

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Cause and effect matrix**

**Matrice des causes et effets**



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INTERNATIONAL  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## CAUSE AND EFFECT MATRIX

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The text of this standard is based on the following documents:

FDIS	Report on voting
65/701/FDIS	65/711/RVD

All information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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## INTRODUCTION

Efficient engineering and reliable operation of automated plants strongly depend on clear and unambiguous description of regulatory controls and logic interlocks. For regulatory controls this description can typically be done for example via process flow diagrams and P&IDs (ISO 10628), which are accepted by process and I&C staff in engineering and operation of manufacturing and process plants. Regarding logic interlocks the widely distributed logic or functional diagrams are very often regarded by process engineers and plant operators as too complex (especially when using the fail-safe principle) and overloaded with detailed information.

This document describes a simple and widely accepted method to document logic interlocks in process and manufacturing industries – the "cause and effect matrix" (C&E matrix). C&E matrices can be applied with minimal previous knowledge and easy handling to describe the functions required for controlling a process independently from the automation platform used. They enable a sound understanding of the required relation from a process point of view without the need of detailed knowledge of the platform specific corresponding PLC/DCS program logic.

During the entire life cycle of a plant (e.g. engineering, commissioning, start-up and operation) C&E matrices are very useful to illustrate the functionalities of package units and their interfaces to related sections of the plant. In particular they support the fulfilment of legal or insurance requirements (e.g. governmental regulations, fire and gas regulations, machinery directives such as IEC 62061). It is possible to find C&E matrices included in other types of documents, for example fire protection datasheets but still the principle of identification of the cause and the effects and their logical relations defined in an intersection applies.

In addition, they can be used to illustrate the consequences of embedded diagnostic functions (e.g. activation of a trip function in case of detection of a broken wire), the functionality of installed back-up systems (e.g. fail to start a pump and switch over to a second one) or the required operator actions to reset plant sections or safety related functions after partial shut downs.

The information presented by C&E matrices might be structured according to the individual needs, for example information necessary for process interlocks in electrical switch gears.

C&E matrices describe the relationship between causing conditions – the causes – and the required outcome or action – the effects. The causes are herein represented by signals created by sensors or other means of information; effects are actions automatically done by actuators (mainly valves and motors) or manually by shift operators, or alarms and messages provided to operators. Both are linked via a matrix containing the relations. These basic relations are hence documented in an appropriate and structured form enabling a reliable information exchange at the interface between process design, electrical engineering, I&C engineering etc. In the further course of detail engineering C&E matrices are used as a starting point for the development of more detailed and platform specific (e.g. fail-safe PLC) logic enhancements.

During plant operation the C&E matrices can serve as functional descriptions, for example for the training of plant operation staff.

However, C&E matrices typically are not designed to specify functional sequences (e.g. batch mode of operation) or functional details as might be provided by other methods, for example logic descriptions complying with IEC 61131-3.

## CAUSE AND EFFECT MATRIX

### 1 Scope

This document addresses the setting and implementation of C&E matrices for a consistent use in engineering activities. It aims to describe a simple format used to support a consistent exchange of information between different engineering disciplines involved in project or maintenance activities. The document defines the minimum requirements of the C&E matrix content, which is derived from existing design documents, for example P&ID or verbal descriptions.

The transfer of the relations defined in C&E matrices into a functional or source code for the application programming of PLC/DCS is out of the scope of this document. In addition, this document does not cover the implementation of complex and/or sequential logics at a dedicated automation platform, which will require additional stipulations to be done/followed.

It is understood, that C&E matrices in fact can be used to document the fault actions of the plant equipment and therefore can be used as reference point for the necessary safety verifications to be applied.

C&E matrices as defined in this document do not have the same scope as Fishbone or Ishikawa diagrams, which are often named in the literature as cause and effect diagrams.

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62708, *Document kinds for electrical and instrumentation projects in the process industry*

IEC 81346-1, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

ISO 7200, *Technical product documentation – Data fields in title blocks and document headers*

### 3 Terms, definition and abbreviated terms

#### 3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

##### 3.1.1

##### **cause and effect matrix**

matrix which associates causes (3.1.2) and their effects (3.1.3) with the respective relations (3.1.4)

Note 1 to entry: A similar definition is found in ISO 10418:2003, Clauses 5 and C.1 for off-shore production platforms in oil and gas industry.