

DEVELOPMENT OF UTILITY GENERIC FUNCTIONAL REQUIREMENTS FOR ELECTRONIC WORK PACKAGES AND COMPUTER-BASED PROCEDURES

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ABSTRACT

The Nuclear Electronic Work Packages - Enterprise Requirements (NEWPER) initiative is a step toward a vision of implementing an eWP framework that includes many types of eWPs. This will enable immediate paper-related cost savings in work management and provide a path to future labor efficiency gains through enhanced integration and process improvement in support of the Nuclear Promise (Nuclear Energy Institute 2016). The NEWPER initiative was organized by the Nuclear Information Technology Strategic Leadership (NITSL) group, which is an organization that brings together leaders from the nuclear utility industry and regulatory agencies to address issues involved with information technology used in nuclear-power utilities. NITSL strives to maintain awareness of industry information technology-related initiatives and events and communicates those events to its membership. NITSL and LWRS Program researchers have been coordinating activities, including joint organization of NEWPER-related meetings and report development. The main goal of the NEWPER initiative was to develop a set of utility generic functional requirements for eWP systems. This set of requirements will support each utility in their process of identifying plant-specific functional and non-functional requirements.

The NEWPER initiative has 140 members where the largest group of members consists of 19 commercial U.S. nuclear utilities and eleven of the most prominent vendors of eWP solutions. Through the NEWPER initiative two sets of functional requirements were developed; functional requirements for electronic work packages and functional requirements for computer-based procedures. This paper will describe the development process as well as a summary of the requirements.

Key Words: electronic work packages, mobile work management

1 INTRODUCTION

The nuclear industry is constantly trying to find ways to decrease human error rates, especially human errors associated with procedure use. In the nuclear industry almost all activities that involve human interaction with plant systems are guided by procedures, instructions, or checklists. Paper-based processes and procedures currently used by most utilities have a demonstrated history of ensuring safety; however, improving procedure use could yield significant savings in increased efficiency, as well as improved safety through human performance gains.

At most nuclear utilities the worker in the field brings a large binder of information to the work site in the plant. The information contains all information needed to fully understand the scope and background of the task as well as the instructions needed to conduct the task. Due to the static nature of paper, these work packages are difficult to develop, implement, control, review, close out, archive, and overall manage. The paper-based work package also limits the amount of information the worker may access while at the work site. There is only so much paper the worker is willing to carry around. The work package is an essential

part of the work management process used to coordinate maintenance, modifications, surveillances, testing, engineering support, and any other work activities in the plant [1].

In recent years the nuclear industry has started to transition from a paper-based work management process to an electronic process. According to the Electric Power Research Institute (EPRI) an electronic work package (eWP) is an electronic file or series of files that makes up a work package used to complete a work task using a portable device (such as a tablet) and mobile work management is defined as an electronic platform that provides the ability to manage (assemble, revise, review, assign, track, execute, close out, transfer data and generate a final quality assurance record) electronic work packages [1].

The benefits of an eWP solution are a simplified and more streamlined work management process, the reduction of paper and resource costs, increased productivity in the field, and easier access to additional information while out at the work site.

Some utilities such as Exelon and Florida Power and Light have already implemented eWP solutions, other utilities such as Southern Nuclear Company and Duke Energy are currently in the process of deploying eWP systems, and many other utilities are in the very early stage of defining scope and requirements for such transition.

1.1 The Nuclear Electronic Work Packages - Enterprise Requirements (NEWPER) initiative

The Nuclear Electronic Work Packages - Enterprise Requirements (NEWPER) initiative is a step toward a vision of implementing an electronic work package (eWP) framework that includes many types of eWPs. This will enable immediate paper-related cost savings in work management and provide a path to future labor efficiency gains through enhanced integration and process improvement in support of the Nuclear Promise [2].

The NEWPER initiative was organized by the Nuclear Information Technology Strategic Leadership (NITS) group, which is an organization that brings together leaders from the nuclear utility industry and regulatory agencies to address issues involved with information technology used in nuclear-power utilities. NITS strives to maintain awareness of industry information technology-related initiatives and events and communicates those events to its membership. NITS and Light Water Reactor Sustainability (LWRS) Program researchers have been coordinating activities, including joint organization of NEWPER-related meetings and report development.

The main goal of the NEWPER initiative was to develop a set of utility generic functional requirements for eWP systems. This set of requirements will support each utility in their process of identifying plant-specific functional and non-functional requirements. The overall goals of the initiative are as follows:

- Define core components of an eWP system
- Define functional requirements for these core components, covering the full spectrum of eWPs from basic pdfs to dynamic smart documents
- Share operational experience that is related to ongoing eWP implementation activities in industry (e.g., benefits gained and identified issues)
- Communicate utilities needs and wants to vendors
- Standardize terminology related to eWP and smart documents.

