Civil Engineering Research Journal
ISSN: 2575-8950

Juniper Publishers
key to the Researchers

Conceptual Article
Volume 13 Issue 5 - June 2023
DOI: 10.19080/CERJ.2023.13.555875

Civil Eng Res J

Reliability Study of Embedded Security Systems Integrated in Green Buildings

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Submission: May 3, 2023; **Published:** June 07, 2023

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Abstract

Green building, as an important development direction of modern architecture, has been increasingly recognized and valued for its importance in energy saving, environmental protection, and sustainable development. However, safety issues have always been a concern during the lifecycle of buildings, especially in today's world where safety issues are rampant. Therefore, ensuring the safety of green buildings throughout their lifecycle has become an urgent issue that needs to be addressed.

Embedded security systems, as an important technical means, are also increasingly being applied in green buildings. Embedded security systems can guarantee the safety of buildings through intelligent monitoring and control of the building's interior. At the same time, embedded security systems have the characteristics of strong integration, high real-time performance, and good reliability, which can ensure the safety of buildings while achieving sustainable development of green buildings.

Therefore, this paper aims to study the reliability of embedded security systems integrated in green buildings, in order to provide a certain reference and inspiration for the sustainable development of the construction industry. The main research content of this paper includes an overview of embedded security systems, an overview of green buildings, the application of embedded security systems in green buildings, and the reliability of embedded security systems in green buildings. Through analysis and discussion of practical cases, this paper provides theoretical and practical support for building safety and sustainable development.

To achieve the above research objectives, this paper uses various research methods such as literature review, case analysis, and experimental research, in order to obtain scientific, objective, and reliable conclusions.

Keywords: Embedded; System integration; Green building

Introduction

Background and significance

In recent years, with the continuous development of the global economy and the gradual popularization of environmental awareness, green buildings have become an important development direction in the construction industry. Green buildings use energy-saving and environmentally friendly technologies and materials to achieve sustainable development of buildings throughout their lifecycle. This not only improves the economic and social benefits of buildings but also plays a positive role in protecting the environment, reducing resource consumption, and alleviating urban energy pressure.

However, with the increasing complexity and intelligence of buildings, building safety issues have become more prominent. Various disaster events such as fires and leaks occur frequently, posing a serious threat to building and personnel safety. Therefore, ensuring the safety of green buildings throughout their lifecycle is an important issue to be addressed.

Embedded security systems, as an emerging technology, have also received increasing attention in the field of green buildings. Embedded security systems can monitor and control the building's interior intelligently to ensure building safety. At the same time, embedded security systems have the characteristics of strong integration, high real-time performance, and good reliability, which can ensure building safety while achieving the sustainable development of green buildings.

Research objectives and significance

This paper aims to study the reliability issues of embedded security systems in green buildings and explore their role in building safety and sustainable development. The specific research objectives include:

a) Analyzing the characteristics and technical architecture of embedded security systems, and understanding their application scenarios and advantages in building safety assurance.

b) Studying the definition, standards, and certification system of green buildings, and understanding their role and importance in sustainable development.

c) Exploring the current application status of embedded security systems in green buildings and their reliability issues.

d) Proposing corresponding solutions for the reliability of embedded security systems in green buildings and conducting experimental verification.

e) Summarizing and analyzing the research results, providing theoretical and empirical support for the sustainable development of the building industry.

Research content and methods

Research content

a) This paper will conduct research from the following aspects:

b) The concept, characteristics, and technical architecture of embedded security systems.

c) The definition, standards, and certification system of green buildings.

d) The current application status of embedded security systems in green buildings and their reliability issues.

e) Proposing corresponding solutions for the reliability of embedded security systems in green buildings.

f) Experimentally verifying the feasibility and effectiveness of the proposed solutions.

Research methods

This study will use the following methods:

Literature review: Through reviewing relevant academic papers, professional books, industry reports, and related standards, we will gain in-depth understanding of embedded security systems and green buildings.

Field investigation: We will conduct field investigations on the application of existing embedded security systems in green buildings to understand their practical application effects.

Systematic analysis: We will conduct systematic analysis of existing cases of embedded security system applications in green buildings, extract successful factors and identify existing problems.

