IAEA ACTIVITY ON OPERATOR SUPPORT SYSTEMS IN NUCLEAR POWER PLANTS

V. Dounaev
Consyst Co., Ltd.,
Moscow, Russia

Y. Fujita
Mitsubishi Atomic Power Industries, Inc.,
Tokyo, Japan

K. Juslin
Technical Research Centre of Finland,
Espoo, Finland

K. Haugset
OECD Halden Reactor Project,
Institutt for Energiteknikk,
Halden, Norway

A. Kossilov
International Atomic Energy Agency,
Vienna, Austria

I. Lux
KFKI Atomic Energy Research Institute,
Budapest, Hungary

J. Naser
Electrical Power Research Institute,
Palo Alto, California
United States of America

Abstract

Various operator support systems for nuclear power plants are already operational or under development in the IAEA Member States. Operator support systems are based on intelligent data processing and, in addition to plant operation, they are also becoming more important for safety. A key feature of operator support systems is their availability to restructure data to increase its relevance for a given situation. This can improve the user's ability to identify plant mode, system state, and component state and to identify and diagnose faults. Operator support systems can also assist the user in planning and implementing corrective actions to improve the nuclear power plant's availability and safety. In September 1991, the IAEA Committee for Contractual Scientific Services approved the Co-ordinated Research Programme (CRP) on "Operator Support Systems in Nuclear Power Plants" in the

framework of the Project "Man-Machine Interface Studies". The main objective of this programme is to provide guidance and technology transfer for the development and implementation of operator support systems. This includes the experience with human-machine interfaces and closely related issues such as instrumentation and control, the use of computers in nuclear power plants, and operator qualification.

1. INTRODUCTION

An international organization is in an ideal position for creating a framework that is instrumental in the exchange of knowledge and experience. The role of the IAEA in collecting, systematizing, and developing scattered knowledge and experience has been recognized since its inception.

Following recommendations made at the Specialists' Meetings in Helsinki ("Artificial Intelligence in Nuclear Power Plants", October 10-12, 1989) and Lyon ("Communication and Data Transfer in Nuclear Power Plants", April 24-26, 1990), the International Working Group on Nuclear Power Plant Control and Instrumentation (IWG-NPPCI) suggested the organization of a CRP on "Operator Support Systems in Nuclear Power Plants".

It was suggested by the IWG-NPPCI that the proposed CRP should focus its efforts on various aspects of who are the users of operator support system, what are their needs, and what would be the benefits of operator support systems. In September 1991, the IAEA Committee for Contractual Scientific Services approved the programme in the framework of the "Man-Machine Interface Studies" project.

The main objective of this programme is to provide systematic guidance and information on human-machine interfaces and closely-related issues including instrumentation and control, the use of computers in nuclear power plants, and operator qualification. An essential part of this objective is to exchange experiences in these areas between co-operating organizations.

2. SCIENTIFIC BACKGROUND

Motivation

In the last twenty five years, the size and complexity of nuclear power plants have increased significantly. In addition, the requirements on operations, maintenance, engineering, and management personnel to improve availability, reliability, and productivity and to reduce safety challenges to the plant have increased. These personnel are working with more complex systems, and responding to increasing operational, financial, and regulatory demands. As tasks become more complex, involving large numbers of subsystem interrelationships and large amounts of data, the likelihood of potential errors and their detrimental consequences may increase. Reliable, integrated operator support systems can play a critical role in increasing availability and reliability, in reducing operation and maintenance costs, and in protecting the utility's capital investment.

The technological advances of the last few years have made it possible to develop sophisticated operator support systems, which can not only process and present information, but can also give advice to the operator. With appropriately implemented operator support systems, humans can be augmented substantially in their capacity to monitor, process, interpret, and apply information; thus reducing errors and increasing reliability and availability. These operator support systems can increase productivity by eliminating routine human-power-intensive efforts such as recording, collecting, integrating, and evaluating data; and by assisting in monitoring and control activities. They can improve the consistency and completeness of decision-making activities by performing the role of diagnostic and decision-support advisors. Operator support systems can assist in reducing safety challenges to the plant by presenting more complete, integrated, and reliable information to plant staff to better cope with operating and emergency conditions. Reducing safety challenges leads directly to improved reliability and availability and hence productivity. An additional advantage of operator support systems is that they can, and should be, tailored to the specific needs of the user.

