



**A Review of the *Second Edition (2007)* version of  
EEMUA's Publication 191:  
Alarm Systems: A Guide to Design, Management, and Procurement**

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**Objective:**

This document is a comparative analysis of the newly published Second Edition of EEMUA Publication 191, vs. the first edition of the same document.

**Executive Summary:**

The Engineering Equipment and Materials Users Association (EEMUA, [www.eemua.org](http://www.eemua.org)) is a European, non profit industry association, run for the benefit of companies that own or operate industrial facilities. EEMUA publishes a range of engineering guides, industry standards and specifications.

In 1999, they first published document 191: *Alarm Systems: A Guide to Design, Management, and Procurement*. This year, they published a Second Edition of their well-known Alarm Management text – a short review of which is offered here.

The new publication (ISBN 0 85931 155 4) contains a number of improvements, including:

- Three previously discussed measurements are identified as “key performance indicators,” and some others as important secondary measurements.
- The concept of *Performance Levels* is introduced, based on previously published articles.
- A “buyer’s guide” list is provided, containing features that should be present in original equipment manufacturer (OEM) or third-party alarm analysis tools.
- A third method of alarm rationalization, consisting of 4 pages of flowsheets, is added to the original two methods.
- The concept of Operator Alerts is introduced.
- A new appendix concerning Alarm Management in Batch Plants is provided.
- A work process methodology for conducting alarm system improvement is introduced.

**PAS recommends that alarm management professionals purchase a copy of the new edition.**

The EEMUA guide is further recommended as an ideal companion text even for those already owning *Alarm Management: Seven Effective Methods for Optimum Performance* from the ISA or *The Alarm Management Handbook* from PAS.

### **Introduction and Background:**

EEMUA (The Engineering Equipment and Materials Users Association) is a U.K.-based, influential organization of purchasers, specifiers and users of engineering-related products, particularly relevant to the processing industries. EEMUA produces a variety of valuable documents designed to assist companies in the proper design, installation operation, and maintenance of plant facilities.

In 1999, EEMUA did the world a large service via the original publication of their document 191: *Alarm Systems: A Guide to Design, Management, and Procurement*. This foundational document addressed the widespread problems associated with screen-based alarm systems, mostly associated with Distributed Control Systems (DCSs). The field of knowledge is known as Alarm Management.

In this original document, henceforth referred to as 191-V1 (Version 1), EEMUA described a variety of principles, practices, measurements, work practices, and provided other valuable information about Alarm Management.

### **Subsequent Works:**

In the ensuing years, 191-V1 received widespread acceptance and use. Many companies have analyzed and improved their alarm systems. Literally terabytes of information, and hundreds of successful alarm improvement projects were implemented subsequent to the publication of 191-V1.

Many magazine articles expanding on the information in 191-V1 were written and the Alarm Management knowledge base expanded significantly.

In 2006, PAS published a book designed to complement and expand on the information provided in the 191-V1. *The Alarm Management Handbook* contains detailed state-of-the-art information about not only “what to do” relative to the alarm problem, but highly detailed information on exactly **how to do it**, in an effective, efficient, and productive manner. The information is based on proven experience gained through the actual analysis and improvement of hundreds of alarm systems. The book includes the complete contents of a comprehensive alarm philosophy. It is available through [www.PAS.com](http://www.PAS.com) or on Amazon.com.

In 2007, the Instrumentation, Systems, and Automation Society (ISA) published a version of this same book, under the ISA title *Alarm Management: Seven Effective Methods for Optimum Performance*. ([www.isa.org](http://www.isa.org))

### **The New, Second Edition of the EEMUA 191 Document**

In June 2007, EEMUA issued the Second Edition of the 191 document (to be referred to herein as 191-V2). Price is 87 Pounds (~ \$174), available at [www.eemua.org](http://www.eemua.org).

