**Date last modified/updated:** Click here to enter a date. **Internal audit:** Click here to enter a date.

**Who last modified/updated:** Click here to enter text. **Management review:** Click here to enter a date.

**This part of the Navigator Playbook is completed when you have:**

1. **Determined what data or information is needed to establish trends in EnMS performance, including trends in nonconformities, corrective actions, and results in monitoring and measurement, internal and external audits, and evaluations of compliance with applicable energy-related legal and other requirements.**
2. **Determined what data or information is needed to monitor, measure, analyze and evaluate the results of the EnMS and its effectiveness as related to the intended outcomes of your EnMS and the strategic goals and priorities of your organization.**
3. **Determined the methods to be used, when the monitoring and measurement will be done, and when the results will be analyzed and evaluated.**
4. **Implemented the monitoring, measurement analysis of EnMS performance and the evaluation of EnMS effectiveness.**
5. Determine what data or information is needed to establish trends in EnMS performance, including trends in nonconformities, corrective actions, and results in monitoring and measurement, internal and external audits, and evaluations of compliance with applicable energy-related legal and other requirements.

|  |  |  |
| --- | --- | --- |
| ☒ | We have established a process for determining the results of the management system and for connecting these results back to top management’s expectations and the organization’s strategic direction and priorities. | Conducted quarterly. |
| ☒ | These expectations and priorities include:  | Items checked below. |

☒ Cost and energy savings

☒ Reduction of CO2 emissions

☐ Reduced risks to security of energy supply

☐ Improved community relations

☒ Other IT equipment thermal conditions.

☒ Other Local laws/regulations.

|  |  |  |
| --- | --- | --- |
| ☒ | We have evaluated the effectiveness of the EnMS using the performance evaluation and improvement processes of the EnMS as outlined below: | Items checked below. |

☒ Monitoring, measurement, and analysis (this task).

☒ Evaluating compliance with the applicable energy-related legal and other requirements (People and Legal Requirements Affecting the EnMS task).

☒ Performing internal audits to provide information on whether the EnMS is effectively implemented and maintained (Internal Audits task).

☒ Management review of the EnMS’s ongoing suitability, adequacy, effectiveness and alignment with the strategic direction of the organization (Management Review task).

☒ Finding and fixing nonconformities and problems in the management system (Corrective Actions task).

|  |  |  |
| --- | --- | --- |
| ☒ | We have developed trend information on EnMS performance and prepared it for review by top management, as well as for evaluation of EnMS effectiveness. This trend information includes: | Items checked below. |

☒ Nonconformities

☒ Corrective actions

☒ Monitoring and measuring results

☒ Results of EnMS internal audits

☐ Results of EnMS external audits (if applicable)

☒Results of evaluations of compliance with applicable energy-related legal and other requirements

*The following worksheet can be useful in identifying the compliance evaluation trend information, along with other data and metrics related to trends in EnMS performance that will be monitored, measured and analyzed for management review and the evaluation of the EnMS effectiveness.*

Monitoring and Measurement of Key Characteristics Planning Worksheet

**Date:** 5/18/24 **Prepared by:** Director of Engineering

**Key Characteristic: Energy sources, Current energy use and consumption**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Energy Source/****Energy Use/****Energy Consumption** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Electricity | Engineering | Utility bills and installed meters. | Continuously. | EnMS, once operational, is supplemented by manual review. | Annual calibration per manufacturer's instructions. |
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**Key Characteristic: Significant energy uses**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Significant Energy Use** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| HVAC System (chillers, AHUs, and pumps) | Engineering | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS). |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |
| IT Equipment (servers, storage, and network) | Engineering | Data Center Infrastructure Management (DCIM) system and Data Center Networking tools. |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |
| Electrical System (transformers, UPSs, and PDUs) | Engineering | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |

**Key Characteristic: Variables affecting significant energy uses**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Significant Energy Use Variable** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Supply air temperature to the IT equipment room | Engineering | Data Center Infrastructure Management (DCIM) system with input from the server Baseboard Management Controllers (BMC). |  Hourly | With the data Center Infrastructure Management (DCIM) system. | Sensors are self-calibrated. |
| Server utilization. | Engineering | Data Center Infrastructure Management (DCIM) system with input from the server Baseboard Management Controllers (BMC). |  Hourly | With the data Center Infrastructure Management (DCIM) system. | Sensors are self-calibrated. |
| UPS utilization. | Engineering | Data Center Infrastructure Management (DCIM) system, utilizing input from the UPS's onboard sensors. |  Hourly | With the data Center Infrastructure Management (DCIM) system. | Sensors are self-calibrated. |

