Study Committee B3

Substations and Electrical Installations

10319_2022

# Application of Substation Asset Health Management System (AHMS) for a utility in Mozambique

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## Motivation

- Needs of AHMS
  : Many global electric power utilities are requiring various power equipment asset management solutions
  - systematic management services throughout the life cycle of the equipment assets
- AHMS for Mozambique Power Grid
  : Construct a unified management, maintenance, and operation system of transformers through the introduction of an asset management system for all substations.

## Overview of AHMS

- All data are stored in the cloud-based data center by computerizing on-line and off-line data
- Through data analysis by a data center, it will carry out various risk analyses
- It will formulate a maintenance strategy about new investment, replacement, repair and remodeling of a apparatus based on the results of the risk assessment
- It will store and update data related to the actual execution and implementation of maintenance & repairs and preventive maintenance of apparatuses

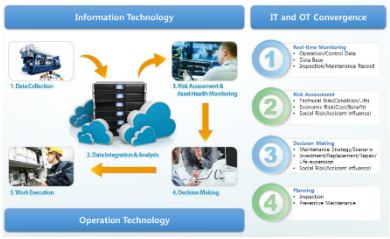


**Figure 1. Diagram of function blocks of AHMS**

- Cloud AHMS : the data of the utility are transmitted to the manufacturer's data center and the data center provides comprehensive analysis and cloud-based solutions for asset management to the utility.

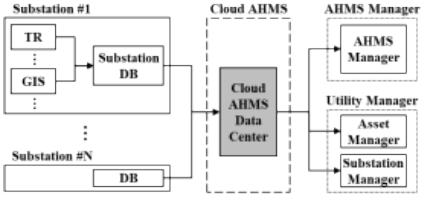


**Figure 2. Architecture of Cloud AHMS**

- On-premise AHMS : constructed in the data center of the utility itself and directly operated by the utility.

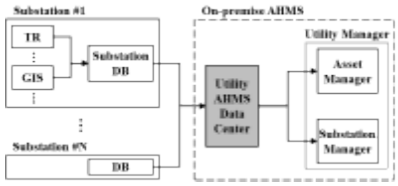


**Figure 3. Architecture of On-premise AHMS**

## AHMS for Mozambique Power Grid

- Construct a unified management, maintenance, and operation system of transformers through the introduction of an asset management system for all substations.
- **Scope of AHMS** : 127 transformers of 60 kV or higher in all 72 substations
- **On-premise AHMS system** : developed so that it could be operated by itself.
- **First requirement** : the definition of standardized input data and the construction of a database.
- **Second requirement** : the system design for which the movement of transformers between substations was taken into account.

## Approach

- The off-line data and the on-line data are collected, and the data that can be commonly applied to all the substations are selected and standardized.
- The inputs/outputs of AHMS are finally defined for the utility environment based on all the obtained standardized data.
- The system inputs/outputs that are defined become the key factors in customizing the health index evaluation algorithm and the equipment unit maintenance strategy establishment algorithm
- A process of developing an On-premise type AHMS IT system is carried out based on the construction of a database with the standardized data that are secured and the customizing of algorithm.

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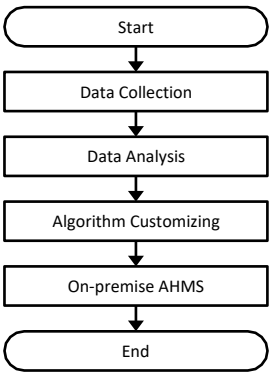



**Figure 4. AHMS Development Process**

## Data Collection

- Data collection for each substation (68 cases (54%) )
- Classification of commonly available data

**Figure 5. Example of Standardized Input Data**

## Data Analysis

- Standardized data collection for each substation (Operation, movement and maintenance data, etc.)
- Among the collected data, the existing evaluation items of which the data acquisition rate was not higher than 50% were deactivated and excluded
- Definition of system input/output data