In addition, the NEWPER initiative provided an opportunity for establishing new or reinforcing existing relationships between utilities and eWP vendors.

The NEWPER initiative was started in October 2015 and as of January 2017 the initiative has 140 members. The largest group of members consists of 19 commercial nuclear utilities that represent the vast

majority of the U.S. commercial nuclear industry. The second largest member group includes 11 of the most prominent vendors of eWP solutions, along with two management consultant companies. Other organizations such as the EPRI, the Institute of Nuclear Power Operations, EDF Energy, Idaho National Laboratory, Los Alamos National Laboratory, and Savannah River National Laboratory are also members of NEWPER. In addition to NITS, the Nuclear Information and Records Management Association and the Procedure Professionals Association are also represented in the member pool [3].

The vision statement developed by the NEWPER members is: Implement an open eWP framework, which covers the entire eWP spectrum, enabling immediate paper-related cost savings in work management and providing a path to future labor efficiency gains through enhanced integration and process improvement in support of the nuclear promise.” A first step toward the vision was to define a common taxonomy for eWPs. Before NEWPER most entities used either vendor specific taxonomy or a taxonomy that made sense to the individual. To make sure the NEWPER initiative became as useful as possible to its members it was essential to agree on a common language.

EPRI’s taxonomy [1] for smart documents, i.e., electronic documents with capabilities beyond a traditional paper form that, was used as a starting point for the NEWPER taxonomy. NEWPER made slight modifications to the taxonomy, such as removing dependencies to wireless technology as well as defining the most technology advanced version of smart documents dynamic or adaptive rather than intelligent.

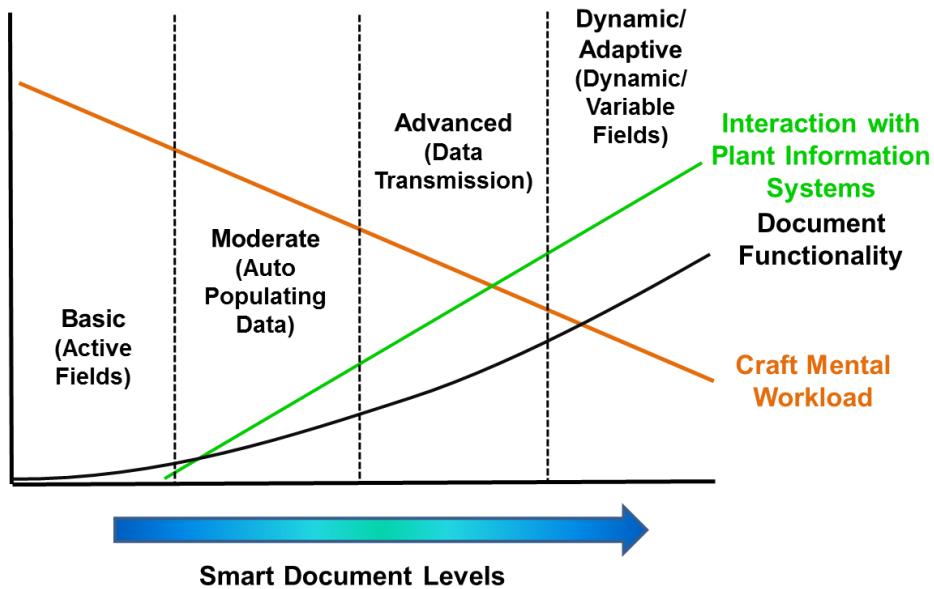


Figure 1. The NEWPER taxonomy for smart documents, which is based on a taxonomy developed by EPRI, [1], [3].

The wireless network needs were excluded after concluding that other solutions (such as docking stations and Wi-Fi hot spots) could be sufficient for gaining benefits from different types of smart documents. The taxonomy consists of four levels of smart documents: (1) basic, (2) moderate, (3) advanced, and (4) dynamic. Table I summarizes each of the levels.

Table I. Summary of smart document levels.

Level	Summary
Basic (Active Fields)	The document has fields for recording input such as text, dates, numbers, and equipment status.
Moderate (Automatic Population of Data)	The document incorporates additional functionalities such as form field data “type” validation (e.g. date, text, number, and signature) of data entered and/or self-populated basic document information (usually from existing host application meta data) on the form when the user first opens it.
Advanced (Data Transmission)	The document provides the capability to transmit data entered into other data systems.
Dynamic (Adaptive/Variable Fields)	The document uses variable (i.e., dynamic) field options based on previously completed data entries or links to other electronic documents or media.

The main focus of the NEWPER initiative in 2016 was to develop utility generic functional requirements for eWPs and smart documents. The members worked on two different sets of requirements; functional requirements for an eWP including basic and moderate smart documents, and functional requirements for advanced and dynamic smart documents.

