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Machine Performance Sustainability Design With Overall Measure Of Maintenance Performance (OMMP) *And Integrated Environment Performance Measurement System* (IEPMS)

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Keywords:
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Abstract

Analisis efektivitas komprehensif sistem pemeliharaan instalasi pengolahan air Sampai saat ini, *Integrated Environmental Performance Measuring System* (IEPMS) dan *Overall Maintenance Performance Measuring Process* (OMMP) telah menjadi standar yang digunakan dalam mengevaluasi kinerja lingkungan, sehingga integrasi yang baik antara kedua sistem ini menjadi sangat penting. Tujuan dari penelitian ini ialah Bagaimana PT. B, B, C menilai efektivitas pemeliharaannya, kemudian bagaimana pengevaluasian kinerja lingkungan dari air yang diproduksi dan air limbahnya. Serta penentuan Indikator kinerja pemeliharaan instalasi pengolahan dan air limbah PT. Penelitian berikut mempergunakan deskriptif. Berdasarkan hasil penelitian ini, menghasilkan kesimpulan Penggunaan metode OMMP, PT ABC *Offshore* memiliki kinerja perawatan secara keseluruhan sebesar 5,388, yang menunjukkan tingkat kinerja perawatan yang tinggi. Berikutnya waktu henti peralatan, jam operasi, dan jam kerja darurat. Terakhir, Kinerja lingkungan perusahaan seluruhnya mendapat skor 9,57 dengan masuk zona hijau dan mengindikasikan bahwa PT ABC *Offshore* memenuhi target pengendalian kinerja lingkungan selama 12 bulan. Hasil *Root Cause Analysis* (RCA) menunjukkan bahwa hanya 1 KEPI yang masih berada di zona hati-hati dan disarankan untuk diperbaiki.

Keywords:
Machine Performance;
Overall Measure of Maintenance Performance (OMMP);

Abstract

Comprehensive effectiveness analysis of water treatment plant maintenance systems To date, the Integrated Environmental Performance Measuring System (IEPMS) and the Overall Maintenance Performance Measuring Process (OMMP) have become the standards used in evaluating environmental performance, so good integration between these two systems is very important. The purpose of this study is how PT. B, B, C assesses the effectiveness of its maintenance, then how to

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Environmental Performance Measurement System (IEPMS);

evaluate the environmental performance of produced water and wastewater. As well as determining the performance indicators of the maintenance of the treatment plant and wastewater of PT. The following research uses descriptive. Based on the results of this study, it concludes that using the OMMP method, PT ABC Offshore has an overall maintenance performance of 5.388, which indicates a high level of maintenance performance. Next is equipment downtime, operating hours, and emergency working hours. Finally, the company's overall environmental performance scored 9.57 by entering the green zone and indicating that PT ABC Offshore met the environmental performance control target for 12 months. Root Cause Analysis (RCA) results show that only 1 KEPI is still in the caution zone and is recommended for improvement.

1. INTRODUCTION

In the process of oil and gas production both in onshore and *offshore* fields, there is also produced water that flows out together with crude oil, the amount of which varies between 10-70% and natural gas ranges from 1-5% in each well.

A common problem experienced in oil and gas processing that has been operating for a long time is the disposal of waste that does not meet the quality standard requirements. Where in Permenlh no.19 of 2010 the oil and grease content of produced water for exploration and production facilities in the oil and gas industry is allowed to be 25-40 mg/l.

Table 1. Quality standards of permenlh no.19 of 2010 wastewater from oil and gas processing facilities

No	Type of wastewater	Parameters	Measurement	Measurement method
1	*Offshore* produced water	Oil and Fat	40 mg/L	SNI 06-6989.10-2004
2	Onshore produced water	Oil and Fat	25 mg/L	SNI 06-6989.10-2004
		TDS	4 ppt	SNI 06-6989.27-2004

The negative impact of the poor quality of produced water waste is the emergence of environmental pollution, especially polluting water and soil so that people who live around processing facilities can be exposed directly from their water or from the food they consume.

One aspect of the industry that needs attention is the aspect of machine maintenance. Therefore, for the smooth running of an industry, good machine maintenance is necessary. Machine maintenance where in simple terms, maintenance is everything that is done to the facility to keep it functioning and ready to use at any time.

