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TECHNICAL REPORT

On-line analyser systems – Guide to design and installation

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TECHNICAL REPORT

On-line analyser systems – Guide to design and installation

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ELECTROTECHNICAL
COMMISSION

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ON-LINE ANALYSER SYSTEMS – GUIDE TO DESIGN AND INSTALLATION

FOREWORD

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IEC 61831, which is a technical report, has been prepared by subcommittee 65B: Devices and integration in enterprise systems, of IEC technical committee 65: Industrial-process measurement, control and automation.

With the kind permission of the Engineering Equipment and Materials Users Association this report is based on and includes extracts from EEMUA Publication 138.

This second edition cancels and replaces the first edition published in 1999. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below.

- Updated references;

- Made consistent with current practices and regulations;
- Incorporating new technologies where applicable.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65B/744/DTR	65B/793/RVC

Full information on the voting for the approval of this technical report 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 web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This Technical Report provides guidance on the design and installation of on-line analyser systems. There are many International standards and documents which are referenced below relating to specific parts of the design and safety of on-line analyser systems. However, there is limited practical guidance available on the overall design concepts, approaches, tools and methodology for the design and installation of on-line analyser systems to ensure they perform with the required reliability and precision which this publication addresses.

The document is divided into eight clauses

1. General
2. Normative references
3. Terms and definitions
4. Remarks and considerations
5. Health, safety and environmental considerations
6. Housings
7. Sampling systems
8. Analyser communications

Individual users of on-line analysers have varying practices but the fundamental approach is generally similar. It is therefore hoped that this document will encourage standardisation within industry and lead to reduction in design and construction costs and to improved safety.

The word "analyser" has been used throughout this document to refer to instruments variously known as on-line analysers, process stream analysers, quality analysers, quality measuring instruments and process quality monitors.

Where reference is made to International standards it should be noted that National authorities may have statutory requirements that are mandatory.

ON-LINE ANALYSER SYSTEMS – GUIDE TO DESIGN AND INSTALLATION

1 Scope

This technical report is a guide applicable to on-line analyser systems. It provides the necessary guidance for the system supplier and user to specify or design a complete analyser system from sample point in the process to the final output for display or control purposes.

2 Normative references

IEC 61285:2004, *Industrial-process control – Safety of analyzer houses*

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

BS 5925:1991, *Code of practice for ventilation principles and designing for natural ventilation*

API (ANSI/ASTM D4177), *Manual of Petroleum Measurement Standards – Part 8: Chapter 8.2 Automatic Sampling of Petroleum Products ()*

EEMUA 175, *Code of Practice for Calibration and Checking Process Analysers (Formerly IP 340)*

3 Terms and definitions

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

3.1
analyser housing
general term including any of the following terms:

3.2
analyser case
enclosure forming part of the instrument

3.3
analyser cabinet
small simple housing in which analysers are installed singly or grouped together. Maintenance is carried out from outside the cabinet

3.4
analyser shelter
structure with one or more sides open and free from obstruction to the natural passage of air, in which are installed one or more analysers. The maintenance of the analyser is normally carried out from within the shelter

3.5
analyser house
enclosed structure in which are installed one or more analysers. Either natural or forced ventilation is used. The maintenance of the analyser is always carried out from within the house

4 Remarks and considerations

4.1 General remarks

The petrochemical, chemical, pharmaceutical and food industries need to be able to control their processes to ensure safety and environmental compliance and to optimise operations for maximum profitability. The use of on-line process analysers is a valuable tool in helping to achieve these objectives. This is because analysers provide frequent (continuous or cyclic) analytical information on key process properties to allow continuous on-line optimisation of the plant and rapid identification and correction of off-spec or undesirable operating conditions. Analyser repeatability is also usually better than a laboratory reference method which allows closer control and targeting to product specification.

However, the correct design and installation of on-line analysers which are addressed in this publication are essential to achieve the full benefits from the analyser systems. Analysers are expensive to install and maintain and should only be installed when there is a clearly defined and quantified benefit. On-line process analysers are usually justified for one or more of the following reasons:

a) Personnel and plant safety
b) Pollution measurement, prevention and control
c) Optimising plant operations for yield and throughput
d) Control of final products as closely as possible to maintain specification and minimise product quality give-away
e) Minimising product degradation and reprocessing costs in cases of plant upsets, change in mode of operation and start-ups
f) Improving energy efficiency of boilers, furnaces, distillation columns and reactors
g) Corrosion control