Many people are highly interested in knowing “what’s new” in 191-V2. The new edition contains both additional information and changed information. This review will focus on the new material and is not a comprehensive review of the entire document. Clearly, as a reference document for people dealing with alarm management, access to a copy of EEMUA 191 (either version) is a wise investment.

If you already have 191-V1 and are wondering if 191-V2 is needed as well, this review should be of assistance. If you have access to 191-V1 and also a copy of *The Alarm Management Handbook* (or the ISA version) this review will be particularly useful.

### **Summary of Changes: The Second Edition of EEMUA 191**

EEMUA 191-V2 contains the following changes and additions, with some other modifications of lesser significance.

- Three previously discussed measurements are identified as “key performance indicators,” and some others as important secondary measurements.
- The concept of *Performance Levels* is introduced, based on previously published articles.
- A “buyer’s guide” list is provided, containing features that should be present in original equipment manufacturer (OEM) or third-party alarm analysis tools.
- A third method of alarm rationalization, consisting of 4 pages of flowsheets, is added to the original two methods.
- The concept of Operator Alerts is introduced.
- A new appendix concerning Alarm Management in Batch Plants is provided.
- A work process methodology for conducting alarm system improvement is introduced.

The details and comparative significance of these changes are covered in the remainder of this review.

### **A Section-by-Section Detailed Review of the EEMUA 191 Second Edition:**

#### **Section 1 – Alarm Philosophy (six pages)**

No significant changes.

#### **Section 2 – Principles of Alarm System Design (16 pages)**

Only section 2.3.3 – *Safety Related Alarms* (1 page) has significant changes. 191-V2 intentionally deletes some of the information provided in 191-V1 and emphasizes that such alarms should be designed per IEC 61508 and 61511.

#### **Section 3 – Implementation Issues (11.5 pages)**

Sections 3.1 to 3.5 – no significant changes.

Section 3.6 – Testing of Alarms (2.5 pages). The original 191-V1 had a flowchart for determining test frequency. In 191-V2 this flowchart is deleted.

#### **Section 4 – Measuring Performance (8 pages)**

The original 191-V1 only contained 2 pages in this section. This is now expanded, along with an entirely new *Appendix 13 – Performance Level* (reviewed below). EEMUA now identifies 3 measurements (which were previously mentioned in 191-V1) as Key Performance Indicators. They are:

- Average Alarm rate (per 10 minute or per hour)
- Maximum alarm rate (per 10 minute)
- Percentage of Time alarm rates are outside of the acceptability target

191-V1 also describes how to calculate these. These are not new measurements; what is new is that EEMUA now says that they are key measurements. Targets and ranges remain unchanged from the original 191-V1.

The term *Performance Level* is introduced and briefly described. In Section 4, this is only an introduction, which is more thoroughly addressed in Appendix 13. The entire concept is reviewed in the Appendix 13 section below.

Also identified as important secondary measurements are:

- Number and duration of Shelved Alarms
- Number and duration of standing alarms
- Percentage of the overall alarm load that is produced by the top 10 most frequent alarms

Additionally new is *Section 4.2.1 – Specification of Alarm Logging and Analysis Tools*. This is a “buyers guide” regarding important features that original equipment manufacturer (OEM) or third-party alarm analysis tools should have. From an examination of the items, it appears to me that most of the major third-party players that offer this type of software essentially meet the recommendations in the list (there are no surprises).

Note that the *The Alarm Management Handbook* (or the ISA version), thoroughly covers all of these measurement topics, and is supportive of both 191-V1 or 191-V2.

### **Section 5 – Managing an Improvement Programme (3 pages)**

No significant changes.

### **Section 6 – Buying a New Alarm System (4 pages)**

No significant changes. This is a bit surprising considering the advances in OEM technology since the 1999 publication of 191-V1.

## **EEMUA 191-V2 Appendices**

### **Appendix 1 – Glossary (3 pages)**

The glossary expanded from 1 page to 3.

### **Appendix 2 – Design of Individual Alarms (5 pages)**

No significant changes.