PT ABC's processing unit has been operating for a long time making performance decrease due to the age of equipment, components, and maintenance management that is less than optimal so that it affects the poor quality of waste discharged into the environment.

Table 2. Average oil and fat content values of PT ABC from June 2021 to May 2022.

Period	Hydrocyclone V-2701 Outlet (mg/l)	Hydrocyclone V-2711 Outlet (mg/l)	Hydrocyclone V-2702 Outlet (mg/l)	Hydrocyclone V-2712 Outlet (mg/l)
June 2021	41.5	39.0	31.4	36.8
July 2021	21.8	46.7	35.3	42.4
August 2021	24.8	33.3	39.7	24.1
September 2021	27.5	34.1	64.7	27.4
October 2021	29.4	42.4	37.0	21.2
November 2021	32.4	31.4	38.9	36.6
December 2021	37.5	32.9	30.8	48.5
January 2022	38.4	36.6	31.3	30.1
February 2022	38.2	41.0	35.7	33.8
March 2022	32.4	26.8	39.1	36.5
April 2022	39.1	31.1	47.4	37.8
May 2022	49.9	33.6	30.4	44.6

From table 2. it can be seen that of the 4 hydrocyclone units monitored for 12 months there are those where the unit provides waste products that do not meet quality standards, so that emergency maintenance or unplanned maintenance is carried out on the unit. If this happens often, it will certainly cause losses to the company due to maintenance costs that continue to increase. Recorded downtime hours recorded for 1 year on each unit can be seen in

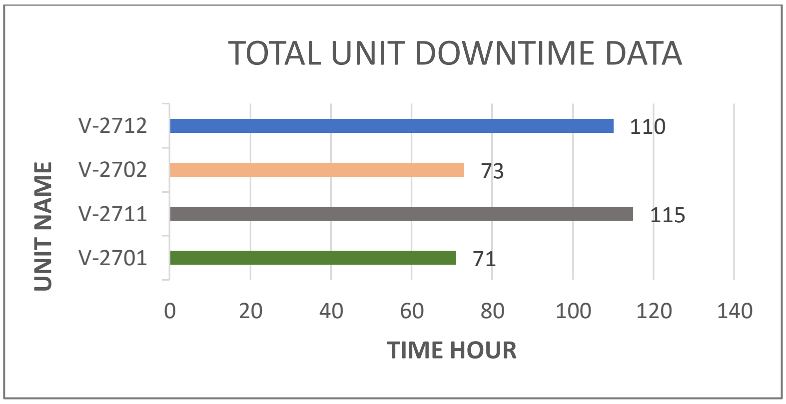

Figure 1. Total hours of unplanned downtime of the machine is 369 hours.

Unit breakdown data June 2020-May 2021 ri figure 1. it appears that the four hydrocyclones have high unpplanned downtime, many factors affect the length of downtime such as the level of damage, availability of spare parts, external conditions etc.. That way downtime is one of the most important indicators in measuring performance in the production process.

Some of the failures that occur in the treatment system that cause low effluent quality include:
First, the formation of sludge oil in the processing system, this is due to the flow of wastewater that has a high oil and sediment content. Exceeding the standards set by the manufacturer.
Secondly, failure of the liner component in the hydrocyclone vessel causes a lack of liner performance in separating the oil phase and oil particles in the wastewater. Failure of the reject oil valve, the oil separation results from the liquid waste then flow into reject oil and then continue to the oil phase process. However, leaks in the valve sometimes occur and result in the separated oil phase eventually re-entering the system. Application of procedures that are not in accordance with the standard operating system unit such as working pressure, working temperature and so on.

Research (Herdanarpati & Achmadi, 2022) on "Analysis of productivity improvement of exploration drilling machine units with the total productive maintenance (TPM) method, OEE and OMMP tools". The study found that the OEE value and OMMP value were still below the specified standard. The results of the calculation of the Six Big Losses for all units are Reduced Speed Losses and Equipment Failure Losses and are suggested in TPM improvements to be able to increase the application of Initial phase Management, Education & Training, Autonomous Maintenance, and Planned Maintenance. The results of research from (Cahyono et al., 2021) on analyzing maintenance activities with RCM and OMMP methods on Corrugator type H-200 machines with the use of FMEA, KPI, Pareto Diagram, and Risk Priority Number (RPN) tools. The results obtained obtained downtime of 28 hours or 1680 minutes in March 2020 and is a large enough result for the company. Meanwhile, (Sugiharto & Basuki, 2022) conducted research on mitigating operation and maintenance failures using the OMMP and Multi-attribute failure mode analysis (MAFMA) approaches, the results obtained were the identification of various main factors of failure in the STP operation and maintenance system, the causes of failure were ammonia content in effluent, equipment breakdown, and overflow of limbeh water in the sump pit, the recommendations provided were several additional proposals related to procedures for STP operation and maintenance.