4.2 Further considerations

The following considerations are also important in the application of on-line analyser systems:

a) Analysers and associated sampling systems are often complex installations demanding attention from specialist personnel responsible for their maintenance. Therefore, it is essential that the end user has the appropriate, correctly trained manpower resources and spare parts available to ensure the analysers operate at the required level of performance to capture the anticipated benefits
b) The justification for analysers is not usually based on the reduction in the cost of laboratory testing as this saving is often offset by the associated increase in analyser maintenance costs. To promote the effective use of analysers by operators it is often beneficial to discontinue the duplication of analyses by laboratory testing. Laboratory facilities are still required for validating and calibrating the on-line analyser systems and for any statutory requirements
c) Single stream analysers are preferred and are usually essential for continuous automatic control
d) On-line analysers usually require environmental protection in the form of housings to ensure reliable operation

4.3 Reliability

The following points are important considerations in the design and installation of analyser systems:

a) Correct location and orientation of sample point
b) Proper design of the sample transport and sample conditioning systems
c) Availability of reliable and clean utilities
d) Environmental protection against heat/cold, humidity, solar radiation, rain, dust and corrosion
e) Ease of accessibility for maintenance of all the analyser system components
f) Proper design of validation and calibration facilities
g) Adequate preventive maintenance

4.4 Design

The design should permit maintenance, adjustments and repairs to be carried out quickly and preferably whilst the analyser is in operation. Components likely to require attention should be accessible without the aid of portable ladders or other temporary means and shall have mountings/fixings located such they are also accessible from the front. The overall design should eliminate or keep to a minimum the emission of hazardous or noxious gases and vapours and the possibility of liquid spillage.

4.5 Centralisation

The grouping together of a number of analysers where practical in a shared analyser house or shelter has a number of advantages:

a) Single housing
b) Common multi-core signal cables to control system
c) Common location for power, water, steam and compressed air supplies. Common drain, vent and purge lines
d) More efficient for maintenance
e) Common heating, ventilation and air conditioning (HVAC) systems

4.6 Local mounting

There are, however, cases where local mounting is desirable for the following reasons:

a) When the cost of centralisation would be disproportionate to the expected benefit
b) When centralisation would result in excessive sample transport time lags
c) When sample handling problems are to be expected e.g. waxy samples, trace components

4.7 Pre-assembled systems

Pre-assembled analyser systems supplied by specialist analyser systems contractors or the analyser vendors are generally the most convenient and economical approach to install new analyser systems in the plant. They may include one or more analysers with their associated sample conditioning system and common utility connections mounted together in the appropriate housing(s). There are many advantages to this approach:

a) Systems designed and factory constructed by a specialist supplier are generally superior to those produced in the field by a contractor on site
b) Detailed design and field construction by site contractor are reduced
c) Factory construction is independent of weather and labour conditions at site
d) Manpower at site is not usually skilled and experienced in this type of work

e) Systems can be fully tested under simulated operating conditions and major design, equipment and construction faults corrected before delivery to site

f) Proven designs can be used with consequent savings in costs and improved reliability

g) All relevant documentation can be incorporated into a single design and operating manual by the specialist supplier

5 Health, safety and environmental considerations

5.1 Overview

Analyser systems shall be designed, installed and operated in such a manner that they are non-hazardous to personnel, to the process plant and to the environment.

The principle hazards are ignition of flammable substances, contact with toxic substances, asphyxiation in enclosed spaces and release of harmful or polluting materials to the environment. It is also important that personnel coming into contact with analyser systems do not suffer injury from additional hazards such as burns, electric shock and cuts from exposed sharp edges.

A number of statutory requirements pertaining to safe design and practices are in force in many countries e.g. the ATEX and PED Directives in Europe. There are also specific standards relating to the safety of analyser systems e.g, IEC 61825. (See Clause 2 for normative references and bibliography for other references.).

5.2 Prevention of explosions and fires

The same conditions apply to the installation of analysers as with installation of any other electrical equipment in electrically classified hazardous areas and the appropriate relevant legal regulations and standards should be followed for the country in which the equipment is being installed.

The extent to which the measures need to be applied can be minimised by restricting the likely size of an internal release in the housing by:

a) Minimising and restricting the quantity of potentially dangerous materials entering the housing

b) Reducing the number of joints in sample lines

c) Using the lowest possible operating pressures

d) Reducing the power dissipation of the electrical equipment installed within the main enclosure of the equipment

e) Ensuring that the design does not produce surface temperatures above the ignition temperature of the gases or vapours that may be present

5.3 Prevention of toxic and asphyxiant hazards

When a system is designed, the toxicity of the substances should be considered so that under the worst fault conditions, the legal short-term exposure limits of the substances in the atmosphere are not exceeded. The design shall also ensure that, under the worst fault conditions, the atmosphere inside enclosed spaces which personnel may also enter, cannot reach asphyxiating levels. It should be noted that many substances will reach the short-term exposure limit or asphyxiant levels long before the lower flammable limit value.

Analysers handling toxic substances may need to be separately housed and clearly identified.