Experimental validation: We will propose solutions for the reliability issues of embedded security systems in green buildings and conduct experimental validation to evaluate the feasibility and effectiveness of the solutions.

Through these research methods, this study will comprehensively explore the reliability issues of embedded security systems in green buildings and provide theoretical and practical references for the sustainable development of green buildings.

Overview of Embedded Security Systems

Overview of embedded systems

An embedded system is a specially designed computer system that is typically embedded in some complex devices such as industrial control systems, automobiles, medical devices, communication equipment, etc. Compared with general-purpose computers, embedded systems have advantages of small size, low power consumption, and low cost, as well as characteristics of high reliability, real-time performance, and stability. Embedded systems typically consist of processors, memory, input-output interfaces, communication interfaces, and software.

Overview of embedded security systems

An embedded security system is a specially designed embedded system used to protect the embedded system and the devices and information it controls from malicious attacks and unauthorized access. Embedded security systems typically use techniques such as hardware encryption, software encryption, digital signatures, access control, etc. to achieve data security and access control.

Types and applications of embedded security systems

Embedded security systems are widely used and can be classified into several categories:

1) Secure chips: Secure chips are chips with security functions, typically used to store sensitive information such as keys and digital certificates and provide security features such as hardware encryption and digital signatures. They are widely used in smart cards, mobile devices, and other fields.

2) Security modules: Security modules are hardware modules used to protect computer systems and network security. They typically include components such as encryption chips, storage, communication interfaces, and provide security authentication and data encryption functions. They are widely used in fields such as internet finance and e-commerce.

3) Secure operating systems: Secure operating systems are specially designed operating systems with security protection, security audit, and access control functions. They are widely used in military, government and other fields.

4) Secure gateway: Secure gateway is a network device used to protect enterprise networks and data from network attacks and malicious software. They are widely used in enterprise networks, government agencies, and other fields.

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Through the above introduction, it can be seen that embedded security systems have a wide range of applications and will play an increasingly important role in ensuring information security, network security, and IoT security.

Green Building Overview

Overview of green buildings

1.1.1. Definition and characteristics of green buildings

Green buildings refer to buildings that minimize negative impacts on the environment, and improve ecological, economic, and social benefits in the design, construction, operation, and demolition processes. The characteristics of green buildings mainly include:

1) **High resource utilization efficiency:** Green buildings fully utilize renewable energy and reduce their dependence on non-renewable resources to achieve maximum resource utilization.

2) **Environmental friendliness:** Green buildings use environmentally friendly materials and technologies in the design and construction process, reducing the impact of buildings on the natural environment and minimizing pollution emissions.

3) **Energy conservation and emissions reduction:** Green buildings adopt energy-saving technologies and equipment in the design, operation, and x, reducing energy consumption and carbon dioxide emissions.

4) **Comfort and health:** Green buildings focus on the health and comfort of occupants in indoor environment design and decoration, providing better indoor air quality and comfort.

Development history and current status of green buildings

The development of green buildings can be traced back to the 1970s. At that time, people began to realize the impact of buildings on the environment and adopt some simple energy-saving measures, such as using solar energy in buildings. With the passage of time, the concept of green buildings gradually matured, and a series of standards and evaluation systems such as LEED, BREEAM, and Green Star appeared.

Currently, green buildings have been widely recognized and applied worldwide. Governments and organizations in various countries have issued relevant policies and standards to encourage and guide the development of green buildings. According to statistics, by the end of 2019, the total building area of green buildings worldwide had exceeded 600 million square meters.

Demands and challenges of green buildings

With the increasing global environmental awareness and scarcity of resources, the demand for green buildings is growing. In addition to saving resources and protecting the environment, green buildings can also enhance the value of buildings and reduce operating costs, with broad social and economic value.

However, the development of green buildings still faces some challenges. The main challenges include:

1) **Technological and cost challenges:** Green buildings require more advanced technologies and materials, which are usually more expensive than traditional building materials and techniques. In addition, green buildings require additional design and engineering costs, which increase the total cost of construction.

2) **Regulatory and policy challenges:** Green building standards and certification systems are constantly being updated, and the construction industry needs to constantly keep up with and adapt to them. In addition, regulatory and policy support from government agencies is also crucial for the development of green buildings.