The functional requirements were identified both through face-to-face workshops and teleconferences. The first set of requirements to be complete is the functional requirements for eWPs (including basic and moderate smart documents). These identified functional requirements were grouped into role-based categories; Planner, Supervisor, Craft, Work Package Approval Reviewer, Operations, Scheduling/Work Control, and Supporting Functions. The categories Statistics, Records, Information Technology are also included used to group the requirements. These requirements are described in detail in the report Functional Requirements for an Electronic Work Package System [4]. The next section in this paper provides a summary of these requirements.

2 UTILITY GENERIC FUNCTIONAL REQUIREMENTS

As mentioned above, the nuclear industry is moving towards the transition from a paper-based work process to an electronic. A couple of utilities have already deployed these types of eWP systems, however, the majority of the utilities are in the early stages of planning and preparing for the transition. To help the utilities that are in the early stage of their transition projects a set of utility generic functional requirements were developed. On a high-level the work process used to conduct tasks in nuclear plants are similar across the nuclear industry. Through the NEWPER initiative lessons learned from the utilities that already developed functional requirements for eWP systems were leveraged as well as the input from research organizations and vendors. The focus of the effort was to identify requirements that are applicable to most utilities. It is recognized that it is most likely less resource intense to personalize already defined requirements to match the specific need of a utility than to define a set of requirements from scratch. In addition, the utility generic set of requirements is meant as a starting point to support the discussion about what functions should and could be included in the eWP solution to make it the best fit for the utility.

The utility generic functional requirements for an eWP system presented in this paper are mainly applied to eWP system supporting Basic and Moderate types of smart documents, i.e., documents that have fields for recording input such as text, dates, numbers, and equipment status, and documents which incorporate additional functionalities such as form field data “type” validation (e.g. date, text, number, and signature) of data entered and/or self-populate basic document information (usually from existing host application metadata) on the form when the user first opens it.

All the requirements are categorized by the roles; Planner, Supervisor, Craft, Work Package Approval Reviewer, Operations, Scheduling/Work Control, and Supporting Functions. The categories Statistics, Records, Information Technology are also included used to group the requirements. Table II to Table XI present the high-level functional requirements per role. For detailed examples, please refer to the report “Functional Requirements for an Electronic Work Package System” [4].

The Planner should have access to a summary of assigned work order tasks as well as the associated work packages as well as be able to create new work packages. This includes the creation of a list of documents associated with the work package, i.e., the table of contents. The Planner should be able to manage continuous activities such as minor maintenance, fix-it-now work, or skill of the craft activities. These are work processes that typically do not require detailed work instructions due to low risk or only requiring craft skill (e.g. change light bulbs and inspections). These tasks are usually defined in utilities’ procedures. The Planner should be able to manage which discipline the work package will be assigned to. The Planner should also be able to manage the Planner assigned to a specific work package. For example, if the assigned Planner for some reason is not able to fulfill the Planner responsibilities, then there should be an option to assign another Planner to ensure adequate management of the work package. The Planner should be able to manage which discipline the work package will be assigned to. The Planner should also be able to manage the Planner assigned to a specific work package. For example, if the assigned Planner for some reason is not able to fulfill the Planner responsibilities, then there should be an option to assign another Planner to ensure adequate management of the work package. Table II presents the functional requirements for the Planner role.

Table II. Functional Requirements – Planner

Functional Requirements - Planner	
1.	Ability to view assigned task
2.	Ability to create a work package for an assigned task
3.	Ability to manage returned work packages
4.	Ability to manage continuous work
5.	Ability to manage responsibility assignments of work packages
6.	Ability to manage required documents in the work package
7.	Ability to integrate computerized maintenance management system holds into the work package
8.	Ability to add hold points, critical steps, and other status markers
9.	Ability to modify a work package
10.	Ability to manage Planner walkdowns
11.	Ability to conduct verifications and inspections using the mobile device
12.	Ability to enforce workability review before work execution
13.	Ability to route work package for approvals
14.	Ability to track work package status
15.	Ability to efficiently respond to needs to the Craft
16.	Ability to assign Record retention requirements to documents

The Supervisor needs to be able to manage (view and sort) the queue of assigned work packages and work order tasks to be performed to efficiently assess and plan the work. Table 12 provides examples of detailed requirements. Unplanned tasks are work order tasks that are still in the development process or returned for amendment with the Planning organization. The Supervisor need to be able to plan for unplanned or continuous work such as fix-it-now tasks. The Supervisor will do so by view, create, and complete work packages for the unplanned tasks. The Supervisor should be able to assign the work package to either a Craft or specific Crew who will be responsible to execute the work package. The Supervisor could also be able to assign the work package either to an individual or a mobile device (i.e., the handheld

device the Craft uses to access the work package and to complete the work order tasks in the field). This would add flexibility to the process. Table III lists the functional requirements for the Supervisor.