### **Appendix 3 – Qualitative and Quantitative Risk Assessment (2 pages)**

No significant changes.

### **Appendix 4 – Examples of Risk Assessment (3.5 pages)**

Only item *A4.1.1 – Identification of Risks*, is significantly changed. In this item, the example using “motor current” is extended from 3 paragraphs to 8 paragraphs. Other than this, there are no significant changes to the remainder of this Appendix.

## **Appendix 5 – Setting of Priority (14 pages)**

The changes to this section are as follows:

In *Section A5.1 – Severity of Consequences*, the original 191-V1 contained a Figure 23 – Comparison of Pre-Trip and Final Warning Alarms. This figure has been removed in 191-V2.

In section *A5.3 – Priority Distribution of Alarms*, EEMUA more strongly emphasizes that the desirable 80% Low – 15% Medium – 5% High priority distribution is approximate and will vary with the type of plant.

Beginning with Section *A5.5 – Example Procedures for Setting Priority*, EEMUA retains the first two methods described in 191-V1, then adds a third new one. In new section *A5.5.3 – Method 3: General Alarm Assessment*, EEMUA introduces a prioritization method involving 4 separate flowcharts.

The first two methods are based upon probabilistic risk assessment techniques. By far, most companies consider such methods overly complex and overly time-consuming for the task of alarm rationalization. Most Abnormal Situation Management (ASM®) Consortium companies use a much more straightforward, efficient, and proven method that is described in great detail in *The Alarm Management Handbook* (and the ISA version).

My examination of the flowcharts for the new, 3<sup>rd</sup> method indicates that they are a significantly more complex way of essentially stating a similar methodology to the ASM Consortium method mentioned above. That is, in using these flowcharts one will arrive at substantially the same results as the more straightforward method that is already well-known.

The listing in *Section 5.6 – Record Keeping*, of information to obtain during Rationalization is unchanged. However, EEMUA adds a new “typical example table” of this information. The example table contains the phrase “Do not consider any ESD backup.” This rather confusing statement is somewhat contradictory to prior wording in 191-V2 Appendix 5, including the new EEMUA flowcharts, where the existence of a Safety Instrumented System is a factor in determining priority. It also contradicts known best practices for rationalizing alarms, described fully in *The Alarm Management Handbook*.

EEMUA confirms that the statement was intentional, “in order to encourage a full examination of the consequence of failure to respond, rather than simply assuming that all will be well because the ESD will eventually initiate.” However, this guidance deserves some examination.

The inclusion of probabilistic evaluation of the *failure rate* of an ESD system, in determining DCS alarm priority, is also seen by most as a needlessly complex and unnecessary step. If you have a concern with the failure rate of your ESD system, the concern is certainly not addressed by increasing a chosen DCS alarm priority! And, the consequences of ESD action are not that “all will be well,” instead ESD activation usually produces significant economic and/or environmental consequences.

## **Appendix 6 – Types of Alarms (2.5 pages)**

No significant changes.

### **Appendix 7 – Alerts (1 page)**

This is a totally new Appendix (and also gives all subsequent appendices different numbers compared to 191-V1).

In this appendix, EEMUA describes (as a best practice) the need for operators to have a technology other than, and separate from, the alarm system for configuring ad-hoc timers, reminders, and process-related notifications for day-to-day use. The alarm system is properly reserved for predetermined (rationalized) events that require operator action to avoid a predetermined consequence. Various day-to-day needs are more properly met by a separate system – one that can be safely set aside during periods where the operator must deal with alarms.

The guidance in this section is very similar to the section “Operator Alert Systems” previously published in *The Alarm Management Handbook*. The mixing in of lesser-importance, non-rationalized “alerts” into the alarm system would act to devalue the importance of the alarm system – a reason for their exclusion into a separate system.

### **Appendix 8 – Logical Processing of Alarms (8 pages)**

No significant changes from the 191-V1 version.

### **Appendix 9 – Repeating and Fleeting Alarms (9.5 pages)**

No significant changes from the 191-V1 version.