Problems experienced and what has been done

Operational, diagnostic, monitoring, and maintenance errors have all occurred in power plants causing reductions in availability and substantial financial consequences. The event at Three Mile Island is an extreme example of this. Since this event, a number of operator support systems have been implemented to assist in the control room such as critical parameter displays, boiling curve displays and tables, and emergency operating procedure flow charts. These operator support systems have demonstrated their ability to assist humans in making their decisions and increasing the availability of the power plant.

In the maintenance area, operator support systems have been developed to reduce equipment failures such as instrumentation out of calibration, emergency diesel generator faults, and pump degradation. These operator support systems allow faster fault detection and diagnosis, and give the capability to know when to perform conditioned-based maintenance on plant equipment. Conditioned-based maintenance and faster fault detection and diagnosis can reduce the plant down time and repair costs.

In the engineering area, operator support systems have been developed to assist in many areas which are either difficult or time consuming. Some examples are refueling planning systems, design aiding tools, and root cause advisors.

Finally, in the management area, operator support systems have been developed to assist in planning and decision making. Examples are maintenance planning advisors and cost-effective plant operation decision aids.

Future directions

Advances in technological and human engineering offer the promise of helping nuclear power plant staff to reduce errors, improve productivity, and reduce the risk to plant and personnel. A plant-wide infrastructure for coordinated operator support systems should be created to enhance these systems and to reduce their implementation costs. This infrastructure will include information communication capabilities, database and knowledge base managers, and a unified human-machine interface. This infrastructure will permit incremental additions of operator support systems in all domains.

Eventually operator support systems will be developed to assist humans in all areas where the systems can demonstrate usefulness to the human. Guidance and tools for developing and implementing these operator support systems will be created. These operator support systems will be implemented both in new plants and as retrofit upgrades to existing plants.

3. PROGRAMME GOALS

The major goal of the IAEA Coordinated Research Programme on Operator Support Systems in Nuclear Power Plants is to supply guidance and technology transfer in the development and implementation of operator support systems. Several subgoals have been identified to accomplish the first steps necessary to achieve this overall goal. These subgoals are to:

- Determine the current status of operator support systems and their availability
- Assess Member States' experience with operator support systems
- Determine plant activities which can benefit from operator support systems
- Identify needed operator support systems and classify them in terms of type, user, and criticality
- Evaluate the consequences of "soft automation" which occurs with some types of operator support systems
- Develop recommendations on how to implement operator support systems in nuclear power plants from both the technological and human factors aspects
- Develop requirements for methods to evaluate the usefulness of operator support systems to the user
- Develop requirements for methods to perform cost/benefit analyses to help justify operator support systems

- o Perform a review of current practices for qualification, verification, and validation of operator support systems.

4. SCOPE OF WORK

The scope of work for this programme has been divided into five areas. The tasks in these five areas are designed to achieve the goals mentioned above. The following is a detailed description of these five areas and some of the questions that still need to be answered.

Operator support systems' current status and experience

Various operator support systems are already operational or under development in different countries. Essential consideration in operator support system development is the integration with other instrumentation and control systems. A serious lack of proven methods and practical international standards to support this integration still exists.

Existing experience in the development and implementation of the operator support system gives the opportunity to evaluate the achieved results, to determine the implementation tasks and difficulties, and to define the requirements of an operator support system to assist power plant personnel. The following activities are needed to achieve this information. The physical and mental tasks to be performed by the operator need to be defined to determine what activities are potentials for an operator support system. Areas of operation that are difficult, error-prone, or routine for human operators both in operational maneuvers and in comprehension and planning should be identified. These are areas which are prime candidates for operator support system development. An understanding of existing operator support system functions and how well they have been utilized can yield important lessons for future implementation activities. An accumulation of a list of operator errors and plant departures from optimum performance will also present potential areas for future operator support system. These activities will help identify the areas of opportunity for operator support system capabilities.

Identification and classification of operator support systems

The problems of terminology and classification are extremely important for all technical areas. Solving these problems allows the implementation of a systematic approach in the design, evaluation, and acceptance of integrated operator support systems. Initial practice in this area by UNIPEDE and the Halden Project can be a basis for the classification of operator support systems. This classification will be useful for designers as well as for licensing organizations.