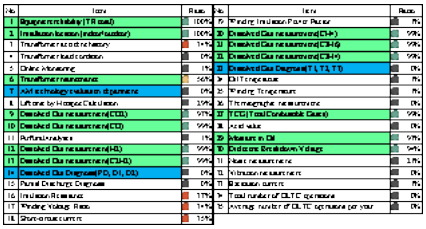


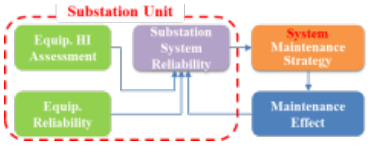
**Figure 6. Example of Health Item Definition**

## Algorithm Customizing

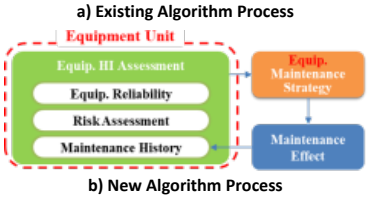
- HI is utilized for the management of assets being linked with equipment life time model and maintenance strategy establishment algorithm.
- The detailed evaluation items of transformer HI were redefined from the existing 35 evaluation items to 16 evaluation items to fit the utility environment.
- The system has been developed to enable the health assessment algorithm to be upgraded by activating the excluded evaluation items through the expansion of the utility's management area in the future.

**Figure 7. Example of Assessment Criterion for Each Health Assessment Item**

- The existing algorithm process
  : substation centered maintenance strategy by reflecting the equipment health assessment result and the maintenance result on the lifetime model of the equipment
- The new algorithm process
  : included both the equipment reliability and the maintenance history of the equipment as the health assessment items of the equipment and was changed to establish a equipment centered maintenance strategy.




**a) Existing Algorithm Process**




**b) New Algorithm Process**

**Figure 8. Change of Algorithm Process**

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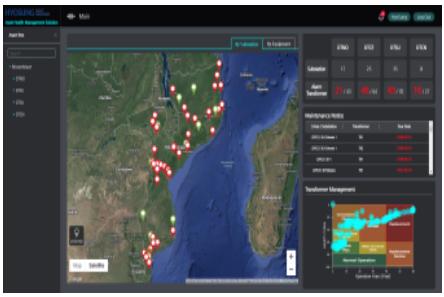
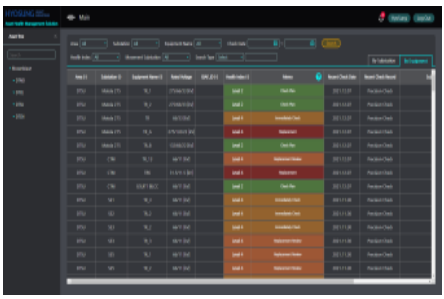
## Case Study of On-premise AHMS in Mozambique

- The AHMS customized to fit the utility environment has been operated in a data-center in Mozambique since it was installed in September 2021.
- On the main screen of the AHMS, substation locations, transformer quantity and the status of the transformers from which an alarm is generated can be checked based on the map.
- The history of the transformer movement between substations can be also checked by reflecting an additional requirement.
- On the screen of the detailed transformer status, the subsystem found to have a problem as a result of health assessment through 3D modelling is displayed in red to enable the part with a problem to be identified.
- On the maintenance strategy establishment screen, inquiries can be made by substation area and maintenance strategy, and maintenance strategies for individual transformers are provided in the form of a risk matrix.

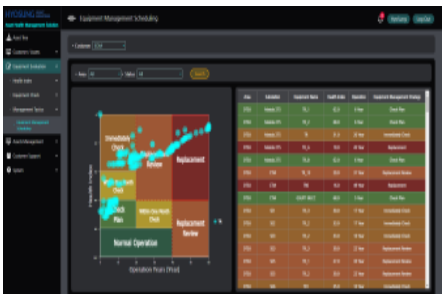


(a) Substation Main board



(b) Equipment Main board

(C) Equipment Condition



(d) Maintenance Strategy

**Figure 9. On-premise AHMS**

## Conclusion

- The introduction of the AHMS helps to enable comprehensive management and systematic maintenance of facilities.
- The Mozambique utility has successfully established an AHMS for 72 substations and 127 transformers, which is currently in operation, and is concentrating its efforts to expand the database by acquiring additional input data.
- As the system is designed to allow easy expansion and change of the algorithm when the database is expanded, the more it is operated, the more it is possible to change the settings to fit the utility environment.