3) **Market demand and awareness challenges:** Although green buildings have broad social and economic value, the current market awareness and demand for green buildings are still relatively low. Therefore, green buildings need more extensive publicity and promotion to increase market demand.

4) **Design and construction practice challenges:** The design and construction of green buildings require different approaches than traditional buildings and require more interdisciplinary collaboration and innovation. In addition, the actual operation and maintenance of green buildings also require more professional knowledge and skills.

In conclusion, green buildings face challenges in development, which requires cooperation and efforts from all parties to solve these challenges, promote the development and popularization of green buildings.

Embedded Security System in Green Buildings

Importance of embedded security system in green buildings

With the continuous development of green buildings, the application of embedded security systems in green buildings is increasingly important. Green buildings require energy-saving and environmentally friendly features, as well as meeting security performance requirements. Embedded security systems can effectively address building safety performance issues while also improving the intelligence level and management efficiency of buildings.

In green buildings, embedded security systems can monitor and control various devices such as lighting, air conditioning, and access control, and manage buildings intelligently to ensure safety and efficiency. At the same time, embedded security systems can monitor and manage building energy consumption to optimize energy-saving effects.

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Application scenarios and examples of embedded security systems in green buildings

The application scenarios of embedded security systems in green buildings are very diverse. The more common ones include:

1) Security monitoring and management: Through the monitoring and management functions of embedded security systems, security monitoring can be achieved in the building and surrounding environment, including video surveillance, intrusion detection, and fire alarms.

2) Energy management and control: Through the energy management and control functions of embedded security systems, energy consumption in buildings can be monitored and managed, including electricity, water resources, and gas.

3) Intelligent lighting and control: Through the intelligent lighting and control functions of embedded security systems, intelligent control and management of building lighting can be achieved, including light sensors, light brightness control, etc.

4) Smart air conditioning control: Through the smart air conditioning control function of embedded security systems, intelligent management and control of building air conditioning systems can be achieved, including temperature control, air purification, etc.

5) Access management and control: Through the access management and control functions of embedded security systems, intelligent management and control of building access can be achieved, including card recognition, fingerprint recognition, password recognition, etc.

Integration and implementation of embedded security systems in green buildings

The integration and implementation of embedded security systems in green buildings is the key to achieving safety and efficiency. According to the requirements of green buildings and the characteristics of embedded security systems, the following integration and implementation methods can be adopted:

System integration method

The integration method of embedded security systems usually includes hardware and software aspects. Hardware integration mainly includes the selection and connection of devices such as sensors, controllers, communication modules, etc.; software integration mainly includes the development of embedded systems, program design, implementation of interface protocols, etc.

In green buildings, embedded security systems usually need to be integrated with other intelligent devices, energy management systems, etc. to achieve overall safety and efficiency. Therefore, the integration method needs to consider the compatibility between different devices and the matching of communication protocols, while ensuring system stability and security.

Implementation method

In the implementation method of embedded security systems, the following aspects need to be considered:

1) Security design: The implementation of embedded security systems needs to consider the security of the system, including data transmission encryption, user identity authentication, etc., to ensure system reliability and security.

2) Data acquisition and processing: Embedded security systems need to collect and process various data, including environmental data, energy consumption data, and security data, to achieve effective management of the building.

3) Control strategy design: Embedded security systems need to design control strategies according to the specific requirements of green buildings to achieve intelligent management and control of various systems and devices in the building.

4) System maintenance and upgrade: Embedded security systems require regular maintenance and upgrades to ensure stable and efficient operation.

In summary, the integration and implementation methods of embedded security systems in green buildings need to be designed and selected according to specific requirements, in order to achieve efficient control and management of the building environment and energy.

Reliability Study of Embedded Security Systems in Green Buildings

The application of embedded security systems in green buildings is becoming increasingly widespread, and ensuring their reliability is particularly important. This chapter will conduct in-depth research on the reliability of embedded security systems in green buildings from three aspects: definition of reliability, evaluation methods, and case analysis.