So far operator support systems, which have been developed, have not been classified as safety systems or safety-related systems requiring a formal licensing procedure. However, there are signs that some operator support system applications might be in these areas in the near future. Therefore, it is essential to identify and correctly classify these systems and to consider the potential licensing ramifications for them.

An important effort in the identification of operator support systems is the development of functional tasks performed by operators and the determination of where operator support systems can contribute to these tasks in a useful manner. This can be achieved by looking at the operational, maintenance, engineering, and management activities in a nuclear power plant. These activities can then be evaluated to determine which could benefit from the utilization of operator support systems. Associated with this effort, it is also necessary to understand the relationships between the responsibilities of the operator and the operator support systems.

In this connection it is important to consider the following needs. Information which would allow the matching of operator support system with operator/operational needs must be obtained. It is important to define who is the operator and what is an appropriate operator support system. A foundation based in plant activities to classify operator support system should be established. An essential aspect for the success of operator support systems is the determination of a method for classifying the relationship between the operator's responsibility and the operator support system's responsibility. Determining the operational degrees of freedom is needed. For example, how much control and responsibility does an operator really have and how much should the operator have, leads to what roles the operator support system can play in the power plant. To support implementation of operator support systems, it is important to develop a classification scheme for operator support system functions.

Human aspects of introducing operator support systems

The availability of advisory systems to the operator is changing the operator's basis for making decisions and performing actions. It is essential that the operator support system does not limit the operator's ability to use his own creativity and knowledge when faced with problem solving tasks. Rather, the operator support system should support him in using his knowledge and extending it. The success or failure of this depends very much on the way the operator support system is designed, and the background the operator has in utilizing this technology. The specific items to be considered are described below.

When designing the operator support system, it is important to ensure that it, in practice, gives the intended support and is accepted by the operator. One way of coping with this is by involving the user at an early phase of the operator support system development. Questions still remain to be answered. Should this be done at the time of the operator support system function specification, during the design of the human-machine interface, or when? Are there many steps in which to involve the user?

Introduction of operator support systems changes the type of information available to the operator. The operator may change his role from performing detailed actions, such as control actions, to making more high-level decisions. Will this change the operator's role and also present new requirements for the operator with respect to basic education and training?

Efficient use of an operator support system can only be made if the operator is familiar with the function of the operator support system and its interface to the user. Training in use of the operator support system is important, so that the operator can use it in the right situation and in the right manner. Training, using a full scope simulator is foreseen, to ensure the operator has these abilities.

Extensive use of operator support systems may make the operator dependent on the system, and reduce his ability to handle the situation correctly if the operator support system is unavailable or gives wrong or incomplete information. Especially in the case of diagnostic systems for the handling of unexpected events, this may have a negative effect on operator performance. The reliance upon an operator support system may lead to what is called "soft automation". Is this desirable, and what requirements does that put on the operator support system quality? Can the operator support systems be designed so that the operator's ability to handle the situation on his own is not deteriorated, but actually improved?

Technology for implementation

In this section, the programme will be focused on computerized operator support systems which are expected to constitute the main part of future operator support systems. With the fast development of computer technology, the main task will be to apply the technology in the correct manner. That is, avoiding technology-driven operator support system development and instead doing development based on user needs.

In cases where a large number of operator support systems are to be implemented in the control room, special attention must be paid to integration of the operator support systems with respect to other systems and to design of a unified human-machine interface for all of the systems. As introduction of a new operator support system normally means that more and new types of information are available, guidance should be given on what information to display and how to display it so that it is useful and does not add a burden to the operator.

Even though new plant designs are being developed, where operator support system-based control room concepts are presented, operator support systems will mainly be utilized through a gradual upgrading of existing plants. Special attention must be paid to establishing the infrastructure necessary to successfully implement operator support systems. Elements in this infrastructure are communication and computing capabilities, databases, and knowledge bases. How to assure compatibility between analog and digital equipment is another important issue. Regarding the human-machine interface, the mixed analog/digital control room represents a particular challenge.