Note that in *A9.6 - De-Bounce Timer*, the very significant differences between ON-DELAY and OFF-DELAY are not explained. (The example algorithm is for OFF-DELAY.) The EEMUA table of recommended default values based upon sensor type contains two entries of 60 seconds. Many companies believe that anything more than a 30 second delay – particularly an ON-DELAY – must be chosen only with great care. This is covered in *The Alarm Management Handbook*.

### **Appendix 10 – Design of Field Alarm Sensors (5 pages)**

No significant changes from the 191-V1 version.

### **Appendix 11 – Design of Alarm List Displays (5 pages)**

This section is designed with DCS manufacturers as the target audience. There are no significant changes to the 191-V1 version. This is a bit surprising, considering the advances in OEM technology since the 1999 publication of 191-V1.

### **Appendix 12 – Performance Metrics (8 pages)**

There are no significant changes from the 191-V1 version, even though the EEMUA 191-V2 page xiv lists this section as significantly revised.

Note that 191-V2 retains the guidance around measuring configured alarms relative to the numbers of control actuators, analog measurements, and digital measurements. This is a complex and time-consuming analysis. Analysis of hundreds of systems has demonstrated that it is not a valid predictor of alarm system performance. That is, systems configured well within these guidelines can often produce thousands of alarms per day.

### **Appendix 13 – Performance Levels (8 pages)**

This is an entirely new Appendix. The information in it is based on an important and influential article by Donald Campbell-Brown. The referenced article is: “*Alarm System Performance – One Size Fits All?*” which was published in *Measurement+Control* (May 2003), page 120 and is available online, including at: <http://www.sipi61508.com/ciks/brownc1.pdf>.

In this article and this EEMUA section, Campbell-Brown describes a 5-level performance ranking system of Overloaded, Reactive, Stable, Robust, and Predictive. Both qualitative and quantitative measures are used to define the attributes of each category. (Note: engineers reading the section may be prone to ignoring the qualitative measures and focus more on just the quantitative ones. In this evaluation, the qualitative measures are quite important!)

The information in this Appendix, and this article, are also thoroughly covered in *The Alarm Management Handbook* (and the ISA version), with proper attribution to Donald Campbell-Brown.

### **Appendix 14 – Operator Questionnaire (4 pages)**

No significant changes from the 191-V1 version.

### **Appendix 15 – Usefulness Questionnaire (2 pages)**

No significant changes from the 191-V1 version.

### **Appendix 16 – The Costs of Poor Alarm Management (4.5 pages)**

There are no significant changes from the 191-V1 version. The list of significant accidents used to illustrate the magnitude of the problem is unchanged. This is a bit surprising, considering the several high-profile accidents that have occurred since the 1998 publication of 191-V1. Also, while the IChemE database is mentioned, the large amount of excellent and relevant information available at the U.S. Chemical Safety Board’s website ([www.chemsafety.gov](http://www.chemsafety.gov)) is not mentioned in EEMUA 191-V2’s text nor mentioned in the references section.

### **Appendix 17 – Specification Checklist – Large System (6 pages)**

No significant changes from the 191-V1 version.

### **Appendix 18 – Specification Checklist – Small System (2 pages)**

No significant changes from the 191-V1 version.

### **Appendix 19 – Alarm Suppression Hazard Study (3 pages)**

No significant changes from the 191-V1 version.

### **Appendix 20 – Alarm Management in Batch Plants (6.5 pages)**

This is an entirely new Appendix. The section is intended to address comments made to EEMUA that there was inadequate coverage of batch-related alarms. The differences have to do with such factors that batch (and semi-batch) plants may not be continuously manned in the control room and thus the “board operator” paradigm may not apply. Computer control and computer-generated alarms are also more common in batch plants. This Appendix has several sections:

*A20.1 Batch Plant Operation (6 paragraphs)*

An overview, with alarm-related considerations based upon possible batch plant differences.