Furthermore, from (Khoiriyah & Fatmawati, 2019) in his research measuring environmental performance in the batik industry in the city of Rembang using the IEPMS method and its tools, namely AHP, KEPI and OMAX, has obtained a total achievement value that is in the red zone or poor performance, so some improvements need to be made to the batik industry. Kurniawan et al. (2017) examines the design of an integrated environmental performance measurement system (IEPMS) in hospitals where the tools used are (TLS) Traffic Light System, AHP, Expert Choice, KEPI, and OMAX, the results of this study obtained a performance achievement value of 7687. Improvements are needed at points that fall into the red category. Then research

(Setiawan et al., 2019) which also designed environmental performance at the WWTP of a textile company using the IEPMS method, the result is that the performance achievement of the textile company is in the green category (81.25%) which means that KEPI is carried out as expected by the company.

The maintenance program that has been implemented at PT ABC is reactive maintenance, preventive maintenance of instruments, and preventive maintenance in the waste treatment process, but in the implementation of maintenance there are still frequent cases of poor quality output from processing, There are 4 units operating 24 hours non-stop every day and have 1 back up unit for emergencies such as maintenance on the main unit or if there is a sudden breakdown. This waste treatment unit is very important to pay attention to so that the effectiveness and efficiency of the treatment process can be achieved, especially the quality of the waste itself.

Based on the problems that have been described, a comprehensive performance measurement is needed to evaluate the processing unit maintenance system that has been operated by measuring performance through the Overall Measure of Maintenance Performance (OMMP) method and the Integrated Enviromental Performance Measurement System (IEPMS) method to become a reference for environmental performance assessment systems and to explain why their effective integration is so important, we present the following document (Setiawan et al., 2019). According to (Anggraeni & Nugroho, 2013) Researching environmental performance indicators is currently very important to develop methods for monitoring environmental impacts as a Key Environment Performace Indicator (KEPI), while for weighting it is carried out through the Analytical Hierarchy Process (AHP) method which carries out comparisons on the intensity level of critical importance.

The application of this method is expected to find out the indicators that cause the maintenance system to be hampered and then repaired to improve the performance of the produced wastewater treatment unit so as to achieve the strategic goals that have been set in a sustainable manner and can maximize environmental performance.

So the purpose of the following research is to assess the performance of the sewage treatment unit maintenance process, environmental performance and determine the performance indicators of the maintenance of the PT. ABC sewage treatment unit.

2. METHODS

The following research carries a method with the arrangement or stages of the process used to solve a problem, therefore research must have a clear target direction to achieve targets and goals.

The type of research conducted is descriptive research, which is to explain objectively about the maintenance system by collecting a number of data and processed using methods that are determined based on the reality that occurs in the field which is then evaluated the performance of the maintenance system and also the output produced for proper decision making by the authorities.

This research was conducted at PT ABC which is engaged in oil and gas refining, while this research focuses on the produced wastewater treatment area, the research implementation time is from March to September 2022.

The selection of research objects is determined intentionally. Purposiveness itself means intentionality, i.e. the selection of objects is based on the objectives to be achieved, not based on a hierarchical system, random system or other systems. Purposiveness is a technique to identify a subject of study through special considerations that make it worthy of being the object of study. Sources that can provide information are deliberately selected to be relevant for a particular purpose. Thus, the research topic will be directly identified and related to the research questions and objectives.

The research subject is a hydrocyclone, which is a water treatment device that produces water before it is discharged into the environment. In addition to the wastewater produced, some data used to determine the quality of the waste include: oil and fat content, total dissolved solids (TDS) and iron content.

