PI – Problem Identification and Resolution
- QA – Questioning Attitude
- WP – Working Processes

Results of the pre-startup reviews demonstrate weaknesses in

- change from construction to operations
- ownership for operation
- establishment of proper new organisational processes
- commitment of management to turn-over
- foreign material exclusion for nuclear fuel.

Here the start-up related AFIs can mostly be connected to OR, OP, EN and FP areas.

It should be emphasized, that the number of AFIs identified during peer review is not an indicator about plant performance. The significance of each specific AFI on plant safety and reliability is important, as well as the success of corrective measures in resolving those issues. The analysis results provided here can be used by the WANO-MC office managers to improve the PR programme as well as by member plants and organisations (utilities) to improve plant performance.