AVW Technical Guide

Stage Automation Safety Fundamentals

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1. Introduction

Modern theatre productions increasingly rely on automated systems to move scenery, performers, and stage elements. These systems allow complex stage effects to be achieved reliably and repeatedly during live performances.

However, stage automation systems can involve large moving structures, heavy loads, and powerful motors operating close to performers and technicians. As a result, safety must be a primary consideration when designing, installing, and operating automation equipment.

Automation safety is achieved through a combination of **engineering design, control systems, mechanical safeguards, and operational procedures**.

This guide introduces the fundamental principles of stage automation safety and provides an overview of the key concepts explored in the AVW Technical Guide series.

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2. Hazards in Stage Automation

Stage machinery can create a variety of hazards if not properly controlled.

Common hazards include:

- moving scenery or stage wagons
- automated flying systems
- stage lifts and elevators
- rotating stages or turntables
- automated performer flying systems

Hazards may arise from:

- uncontrolled motion
- mechanical failure
- control system errors
- operator mistakes
- unexpected interaction between machinery and people

Identifying and controlling these hazards is the foundation of automation safety.

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3. Risk Assessment

Risk assessment is the structured process used to identify hazards and determine appropriate safety measures.

A typical risk assessment process includes:

1. identifying hazards
2. evaluating the severity of potential harm
3. estimating the likelihood of hazardous events
4. implementing measures to reduce risk

Risk assessment is referenced in many safety standards including:

- BS EN 17206
- ISO 13849
- EN IEC 61508

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4. Safety Functions

When hazards cannot be eliminated completely, **safety functions** are used to reduce risk.

A safety function is a system response that prevents a hazardous situation.

Examples include:

- stopping machinery when an emergency stop is activated
- preventing motion beyond defined limits
- detecting overspeed conditions
- monitoring load limits

Safety functions are often implemented using **safety-related control systems**.

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5. Safety Control Systems

Safety control systems monitor sensors and safety inputs and ensure machinery moves to a safe state when necessary.

Typical safety system components include:

- emergency stop buttons
- safety relays or safety PLCs
- limit switches and position sensors
- load monitoring systems

- motor drive safety functions

These systems are designed to detect faults and respond quickly to prevent hazardous motion.

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6. Redundancy and Fault Detection

Automation safety systems often incorporate redundancy and fault detection to improve reliability.

Examples include:

- dual-channel emergency stop circuits
- redundant safety controllers
- multiple motion sensors
- independent braking systems

Redundant designs reduce the probability that a single failure will lead to loss of safety function.

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7. Emergency Stop Systems

Emergency stop systems provide a means for operators to halt machinery immediately in dangerous situations.

E-Stop systems typically:

- override normal control commands
- stop motor drives
- activate braking systems
- require manual reset before restarting

They are considered a **last line of defence** in automation safety.

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8. Motor Drive Safety Functions

Modern automation systems often use variable speed drives or servo drives to control machinery.

These drives frequently include integrated safety functions such as **Safe Torque Off (STO)** which prevents motors from generating torque.

Drive safety functions allow automation systems to respond rapidly to hazardous conditions.

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9. Standards and Safety Frameworks

Stage automation safety systems are often influenced by several safety standards.

Commonly referenced standards include:

- BS EN 17206
- ISO 13849
- EN IEC 61508

These standards provide guidance on how to design and evaluate safety-related control systems.

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10. Key Takeaways

- Stage automation systems must be designed with safety as a primary consideration.
- Risk assessment is the foundation of automation safety.
- Safety functions reduce risk when hazards cannot be eliminated.
- Redundancy and fault detection improve reliability.
- Emergency stop systems provide a critical last line of defence.

About the Author

Anton Woodward works in theatre engineering and stage automation systems.

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