3. RESULT AND DISCUSSION

Maintenance Analysis Work

There are several actions that need to be taken in the study of measuring the maintenance performance of PT ABC Offshore's water treatment unit. The first step is to use the Overall Measure Maintenance Performance (OMMP) technique to examine the company's maintenance issues, and the second is to verify the Key Performance Indicator (KPI) based on current business conditions. 16 of the 23 KPIs that will be used to assess the company's maintenance performance have been verified by the company. Six of the 16 KPIs are related to maintenance administration, six are related to maintenance effectiveness, and four are related to maintenance costs.

Analytical Hierarchy Process (AHP) software and Expert Choice were used in the second stage of this research to weight each Key Performance Indicator (KPI). The first step in creating AHP is to use a pairwise comparison matrix to compare the relative relevance of each viewpoint, dimension, and KPI. Thus, Preventive and Predictive Maintenance has the largest weight of 0.559, followed by Scheduling Degree, Breakdown Repair Hours, and Maintenance Cost per Production Unit which each have a weight of 0.5, while the KPI, Overtime, has the lowest weight of 0.089. 0,089.

In this third step of the analysis, the performance value for each OMMP indicator is measured based on the company's historical data from May 2021 to June 2022. The Objective Matrix (OMAX) was used to calculate the performance evaluation according to the formula for each indication in the OMMP technique. The calculation shows that there are 6 KPIs in the green zone which indicates that the zone is safe and has reached the company's target, 6 KPIs in the yellow zone which indicates that the indicator has not been achieved but is close to the set target, and 4 KPIs that are in the green zone which indicates that the zone is safe and has reached the company's target. There are 4 KPIs in the red zone, indicating that the indicator is still far below the predetermined target and needs to be improved as soon as possible.

Objective Matrix (OMAX) and Traffic Light System (TLS) were used to measure the overall maintenance performance in the fourth and final stage of the study. The calculations show a total performance index value of 5.388 which is in the yellow zone and indicates that while the company has met the targets and the maintenance performance value has not been achieved, there is still a need for immediate improvement on each indicator in the red zone.

Recommendations for Improving Maintenance Performance

After calculating and evaluating maintenance performance, the next step is to provide improvement suggestions to evaluate each Key Performance Indicator (KPI) that is in the red zone because it has a value that is far below the company's target and urgent improvement is needed. Examples of these KPIs include Breakdown repair hours (KPI), Equipment downtime due to breakdown (KPI), Operating duration (KPI), and Emergency work hours. The assessment and suggestions for each KPI that is in the danger zone are listed below.

Breakdown repair hour.

This statistic is intended to measure the amount of time spent on breakdown maintenance tasks. The value of the breakdown repair hours index is calculated by multiplying the overall maintenance time by the amount of time required for breakdown maintenance operations. The indicator value is calculated as follows. Based on table 2, the KPI for damage repair hours has reached a value of 64% but has not yet reached the maximum desired value of 50%. Many factors contribute to the low value of Breakdown KPI repair hours; *Root Cause Analysis is* shown in Figure 2.

Figure 2. *Root Cause Analysis* on Breakdown repair hour

Root Cause Analysis in Figure 2 shows that the high value of KPI Breakdown Repair Hours is due to the slow availability of component spare parts because these spare parts are very difficult to obtain so it takes a long time to reach the installation location of the unit. Another contributing factor is the lack of attention to identifying component damage because the maintenance team does not have enough time due to maintenance schedules in other units. Based on the problems that have been described, improvement recommendations have been given, namely.

1. Perform spare parts inventory planning

A robust machine maintenance history should be used to refine parts inventory planning to make it more effective. When components regularly break down and their procurement takes a long time, it is important for the company to create a parts inventory according to the schedule determined by the team supervisor.

2. Provide monitoring plan

Providing this monitoring plan is very necessary to make it easier for the maintenance team to find out component damage early. And can make maintenance work more efficient

Equipment downtime caused by breakdown

This indicator shows how much production machine downtime is due to breakdown-related failures and unavailability. The indicator value is calculated as follows. Based on the KPI Table, the maximum target of 60% has not been achieved, with equipment downtime due to breakdowns reaching a value of 64%. Many factors contribute to equipment downtime due to failure; *Root Cause Analysis is* shown in Figure 3.