Cost/benefits and evaluation

The cost/benefits of an operator support system is very difficult to determine before experience with the system has been gained through practical application. Especially systems intended to assist in rare events (e.g., disturbances, accidents) are difficult to analyze in this respect. The problem of defining cost/benefits reduces the speed with which operator support systems are introduced in nuclear plants. What may be done to assist in cost/benefits analysis to change this situation? Which methodologies are currently available to arrive at more accurate cost/benefit data?

One way of quantifying the usefulness of an operator support system is to perform a realistic evaluation of the operator support system before actual implementation at the plant. Which methodologies are available to do this (e.g., experimental, analytical) and what requirements are needed to assure realism of the simulators, test subjects, and design of the evaluation experiments? It is also important to develop credible techniques for evaluating the operator support system after implementation.

In the case of computerized operator support systems, which have a relevance to safety, software/hardware qualification and verification and validation (V&V) is of particular importance to ensure sufficient reliability of the operator support system. Especially in the case of complex support systems based on knowledge-based techniques, good V&V techniques are just being developed. How should V&V be performed to guarantee the required quality of the system? What limitations are there in use of the various operator support system development methodologies (e.g., model-based, knowledge-based, simple logic, software size and complexity) for developing systems assisting in the various tasks (e.g., safety critical, safety-related, non safety-related)?

In many countries the utilities and safety authorities do not yet have any well established practice and know-how on qualification of operator support systems. More international cooperation is needed here.

5. RESULTS EXPECTED

This programme will produce several documents and technology transfer meetings. During each year, a Coordinated Research Programme meeting will be held to discuss the progress of each organization on the tasks in this programme. A report of each of these meetings summarizing the results will be put together. At the end of the programme, a final report will be created describing all of the activities carried out by the co-operating organizations. Depending on the success of this programme and interest in performing more work on operator support systems for plant productivity improvements, it is envisioned that a follow-up programme will be developed.

The intermediary and final reports will give guidance for the development and implementation of operator support systems. The information in these reports will consist of shared knowledge and experience of organizations in several countries.

The results of these efforts will benefit all countries in their development and implementation of operator support systems. Obviously, the organizations and countries, which need the most help in developing and implementing operator support systems, will have the most to gain.

A comprehensive set of national technical reports after each Research Coordination Meeting, as well as summary reports and final technical documents, will be distributed to all participating organizations.

6. DEVELOPMENT OF THE IAEA DATABASE ON OPERATOR SUPPORT SYSTEM

The group of organizations taking part in the CRP's first meeting regarded it necessary to set up a database containing the most pertinent characteristics of the operator support systems operating in nuclear power plants worldwide. The main reasons for this decision were the following:

- o The important field of operator support systems is changing very rapidly and a database would be the most efficient means of keeping the interested parties well informed. It was recommended that the IAEA should consider assisting in the creation and maintenance of this database;
- o There is a large amount of activities going on worldwide related to operating support systems. It would be more efficient if the different countries and organizations could learn about each other's experiences and take advantage of them when appropriate;
- o Since the questionnaire will be sent to all countries engaged in nuclear power plant activities, the database will represent a more complete collection of information about the worldwide status of operator support systems at any time than can be supplied by the CRP participants alone;
- o Since the implementation of operator support systems in nuclear power plants is growing every year, and their influence on the operation of the nuclear power plant is increasing, it is of primary importance to share the experiences and practices throughout the world;
- o Since the contents of the database will be available to everybody in connection with the IAEA, it would promote more efficient and further exchange of information among the IAEA members.

Besides the general merits of the planned database as above, the potential users of the database will receive the following benefits and advantages:

- o The database is meant to contain the most detailed and concise information from the widest source of information that has ever been gathered on operator support systems in nuclear power plants.

- o Furthermore, as the database is expected to contain a continuously updated set of data, up-to-date information will be available to all possible interested users at any time.

- o The database will serve as a source of information to
  - possible users of an operator support system
  - possible developers/vendors of an operator support system
  - authorities
  - public relations officials and public.

  As such it may help the mutual understanding of the above parties by offering concise technical contents with well defined terminology and context.

- o The database is an excellent tool for drawing general conclusions on a worldwide basis concerning specific aspects of operator support systems. With properly defined keys for the database, various features of the existing operator support systems can be collected, compared and/or determined. The database will be a unique tool for making statistical analysis of information pertaining to specific characteristics or subsets of the existing operator support systems.