*A20.1.1 Alarm Thresholds (2 paragraphs)*

Desirable flexibility and other considerations for batch-related alarms.

*A20.1.2 Replacement of Batch with Semi-Batch or Continuous Processes (1 paragraph)*

Discusses inherent safety and the use of HSE publication HGS143.

*A20.2 Operator Information (5 paragraphs)*

Describes the operator's role and differentiates between *alarms*, *messages*, and *prompts*.

*A20.3 Alarm rates (3 paragraphs)*

Discusses issues around batch alarm rates compared to the other metrics in EEMUA 191-V2.

*A20.4 Application of Alarm Priorities in Batch Processes (2 paragraphs)*

Recommends using priority to differentiate between types of consequences rather than severity of consequences.

*A20.5 Design of the Alarms (one paragraph, 1 figure)*

Provides a reference to the ISA SP88 standard

*A20.6 Generation of Alarms (4 paragraphs)*

Guidance around the sources of batch alarms and the information that should be contained in them.

*A20.7 Management of Alarm Limits Thresholds. (3 paragraphs, 1 figure)*

General guidance about alarm limits relative to safety of the process, and the need to vary those limits based upon batch-related characteristics.

*A20.8 Sources of Nuisance Alarms (2 paragraphs)*

Describes 2 additional batch-related sources of nuisance alarms

*A20.9 Sources for Alarm Floods (3 paragraphs)*

Puts forward reasons that alarm floods are less of an issue for batch plants and notes some considerations around them.

*A20.10 Getting Information to Remote Operators (6 paragraphs)*

Discusses 6 ways to transmit alarm information remotely (pagers, remote banners, remote indicator lights, remote operator workstations, variable tone alarm klaxons, and fixed alarm annunciator panels/displays).

To be fair, *The Alarm Management Handbook* does not contain a batch-specific section!

**Appendix 21 – Alarm System Improvement Process (4 pages)**

In this section, EEMUA puts forward a methodology to describe the sequence and relationship of tasks for accomplishing alarm improvements. The elements involved are:

- Pre-Cursors
- Problem Identification
- System Capability
- Review Team / Strategy Document
- Supporting Documentation
- System Tuning
- Plant Area Categorization
- Plant Area Review
- Alarm Data Sheet / Database
- Integration

- Monitor /Maintain

These elements are shown in the typical engineering fashion of a block diagram containing multiple lines (solid and dotted), paths, recycles, and arrows going in various directions. The focus is on performing alarm review, and does not include such fundamental steps as the development of an alarm philosophy, creating baselines, etc.

The result is a work process diagram whose clarity and direct relationship to alarm-related measurements, functions, and tasks could be significantly improved.

The Life Cycle methodology being used in the creation of the ISA's new *SP-18 Alarm Management Standard* is a better representation of a practical approach to the issue of alarm system improvement.

However, the simplest, most effective, and thoroughly proven methodology is described in detail in *The Alarm Management Handbook*, namely:

### **Seven Steps to a Highly Effective Alarm System**

#### **“Always-needed” steps:**

- Step 1: Develop, Adopt, and Maintain an Alarm Philosophy
- Step 2: Collect Data and Benchmark Your Systems
- Step 3: Perform “Bad Actor” Alarm Resolution

#### **Steps to implement based on alarm system performance after the first 3 steps:**

- Step 4: Perform Alarm Documentation and Rationalization (D&R)
- Step 5: Implement Alarm Audit and Enforcement Technology.
- Step 6: Implement Real Time Alarm Management
- Step 7: Control and Maintain Your Improved System (*\*this step also always needed*)

### **Appendix 22 – References (3 pages)**

Minor modifications

### **Appendix 24 – Bibliography (1 page)**

New Appendix, has 3 entries

### **Questions? Comments?**

For questions, comments, or further information see [www.pas.com](http://www.pas.com) or contact Bill Hollifield, Principal Alarm Management Consultant via email at [bhollifield@pas.com](mailto:bhollifield@pas.com).