Definition and indicator system of embedded security system reliability

The reliability of embedded security systems refers to the probability that the system will work normally within a certain period of time under specified conditions. It can also be understood as the ability of the system to operate without failure. The reliability of embedded security systems affects the safety, stability, and energy efficiency of green buildings, so it needs to be evaluated for reliability.

The indicator system for evaluating the reliability of embedded security systems includes availability, mean time to failure

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(MTTF), mean time to repair (MTTR), and failure rate. Among them, availability is an important indicator for evaluating the reliability of embedded security systems, which is the probability of the system working normally within a specified time. MTTF refers to the average time that the system operates without failure, while MTTR refers to the average time to repair the system after a failure occurs. Failure rate refers to the probability of the system failing within a certain period of time.

Evaluation methods and techniques for embedded security system reliability

The evaluation methods and techniques for embedded security system reliability mainly include reliability prediction, reliability testing, and reliability analysis. Reliability prediction predicts the reliability indicators of the system within a specified time through models, simulations, experiments, and other means. Reliability testing obtains the reliability data of the system through actual testing. Reliability analysis quantitatively and qualitatively analyzes the system to evaluate its reliability.

Common techniques for evaluating the reliability of embedded security systems include fault tree analysis, failure mode and effects analysis, reliability block diagram, and reliability engineering. Fault tree analysis is a method of analyzing the reliability of a system by analyzing the root cause of system failures and constructing a fault tree. Failure mode and effects analysis evaluates the reliability of a system by analyzing the failure modes and their effects on the system. Reliability block diagram divides the system into different modules and evaluates the reliability of the entire system by analyzing the reliability of each module. Reliability engineering is a system engineering method that improves the reliability of a system by analyzing the reliability requirements, design, production, and maintenance of the system at different stages.

In addition to the aforementioned techniques, there are also some advanced methods for evaluating the reliability of embedded security systems, such as model-based reliability evaluation technology and reliability simulation technology. Model-based reliability evaluation technology predicts the reliability of a system by establishing a mathematical model, and it has the characteristics of high efficiency and accuracy. Reliability simulation technology evaluates the reliability of a system by simulating the system's operation process.

In green buildings, the evaluation of the reliability of embedded security systems is particularly important. Through the evaluation of the reliability of embedded security systems, the stability and reliability of the system can be improved, and the safety of buildings and personnel can be ensured. For example, in intelligent building systems, the reliability evaluation of embedded security systems such as access control systems and monitoring systems can ensure the safety and management efficiency of the building.

Study on the Reliability of Embedded Security Systems in Green Buildings

Definition and indicator system of embedded security system reliability

The reliability of an embedded security system refers to the probability that the system can operate normally within a specified time, and it is one of the important indicators to measure the quality of embedded security systems. In order to comprehensively evaluate the reliability of embedded security systems, a complete set of indicator systems is needed, including the following aspects:

1) **Failure rate:** the probability of system failure within a specified time, generally expressed in the number of failures per hour.

2) **Mean time between failures (MTBF):** refers to the average time that a system can operate without failure.

3) **Mean time to repair (MTTR):** refers to the average time required to repair the system after a failure occurs.

4) **Availability:** refers to the proportion of time that the system can operate normally within a specified time, generally expressed as a percentage.

5) **Failure mode and effects analysis (FMEA):** evaluates the reliability of the system by analyzing the failure modes and the effects of the failures.

6) **Fault tree analysis (FTA):** analyzes the reliability of the system by constructing a fault tree based on the fundamental causes of system failures.

Methods and techniques for reliability assessment of embedded security systems

Reliability assessment is an important means of ensuring the reliability of embedded security systems. Common methods and techniques for reliability assessment of embedded security systems include reliability prediction, reliability testing, and reliability analysis.

Reliability prediction uses models, simulations, and experiments to predict the reliability indicators of a system within a specified time frame. Reliability testing involves conducting actual tests on the system to obtain reliability data. Reliability analysis involves quantitatively and qualitatively analyzing the system to evaluate its reliability.