- o Information concerning specific features of the systems (e.g., configuration, number of input/output signals, methods used, the invested financial and human-power resources) will help other developers and/or users in the design and development of a new system.

- o Comparison of similar systems at various plants may reveal tendencies or systematic differences. The analysis of these may lead to the understanding of the possible future role and development directions for such systems.

- o Analysis of certain features, components, and development methods of the operator support systems may contribute to the formulation or refinement of quality assurance (QA), V&V or other authority-set requirements in some of the member states.

- o Finally, in the most general sense, since the database will be made available to all IAEA members, it will contribute to a more efficient exchange of information among the firms, institutions, and establishments involved.

Questionnaire on existing operator support systems

An important information basis for the present CRP is the current status on the use of operator support systems. To gather as much information on this topic as efficiently as possible, the decision was made to develop a questionnaire to be sent to organizations engaged in this field. The two main groups addressed by the questionnaire are the developers of operator support systems and the users of operator support systems. The same set of questions will be sent to both groups. The information to be gained from the survey is expected to represent an important extension of the information gathered by the CRP members directly from their respective countries.

The questionnaire for the survey on existing operator support systems covers the following areas: organization information, functionality, usage, technical system specification, development process, testing results, use, cost and benefits, training, and documentation. The document was sent out by the IAEA to national representatives who were responsible for further distribution within their own country. The completed questionnaires were returned to the IAEA.

So far, information on existing operator support systems has been collected by the IAEA from more than 60 enterprises, institutions and utilities. This information must be captured in a database to be useful. Therefore, it is necessary to determine the exact contents of the database including indicators, queries and forms of reports, working methods for the creation and supporting of the database, and the additional recommendations for the IAEA to enhance the questionnaire for more efficient use of the database by different users.

The proposed structure of the database

The members at the consultancy group meeting analyzed the responses of the questionnaires. It was considered whether the existing data was sufficient and if new questions should be introduced to complement the collected information. It was found that some questions need additional clarification. After reviewing the questionnaire the following questions were raised from the point-of-view of user requirements, designers, and technology developers.

Answers to the following questions are needed regarding the functional requirements of an operator support system:

- o What are the needs of the users of an operator support system?
- o What specific functions are necessary to satisfy the user's needs?
- o What is required by the licensing authorities?
- o How is the V&V performed?
- o Who uses the system, how many users, what are their relationships?
- o What are the appropriate forms of human-machine interactions?
- o What kind of input and output information is needed for the operator support system?
- o Is the operator support system accepted by the users? What has been learned from the experience with the operator support system?

From design and construction point-of-view the following questions were asked:

- o Which algorithms or information processing technologies can be utilized to achieve a given functional specification?
- o What information processing technology is most suitable in each case?
- o How can the system be integrated with existing instrumentation and control or monitoring systems (e.g., software or hardware configurations)?
- o Which languages or shells are suitable?

Regarding the technical development of operator support system systems, following questions were stated:

- o For what kind of operator support system can a given new algorithm or information processing technology be applied?
- o What kinds of limitations might be imposed and how can these be overcome?

The proposed structure of the database and the additions for the questionnaire were based on the above questions. The names, lengths and types of the data fields in the database were defined.

Also the structure of the database was discussed. The division of the operator support system database into specific tables was also discussed and some primary indicators were prepared (e.g., classification of the systems, functions of the operator support system, plant types).

The resulting database structure and the proposed revision of the questionnaire are given in detail in the Appendix.

Database update process

The recommended database update process consists of the following four steps.

- o Request member states to update relevant information
- o Collect responses
- o Update database and prepare "database update floppy disks"
- o Distribute database update floppy disks

Requests for the information update should cover

(i) corrections/modifications of information already existing in database, and

(ii) collection of information on new systems. Since the volume of update information is not expected to be enormous and the number of entries is not large, paper forms are probably sufficient. For the same reasons, floppy disks seem to be an appropriate form of media to be used for distributing the database update information.

Initial set up of database

There seems to be several tasks that need to be carried out before the initial setup of the database is achieved. These include the following:

- Revise the questionnaires
- Request additional information from organizations which have already answered the questionnaires
- Collect more responses
- Clean-up of the input data
- Database development (It is assumed that Agency is responsible for this task.)
- Develop initial appraisal database.