**Key Characteristic: Future energy use and consumption of the significant energy uses**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Future Energy Use/Consumption** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| HVAC System (chillers, AHUs, and pumps) | Engineering | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS). |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |
| IT Equipment (servers, storage, and network) | Engineering | Data Center Infrastructure Management (DCIM) system and Data Center Networking tools. |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |
| Electrical System (transformers, UPSs, and PDUs) | Engineering | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). |  Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | All sensors and meters that require calibration. |

**Key Characteristic: Energy Performance Indicators (EnPIs)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EnPI** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Electrical consumption for IT equipment (servers, storage, and network) | Engineering | Data Center Infrastructure Management (DCIM) system and Data Center Networking tools. | Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |
| Electrical consumption for the HVAC system (chillers, AHUs, and pumps) | Engineering | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS). | Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |
| Electrical consumption for the electrical system (transformers, UPSs, and PDUs) | Engineering | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). | Hourly | Primarily with the data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |

**Key Characteristic: Action plan completion and effectiveness in achieving objectives and targets**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Action Plan/****Objectives and Targets** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Reduce IT equipment (SEU) electrical consumption by 25% from the 2024 baseline by the end of 2028 (Task 12). | Engineering | Data Center Infrastructure Management (DCIM) system and Data Center Networking tools. | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |
| Reduce HVAC system (SEU) electrical consumption by 50% from the 2024 baseline by the end of 2028 (Task 12). | Engineering | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS). | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |
| Reduce electrical system (SEU) losses by 25% from the 2024 baseline by the end of 2028 (Task 12). | Engineering | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |

**Key Characteristic: Prioritized energy performance improvement opportunities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Energy Improvement Opportunity** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Increase IT equipment utilization: Connect all server Baseboard Management Controllers (BMCs) to the DCIM system to monitor server utilization. | Engineering | Data Center Infrastructure Management (DCIM) system and Data Center Networking tool, utilizing input from the server Baseboard Management Controllers (BMCs). | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Sensors are self-calibrated. |
| Increase HVAC System efficiency: Connect all server Baseboard Management Controllers (BMCs) to the DCIM system to monitor server air intake temperatures. | Engineering | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS), utilizing input from the server Baseboard Management Controllers (BMCs). | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Sensors are self-calibrated. |
| Electrical System: Replace the old UPSs with new, high-efficiency UPSs and ensure high utilization. | Engineering | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). | Hourly | Primarily with the Data Center Infrastructure Management (DCIM) system. | Annual calibration of meters according to the manufacturer's instructions. |
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**Key Characteristic: Actual vs. expected energy consumption**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Actual vs. Expected Energy Consumption** | **Department** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **How will the data be analyzed?** | **What calibration is required?** |
| Utility electricity | Engineering | Utility meter | Hourly | Manual review. | None – utility-grade meter. |
| Click here to enter text. | Click here to enter text. | Click here to enter text. | Click here to enter text. | Click here to enter text. | Click here to enter text. |

1. Determine what data or information is needed to monitor, measure, analyze and evaluate the results of the EnMS and its effectiveness as related to the intended outcomes of your EnMS and the strategic goals and priorities of your organization.

|  |  |  |
| --- | --- | --- |
| ☒ | We reviewed the outcomes, strategic goals, and issues that were developed in the task addressing An EnMS and Your Organization. | Yes. See Task 1 Playbook. |
| ☒ | We developed metrics for the EnMS that align with and support these outcomes, goals, and priorities.  | Yes. See Task 11 & 12 Playbooks. |
| ☒ | We have obtained input from top management as appropriate. | Yes, as part of the Management Review. |

1. Determine the methods to be used, when the monitoring and measurement will be done, and when the results will be analyzed and evaluated.

☒ We have determined the monitoring and measurement methods to be used and when to evaluate results.