Sampling systems containing toxic or otherwise dangerous substances should be purged with air or an inert material prior to disassembly. Warning signs shall be provided to alert personnel to possible toxic and asphyxiate hazards.

Certain analysers contain toxic components and care is needed during maintenance e.g. reagents in wet chemical analysers and certain materials of construction. Toxic calibration samples shall be stored and piped from outside analyser housings.

5.4 Radiation hazards

Apparatus and enclosures containing radioactive sources shall be clearly identified and handled in accordance with the relevant statutory regulations.

5.5 Safety facilities

Gas monitoring and alarm systems for flammable, toxic and asphyxiant substances should be installed in enclosed analyser houses and cabinets as necessary. Fire extinguishers and/or fire blankets should be made readily available at housings containing flammable substances. Fire detection and automatic suppression equipment may also be appropriate. Escape facilities should also be provided as necessary.

Housings containing toxic, acid or alkaline materials should have eye baths and showers in a readily accessible nearby location.

5.6 Manual shut-down facilities

Manual shut-down devices for the incoming power, sample, carrier gas and other potentially hazardous utilities should be fitted close to the analysers. In the case of analyser cabinets, shelters or houses, these devices should be clearly identified and located outside the housing.

A separate shut-down device should be fitted for any associated house ventilation fans.

5.7 Noise

Attention should be paid to noise levels within analyser housings to ensure maximum short term and long term noise exposure limits are not exceeded. The most likely sources of noise are from heating air conditioning and ventilation systems, water chiller units, air vortex coolers, purge systems, pneumatic valve switching and sample pumps.

6 Housings

6.1 Overview

Analysers and analyser sampling systems require varying degrees of protection, depending on the type of analyser, importance of application and the environment in which it has to operate. Where the instrument case itself is not suitable for the working environment, additional protection should be provided. This additional protection is to ensure satisfactory performance of the instrument and to facilitate maintenance.

The selection of the housing required for a particular analyser system depends on a number of factors, such as:

a) Hazardous area classification of the area in which the analyser is to be located

b) Special requirements specified by the relevant safety authority, vendor or user

c) Range of ambient conditions at site (e.g. temperature, rain, humidity, snow, wind, dust/ sand, direct sunlight, corrosive atmosphere)

d) Environment specified by the analyser vendor for reliable, accurate and/or safe operation

e) Protection required for equipment and personnel during maintenance operations

f) Maintenance and accessibility requirements of the system components

g) The initial installed cost

This section primarily describes analyser housings located in hazardous areas and/or into which hazardous samples are introduced. Analyser housings located in a non-hazardous area and into which no flammable, asphyxiate or toxic samples, services, calibration mixtures, or air from a hazardous area is introduced are only required to provide the necessary environment for accurate and reliable operation without any special conditions for ventilation.

Four types of housing, as defined in Clause 3 are considered:

a) Analyser case
b) Analyser cabinet
c) Analyser shelter
d) Analyser house

6.2 Selection of housing

6.2.1 Analyser case

Analysers such as pH meters, electrolytic conductivity meters etc. may be installed directly in the open (enclosed only in the case) provided they comply with the specification of hazardous area classification and environment.

The advantages of this method are that the area around the case is naturally ventilated so there is no risk of accumulating an explosive atmosphere outside the casing. This is the lowest cost method of installation. The disadvantages are that there is no weather protection for equipment or maintenance personnel. Equipment shall be carefully specified to minimize corrosion attack and it may not have as long an operational life as equipment which is installed in a cabinet, shelter or house. This method of housing is not suitable when analysers require heating or extensive maintenance.

6.2.2 Analyser cabinet

Analysers can be installed singly or grouped in cabinets provided that the equipment is installed in accordance with the hazardous area classification. Analyser cabinets provide a low cost means of improving environmental protection for analysers and can help make the equipment more easily accessible for maintenance.

The analyser manufacturers environmental specifications can be met by e.g. including heater in the cabinet if required. Ventilation where necessary is normally achieved by natural means. The advantage of a naturally ventilated method is that ventilation is permanent and independent of mechanical failure.

However, natural ventilation does not change the hazardous area classification inside the cabinet and where a non-certified analyser with cabinet is to be installed in a hazardous area a certified air purge system will be required. The disadvantages of cabinets are that there is a practical limit on the size of analyser installed and no protection is provided for maintenance personnel.

6.2.3 Analyser shelter

This construction can be used when the analysers comply with the hazardous area classification of the location and the ambient environmental conditions comply with the analyser manufacturers specification. A shelter may be conveniently used for equipment requiring minimal protection.

A shelter is advantageous where highly toxic materials are handled. The advantages are that it facilitates the grouping of analysers and affords some protection for maintenance personnel, as well as affording permanent natural ventilation. Its disadvantage is that it does not give the