As discussed above, the members of the consultancy group reached a conclusion that there are several pieces of necessary information which are not covered by the current version of the questionnaires. It is necessary to include this new information so that database can fully answer questions which are likely to be asked by database users. The additional pieces of information that need to be collected include the following (See the Appendix):

- Forms of human-machine interactions
- Forms of integration with existing plant computers
- Need for manual data input by users
- Application software algorithms adopted (i.e. kinds of information processing technologies)
- Use of a simulator for the purpose of testing
- Some additional support functions (i.e. data collection)

This information should be collected from organizations which have already answered the questionnaires using a revised set of questionnaires.

It is expected that information collected from various organizations on a particular operator support system might be inconsistent in many ways. Therefore, some consistency review by specialists will be necessary.

The work being performed by this Co-ordinated Research Programme, along with the database of information being created, will provide guidance and technology transfer for the development and implementation of operator support systems.

QUESTIONNAIRE ON EXISTING OPERATOR SUPPORT SYSTEM

1. Organization information

Organization submitting the form

Name of organization60
Division
Street Address or P.O.Box
Zip-code and town
Country

Type of organization

	Developer (Specify Yes=Y or No=N)	
	User Type of plant	20
	OtherSpecify	

Contact person

Name60	
Streat address or P.O.Box	
Zip-code and town	
Country	
International telephone20	International telefax 20
Electronic mail60	

2. General

Name of system60	
Acronym 20	Version number
Developer Name60	

Plant types for which the system could be applicable

- [ ] PWR
- [ ] BWR
- [ ] CANDU
- [ ] Gas-cooled
- [ ] RBMK
- [ ] Other Specify [40]
- [ ] Any type

State of development — Please indicate dates

[ ]	Development started	6
[ ]	Testing phase started	
[ ]	Implemented	
[ ]	Entered into operation	
[ ]	Latest revision	
[ ]	Retired from operation	
[ ]	OtherSpecify	40

Classification

- [ ] Task oriented displays
- [ ] Intelligent alarm handling
- [ ] Fault detection and diagnosis
- [ ] Safety function monitoring
- [ ] Computerized operational procedures presentation
- [ ] Performance monitoring
- [ ] Core monitoring
- [ ] Vibration monitoring and analysis
- [ ] Loose part monitoring
- [ ] Materials stress monitoring
- [ ] Radiation release monitoring
- [ ] Condition monitoring maintenance support
- [ ] Other Specify [40]

Please fill in a short description of the system

250

3. Motivation

What is the **main** motivation for the system

- [ ] safety
- [ ] business automation
- [ ] reliability/availability
- [ ] reduced workload
- [ ] productivity
- [ ] environment protection
- [ ] regulatory requirements
- [ ] Other Specify [40]

Who initiated the development or installation

- [ ] user
- [ ] system supplier
- [ ] regulatory organization
- [ ] utility personnel (other than user)
- [ ] Other Specify [40]

4. Functionality

The system is designed to assist in (all that apply)

- [ ] Normal situations
- [ ] Incidents
- [ ] Accidents (within DBE)
- [ ] Accidents (beyond DBE)

Does the system support (all that apply)

- [ ] Data collection
- [ ] Data archivation
- [ ] Monitoring
- [ ] Fault identification
- [ ] Diagnosis
- [ ] Selection of procedures
- [ ] Execution of recovery
- [ ] Identification of faulty equipment, components or systems
- [ ] Decisions aid
- [ ] Other Specify [40]

Availability considerations

- [ ] Can the system detect its own failure
- [ ] Is back-up available in case of system failure
- [ ] Redundancy is utilized
- [ ] Diversity is utilized

Specify120 [ ]

Is the system considered

- [ ] Non-safety related
- [ ] Safety related
- [ ] Safety system

5. Usage

Who is using the system	If Yes Specify Job Position
[ ] Control room personnel	40
[ ] Local operator	
[ ] Engineering	
[ ] Maintenance	
[ ] Crisis team	
[ ] Plant management	
[ ] Other	

Specify location where the system (man-machine interface) is being used

- [ ] Control room
- [ ] Laboratories
- [ ] Training centre
- [ ] Emergency Control Room
- [ ] Crisis centre
- [ ] Engineering offices
- [ ] Maintenance areas
- [ ] Plant equipment area
- [ ] Dosimetry control room
- [ ] Other Specify [40]