*The following worksheet can be helpful in determining and capturing when monitoring and measurement will be done and when results will be analyzed and evaluated. These results will help support your consideration of the timing of internal audits, compliance evaluations, strategic planning and management reviews.*

Energy Measurement Plan Worksheet

Using the output from the **Monitoring and Measurement of Key Characteristics Planning Worksheet (above)**, complete the following worksheet to develop your Energy Measurement Plan.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **System/ Process/ Equipment and Location** | **What data is collected?** | **How will it be monitored/ measured?** | **How often will it be monitored/ measured?** | **Who is responsible for monitoring and measurement?** | **What calibration is required?** | **What operational control/ maintenance/ design procurement action or action plan is it linked to?** | **Where is data recorded?** | **How is data analyzed?** | **What significant deviation requires action?** | **How does this demonstrate performance?** |
| Increase IT equipment utilization: Connect all server Baseboard Management Controllers (BMCs) to the DCIM system to monitor server utilization. | Server power and utilization | Data Center Infrastructure Management (DCIM) system and Data Center Networking tool, utilizing input from the server Baseboard Management Controllers (BMCs). | Hourly | Engineering | Sensors are self-calibrated. | Operational controls for IT equipment | Engineering | Primarily with the Data Center Infrastructure Management (DCIM) system. | N/A | When normalized, it shows performance relative to the baseline. |
| Increase HVAC System efficiency: Connect all server Baseboard Management Controllers (BMCs) to the DCIM system to monitor server air intake temperatures. | HVAC power and server air intake temperatures | Data Center Infrastructure Management (DCIM) system and Building Management System (BMS), utilizing input from the server Baseboard Management Controllers (BMCs). | Hourly | Engineering | Sensors are self-calibrated. | Operational controls for HVAC | Engineering | Primarily with the Data Center Infrastructure Management (DCIM) system. | N/A | When normalized, it shows performance relative to the baseline. |
| Reduce electrical System losses: Replace the old UPSs with new, high-efficiency UPSs and ensure high utilization. | UPS power and utilization | Data Center Infrastructure Management (DCIM) system and Electrical Power Monitoring Software (EPMS). | Hourly | Engineering | Annual calibration of meters according to the manufacturer's instructions. | Operational controls for UPS | Engineering | Primarily with the Data Center Infrastructure Management (DCIM) system. | N/A | When normalized, it shows performance relative to the baseline. |
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1. Implement the monitoring, measurement analysis of EnMS performance and the evaluation of EnMS effectiveness.

☒ We performed our compliance evaluations as prescribed under the task guidance for Legal Requirements Affecting the EnMS and all necessary information has been collected.

☒ We initiated the collection, monitoring, measurement and analysis of the information needed to develop trend in the results and have implemented these as an integral part of the compliance evaluation process.

☒ We implemented the monitoring and measurement activities needed to analyze the results related to specific strategic goals and priorities and the achievement of specific intended outcomes.

☒ We have recorded all of our monitoring and measurement activities and are retaining them as documented information.

Hint: Monitoring

* This task draws heavily on information gathered in the Energy Review, so make sure all data is well documented and organized.
* Continual improvement for this task means that there is no set order to monitoring SEUs, relevant variables, action plans, improvement opportunities, and improvement projects.
* Key characteristics can be used to assess the performance of other key characteristics, such that improvement projects can be monitored by evaluating SEU performance.

☒ We are monitoring our implemented projects and have listed details below:

(Note: Table may be modified to accommodate unique criteria)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Implemented Project | When implemented | SEU addressed | Baseline Consumption | Monitoring plan/methods | SEU Performance Improved? | Action Plan changes | Improvement opportunities identified |
| Increase IT equipment utilization | 6/15/24 | IT equipment | 12,000,000 kWh/yr(Task 9) | Primarily with the Data Center Infrastructure Management (DCIM) system. | Yes | None | Improve the links between the Baseboard Management Controllers (BMCs) and the DCIM system. |
| Increase HVAC System efficiency | 6/18/24 | HVAC system | 6,000,000 kWh/yr(Task 9) | Primarily with the Data Center Infrastructure Management (DCIM) system. | Yes | None | Improve the links between the Baseboard Management Controllers (BMCs) and the DCIM system. |
| Reduce electrical System losses | 6/26/24 | Electrical system | 2,000,000 kWh/yr(Task 9) | Primarily with the Data Center Infrastructure Management (DCIM) system. | Yes | None | Update operational controls |

Click here to enter text.

Top Management Approval

|  |  |  |
| --- | --- | --- |
| ☒ | Date approved: | 6/28/24 |
| ☒ | Who approved: | General Manager |

Comments

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