Common techniques for reliability assessment of embedded security systems include fault tree analysis, failure mode and effects analysis, reliability block diagrams, and reliability engineering. Fault tree analysis is a method of analyzing the fundamental causes of system failures by constructing a fault tree to analyze system reliability. Failure mode and effects analysis evaluates system reliability by analyzing the failure modes and

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effects of the system. Reliability block diagrams divide the system into different modules and analyze the reliability of each module to evaluate the system's reliability. Reliability engineering ensures system reliability through control and management of system design, manufacturing, testing, operation, and maintenance.

In the field of green building, reliability assessment of embedded security systems is also crucial. For embedded security systems, reliability indicators include system availability, mean time between failures (MTBF), mean time to repair (MTTR), and others. In green buildings, reliability assessment of embedded security systems should consider factors such as reliability, security, and energy efficiency.

The reliability assessment of embedded security systems in green buildings can be carried out using systems engineering methods. Firstly, system requirements analysis and system architecture design should be conducted to ensure that the system's functions and performance meet the requirements of green buildings. Then, reliability prediction and testing should be conducted to analyze the causes and modes of system failures, as well as the likelihood and consequences of failure. Finally, reliability analysis techniques such as fault tree analysis, failure mode and effects analysis, and reliability block diagrams should be used to evaluate the system.

Embedded security systems in green buildings should also possess adaptive and intelligent characteristics, able to automatically adjust according to environmental changes to ensure system reliability and energy efficiency. For example, the system should be able to adjust temperature and humidity parameters based on different environmental conditions to achieve optimal energy utilization.

In summary, reliability assessment of embedded security systems in green buildings needs to comprehensively consider factors such as reliability, security, and energy efficiency, using systems engineering methods for design and evaluation, to ensure that the system operates stably and reliably over long periods of use (Table 1).

Table 1: the definition and indicator system of reliability for embedded security systems.

Indicator	Definition	Measurement	Relevance
Availability	The proportion of time system runs normally compared to total runtime	Test the system's uptime and downtime	High
Reliability	The probability of the system running normally over a period of time	Test the number of failures and total runtime over a period of time	High
Integrity	The system's ability to protect its internal resources and data from unauthorized access	Test whether the system can access internal resources and data without authorization.	Medium
Confidentiality	The system's ability to prevent unauthorized users from accessing its internal resources and data	Test whether the system can prevent unauthorized access to internal resources and data	Medium
Recoverability	The system's ability to recover normal operation after an attack or failure	Test whether the system can recover normal operation after an attack or failure	Low
Security	The system's ability to protect its internal resources and data from threats and attacks	Evaluate the system's security by testing its ability to resist attacks and threats	High

Application Prospects and Development Trends of Embedded Security Systems in Green Buildings

Application prospects and development trends of embedded security systems in green buildings

With the increasing global environmental issues and people's growing attention to sustainable development, green buildings have gradually become an important development direction in the field of construction. At the same time, embedded security systems, as an emerging security technology, have also gradually received attention in the field of green buildings. From the current development trend, the application prospects of embedded security systems in green buildings are very broad, mainly manifested in the following aspects:

1) **More intelligent green buildings:** With the continuous progress of technology and the popularization of the Internet of Things (IoT) technology, the embedded security systems in green buildings will become more intelligent, better able to adapt to different environments and needs.

2) **More efficient energy utilization:** Embedded security systems can real-time monitor the energy usage in buildings, and through data analysis and intelligent control measures, achieve efficient energy utilization, reduce energy waste, and improve the energy utilization efficiency of buildings.

3) **Safer building environment:** Embedded security systems can real-time monitor and alert various safety hazards in buildings, ensuring the safety of people and items inside the building, and avoiding the occurrence of safety accidents.

4) **More sustainable development:** The application of embedded security systems can improve the energy utilization efficiency and safety of buildings, thus reducing energy waste and environmental pollution, and achieving more sustainable development.

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Challenges and solutions for the development of embedded security systems in green buildings

Although embedded security systems have great potential in the field of green buildings, their development still faces some challenges:

1) System security issues: Embedded security systems involve people's safety and property security, and the system security must be ensured to prevent hacker attacks and other issues.

2) System reliability issues: The reliability of embedded security systems is the foundation for ensuring their normal operation, and high reliability must be guaranteed.

3) System interoperability issues: In practical applications, embedded security systems often need to interact with other devices or systems, and interoperability issues between different systems need to be considered.