What type of human-machine interface is being used If Yes Specify

[ ]	Text CRT	30
[ ]	Graphic CRT	
[ ]	Mimics	
[ ]	Other outputs	
[ ]	Conventional keyboard	
[ ]	Function keyboard	
[ ]	Mouse	
[ ]	Tracker ball	
[ ]	Touch screen	
[ ]	Other inputs	

Which form or forms of interaction does your system adopt

- [ ] Use of one or more dedicated display devices (e.g. CRT)
- [ ] Use of one or more dedicated display pictures which share display devices witch other systems
- [ ] Other Specify [40]

How many users is the system able to support simultaneously [3]

Does the system process or utilize plant data for real time response [ ]

How often is the system used

- [ ] Continuously
- [ ] Frequently
- [ ] Once-in-awhile

Where there additional measures needed for acceptance by users

- [ ] Improvements in user interface
- [ ] Improvement in documentation
- [ ] Additional training
- [ ] Other Specify [40]

6. Technical System Specifications

Please specify hardware characteristics

Brand and type of computers	40

Configuration of the system (e.g. no. of work stations, memory, bus, printers, network communication, disk capacity, plotters)	40

Does the system get data from the plant computer [ ]

Does the system require new sensors (specify)

60

Please specify software characteristics

Programming languages	40

Software shell for development (e.g. type of database, user interface, operating system, type of knowledge base	40

Algorithms and methods used Specify

☐	Calculational methods	40
☐	Statistical methods	
☐	Artificial intelligence	
☐	Neural networks	
☐	Other	

Flexibility

- ☐ Can the system be expanded for new functions
- ☐ Can the system be tuned by the users
- ☐ Is the system hardware dependent
- ☐ Can the system functions be reconfigured for the users
- ☐ Is the system connected or connectable to other plant systems
- ☐ Does the system require manual data input from the operators

Indicate approximate number of input signals (if relevant)	7

7. Development Process

Were formal design methods applied (Y/N) [ ]

Specify methods and tools used for the formal design [40]

Length of development process (months) [3]

Involvement of end user in

- [ ] Specification
- [ ] Design
- [ ] Implementation
- [ ] Validation
- [ ] Testing
- [ ] Other Specify [40]

Were pre-existing software modules utilized (Y/N) [ ]

Scheme of development process

- [ ] Once through
- [ ] Iterative
- [ ] Other Specify [ ]

8. Testing

Methodology and tools applied

- [ ] Module test
- [ ] White block test
- [ ] Black block test
- [ ] Other Specify

Test criteria and requirements (standard defined) by

- [ ] User
- [ ] Authority
- [ ] Other Specify

Was a simulator involved in testing

- [ ] Full scope simulator
- [ ] Part task simulator
- [ ] No simulator based tests

Length of initial testing period (days) 3

Periodic testing requirements

- [ ] Periodically Length of period 40
- [ ] Occasionally Reason for test
- [ ] None

Where there objective, quantifiable tests to evaluate usefulness of the system

Specify	100
User experience	100
Problems discovered	100

9. Documentation

	Existing (Y/N)	Language	Internal usage	External Available
User's manual		20		
Design document				
Functional specification				
QA				
V&V				
Test results				
Training document				
Maintenance document				
Developers document				
Reference to standards				
References				

10. Training

- ☐ Does a user training program exist If yes, how long is the program (days) [3]
- ☐ Is user training performed on a full scope training simulator
- ☐ Is user training performed on a special part task simulator
- ☐ Does a training program exist for maintenance of the system
- ☐ Is technical support available by telephone

11. Cost

Estimated man-years of efforts used for development	3
Estimated man-years of efforts used for implementation	3
Estimated total utility cost of the operator support system including own work, hardware and software	12

Specify type of required hardwar e	40

Specify type of third party software required	40

12. Benefits

Fill in where relevant: Give qualitative statements if quantitative data are not available.

	Expe cted	pro ven	Quantity
Reduced operation and maintenance costs			20
Increased plant availability			
Reduced number of scrams			
Optimization of plant operational cycle			
Improved operational or maintenance procedures			
Other (specify)40			

13. Experience and additional information which you would like to supply

250

14. References of related literature

120

15. Sites where the system has been installed

60