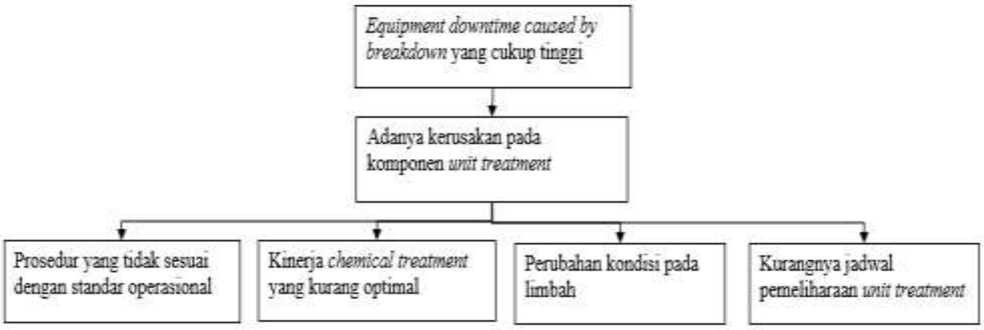

Figure 3. *Root Cause Analysis* on Equipment downtime caused by breakdown

Root Cause Analysis in Figure 3 shows that the high value of KPI Equipment downtime caused by breakdown is certainly caused by failures in each component, the factors are operational procedures that are not according to standards, frequent unplanned shutdowns, poor chemical treatment performance, and waste conditions that often change. The following are recommendations for improvement.

1. Running the water treatment system according to standard procedures
   Operation according to standard procedures is very important for the smooth running of the waste purification process. Some things that are important to note are the flow of waste feed flowing into the treatment plant, working pressure, working temperature, and concentration of waste content, it is highly recommended to follow the information set by the supplier of the unit.
2. Maintain Chemical treatment performance
   Chemicals that are injected into the effluent treatment system are very important to consider because this relates to how far the chemical can help the effluent purification process. It is recommended to carry out chemical quality testing in the laboratory on a planned basis.
3. Making adjustments to the waste feed
   Making adjustments to the process before the waste feed flows into the treatment system can make it easier for the injected chemical treatment and other components that support waste purification to work optimally.
4. Evaluate maintenance timings of critical units in the field.
   The waste treatment unit is one of the important installations in the field because it is related to waste discharged into the environment, it is recommended that the maintenance team supervisor reorganize the maintenance duration, especially for the water treatment unit.

Length of Running

This indicator tells us how effective maintenance is. As such, maintenance efficiency will directly correlate with productivity and availability of production machinery. Table 2 shows the running time KPI has a value of 2427 hours, lower than the targeted goal of 5000 hours. Figure 4 illustrates the root causes of the low value of the Length of running KPI which includes a wide variety of parameters.

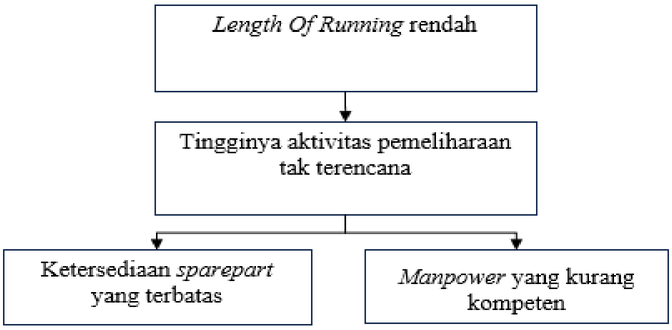

Figure 6. *Root Cause Analysis* on Length of running

From the *Root Cause Analysis* sorted in Figure 4, the improvement recommendations that can be given are.

1. Spare parts planning

Spare parts planning is recommended to field planners and maintenance teams to control stock so that it remains available when spare parts are needed so as to reduce waiting time in planned and unplanned maintenance processes.

2. Improve manpower skills

Provide specialized training on maintenance processes to maintenance crews to increase awareness and skills regarding maintenance knowledge.

3. Emergency man-hour (12)

This statistic compares the number of man-hours spent on emergency maintenance tasks compared to all other maintenance tasks, in particular. Based on the table the KPI for emergency man-hours has reached a value of 47%, still above the desired ceiling of 30%. Many factors contribute to the low value of the Emergency man-hours KPI; the *Root Cause Analysis is* shown in Figure 5.