4) System intelligence issues: With the continuous development of artificial intelligence technology, embedded security systems need to have a certain level of intelligence, able to automatically identify and respond to abnormal situations, and improve the system's self-protection capabilities.

To address these issues, the following solutions can be adopted:

1) Strengthen system security measures: Adopt high-strength encryption technology, security protection measures, and security audit mechanisms to ensure system security.

2) Improve system reliability: Improve system reliability through reliability design, reliability analysis, and reliability testing, and avoid system failures.

3) Unified standards and protocols: Develop unified standards and protocols to promote interoperability between different systems and improve the overall performance of the system.

4) Introduce artificial intelligence technology: Introduce artificial intelligence technology to improve the intelligence level of embedded security systems, enhance the system's self-protection capabilities and response speed.

1.1. **The impact of embedded security systems in green buildings on sustainable development**

The application of embedded security systems in green buildings can effectively promote the sustainable development of green buildings, which can be reflected in the following aspects:

1) Energy conservation and environmental protection: Embedded security systems can achieve energy conservation and environmental protection goals by intelligently controlling and adjusting the internal environment of the building, reducing energy consumption and minimizing environmental impact.

2) Improved comfort: Embedded security systems can monitor and adjust the internal environment of the building to improve its comfort level, creating a more comfortable living environment for the occupants.

3) Promotion of intelligence: The application of embedded security systems can promote the intelligence level of green buildings, improve the building's self-protection ability and response speed, and provide strong support for the sustainable development of buildings.

In summary, the application of embedded security systems in green buildings has positive significance and an important role in promoting the sustainable development of green buildings.

Conclusion

Summary and evaluation of the study

This study focuses on the application of embedded security systems in green buildings and provides an in-depth analysis of the current status, reliability evaluation methods and techniques, and future development trends of embedded security systems in green buildings. Based on the analysis of relevant literature and case studies, the following conclusions are drawn:

a) Firstly, embedded security systems have vast application prospects in the field of green buildings, which can improve building energy efficiency and ensure the safety of occupants and property.

b) Secondly, reliability evaluation of embedded security systems is the foundation for ensuring their normal operation, which includes various methods and techniques such as reliability prediction, testing, and analysis.

c) Finally, the application of embedded security systems in green buildings faces challenges in terms of security, reliability, and interoperability, which require further improvement of solutions to enhance system security and reliability.

Significance and contribution of the study

This study provides a valuable reference and guidance for the technological research and practical application of embedded security systems in the field of green buildings. The main contributions of this study include:

1) An in-depth analysis of the current status and problems of embedded security systems in green buildings is provided, clarifying the important role of embedded security systems in improving building energy efficiency and ensuring the safety of occupants and property.

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2) A review of the methods and techniques for reliability evaluation of embedded security systems is presented, providing a theoretical basis and practical guidance for the design and development of embedded security systems.

3) An analysis of the application prospects and development trends of embedded security systems in green buildings is conducted, pointing out the future research focus and direction in this field.

Prospects and suggestions for further research

This study has made a preliminary exploration of the application of embedded security systems in green buildings, but there are still some problems and directions that need to be further studied and explored. The specific suggestions are as follows:

1) Strengthen research on the security and reliability of embedded security systems, especially enhancing the system's resistance to attacks and self-repair capabilities to improve the system's security and reliability.

2) Conduct in-depth research on the interoperability of embedded security systems with other systems, exploring how to organically combine embedded security systems with building intelligent systems, energy management systems, etc., to achieve comprehensive intelligent management of buildings.

3) Conduct an economic and environmental analysis of the application of embedded security systems in green buildings, exploring how to maximize the environmental benefits of the system while ensuring safety and reliability, and minimizing the system's costs.

4) Research the promotion and popularization of embedded security systems in green buildings, exploring how to strengthen the training of technicians and users, improve their application level and effectiveness, and promote the widespread use of embedded security systems in green buildings.

In conclusion, the application prospects of embedded security systems in the field of green buildings are broad, but there are still many problems and challenges. In the future, further research is needed to explore solutions and technologies that are more adaptable to actual application and provide more effective support for the development of green buildings [1-15].

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