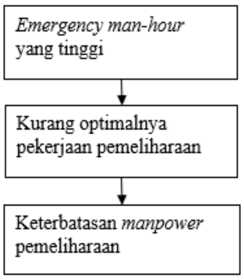

Figure 5. *Root Cause Analysis* on Emergency man-hour

From the *Root Cause Analysis* that is sorted in Figure 5, it can be seen that the limited manpower makes maintenance work suddenly longer. then the improvement recommendation that can be given is to optimize maintenance work planning properly such as requesting additional manpower from 3rd parties or personnel from other locations to speed up the maintenance work process.

Environmental Performance Analysis

Based on the assessment of environmental performance using the IEPMS approach, weighting using AHP, and measuring the value of environmental performance using the omax approach, it was found that the environmental performance value was 9.57, indicating that the company's overall environmental performance was in the green zone during the study period and that PT ABC *Offshore* had reasonable control over the company's environmental performance. Only one of the seven KEPIs now in use - that on effluent pH quality control - is yellow. Consequently, the researcher will concentrate on improving environmental performance, specifically effluent pH quality.

Recommendations for Improving Environmental Performance

The pH value of waste discharged into the environment is very important to note because it can interfere with environmental ecosystems, especially in the sea, as we know that the normal pH value in sea water is around 6-7.5. In Figure 5.5 is the *Root Cause Analysis* on the measurement of the pH value of liquid waste.

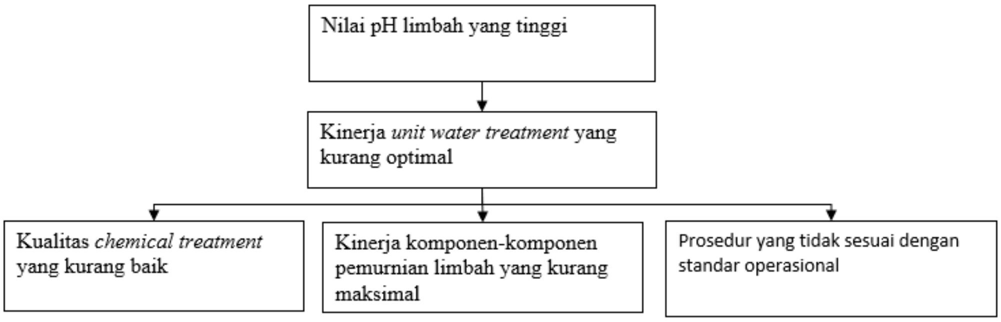

Figure 6. *Root Cause Analysis* on effluent pH value

Based on the problems described in Figure 6, improvement recommendations have been given, namely.

1. Conducting chemical treatment optimization trials in the laboratory, by conducting regular trials the chemical treatment department can provide recommendations regarding the optimal concentration injected into the system.
2. Conducting regular maintenance, it is recommended that the maintenance team make a good maintenance plan, especially for waste purification components such as filters, liners, and strainers in the treatment unit.
3. Running a water treatment system according to standard procedures, a good waste purification process is highly dependent on the concentration of waste content, working pressure, and working temperature in accordance with established standard procedures, so it is highly recommended to follow the information set by the company, supplier or vendor of the unit.

4. CONCLUSION

Conclusions that can be drawn based on the research that has been done include:

Maintenance Performance Measurement

According to the Overall Measure Maintenance Performance (OMMP) approach, the level of maintenance performance at PT ABC *Offshore* has a total maintenance performance value of 5,388. This figure is in the yellow zone, which means that ABC *Offshore's* performance level has not been achieved but is close to the target that the company must achieve. Indicators that are below the company's target must be improved, especially those in the danger zone and need to be improved as soon as possible.

Based on the analysis using *Root Cause Analysis* (RCA), it is recommended that several indicators be improved, such as Hours of damage repair (5), Equipment downtime due to damage (8), Length of operation (11), and Man-hours (12). Environmental Performance Measurement

Measurement of environmental performance at PT ABC *Offshore* obtained a result of 9.57 which indicates that the company's overall environmental performance is in the green zone, meaning that PT ABC *Offshore* has met the target in controlling environmental performance during the 12-month period. However, there is still 1 KEPI which is in the yellow zone and has been given improvement recommendations based on the results of the analysis using *Root Cause Analysis* (RCA).

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