Table III. Functional Requirements – Supervisor

Functional Requirements – Supervisor	
1.	Ability to manage task queues
2.	Ability to create and complete work packages for unplanned tasks
3.	Ability to accept or return work packages
4.	Ability to reassign Supervisor responsibilities
5.	Ability to assign Craft or Crew to a work package
6.	Ability to manage master and duplicate copies of a work package
7.	Ability to process work packages returned by the Craft
8.	Ability to support the completion review
9.	Ability to route the work package for additional reviews
10.	Ability to add status markers to the work package
11.	Ability to add additional documents to the work package
12.	Ability to hold a work package until conditions are met
13.	Ability to monitor work and track status during execution
14.	Ability to capture media to use as part of shift turnovers
15.	Ability to render the work package for backend review

The Craft needs to be able to manage the assigned tasks to be performed to efficiently assess and plan the work. The Craft needs the ability to use the mobile device to conduct a walkdown of the work package prior to the work execution to determine workability and acceptability. The Craft conducts a pre-job walkdown by performing either a field walkdown of work or a tabletop review of a work package to ensure the maintenance or testing can be performed without issues. The Craft must be able to execute the assigned task in the field, either by using a mobile device or a paper copy of the work order. If a mobile device is used during the task execution, the Craft should be able to record the work progress through this device. The Craft should also be able to capture digital media in the field and incorporate this into the work package. In addition, the Craft needs to be able to conduct placekeeping and to be able to sign off work sections while using the mobile device to conduct the task. Table IV provides the functional requirements for the Craft.

Table IV. Functional Requirements – Craft

Functional Requirements – Craft	
1.	Ability to manage assigned tasks
2.	Ability to use the mobile device to determine workability and acceptability
3.	Ability to incorporate digital media into the work package
4.	Ability to record work progress using the mobile device
5.	Ability to sign clearances using the mobile device
6.	Ability to conduct pre job briefs using the mobile device
7.	Ability to conduct verifications and inspections using the mobile device
8.	Ability to conduct placekeeping and sign offs
9.	Ability to conduct correct component verifications
10.	Ability to undo unintended or incorrect action
11.	Ability to determine when and if all materials needed for the task are available

12.	Ability to capture what material was used in the Bills of Materials
13.	Ability to take notes during work execution
14.	Ability to launch a calculator from inside the eWP application
15.	Ability to initiate a work request from mobile device in the field
16.	Ability to access equipment history for components associated with the work package
17.	Ability to access associated media for the components
18.	Ability to update status of a status marker
19.	Ability to use three way communication
20.	Ability to use multiple types of input

There should be a process to route the records to post execution validation. As a part of this process, the Approval Reviewer needs to be able to access, review, and add to the work package (i.e., the work instructions and all documentation associated with a work order task) via the eWP system. Table V shows the functional requirement for the Work Package Approval Reviewer.

Table V. Functional Requirements – Work Package Approval Reviewer

Functional Requirements – Work Package Approval Reviewer	
1.	Ability to route records for post execution validation

The Operations needs to be able to pre-authorize work order tasks that can be initiated before the work package (i.e., the work instructions and all documentation associated with a work order task) is fully approved and authorized for work execution. This is mainly applicable to support tasks in a task based work order. The Operations should be able to use the eWP system to conduct remote sign-offs prior to task execution. The Operation organization could be able to use the eWP system for their own activities, such as rounds, auxiliary operator activities in the field, or activities in the main control room. However, this might require a specific configuration of the system. Table VI lists the functional requirements for Operations.

Table VI. Functional Requirements – Operations

Functional Requirements – Operations	
1.	Ability to create pre authorization of work order tasks
2.	Ability to conduct sign offs prior to task execution (remote)
3.	Ability to use the eWP System for Operations

The Work Control needs to have access to the planned work orders in order to be able to prioritize the tasks for scheduling purposes and they need to be able to update the priority information for individual work order tasks. Table VII provides the functional requirements for Work Control.

Table VII. Functional Requirements – Scheduling/Work Control

Functional Requirements – Scheduling/Work Control	
1.	Ability to view work orders
2.	Ability to view work order tasks
3.	Ability to update priority information

The ability to route recorded inputs and data to organizations and users who might need to review the input and/or use it for trending purposes should be provided. The system should also support the

coordination between disciplines and teams needed to efficiently complete the work order tasks. This can be done via alerts or notifications. There should also be the ability to share task status (i.e., the indication of where a work order task is in the workflow process) with other disciplines or organizations who might need it. For example, the task status can be displayed on an outage control center dashboard for the outage management or it can be tied to the radiological protection dose management application. The main purpose would be to provide the transparency of (critical) or time sensitive task status. Table VIII lists the functional requirements for the Supporting Functions.

Table VIII. Functional Requirements – Supporting Functions

Functional Requirements – Supporting Functions	
1.	Ability for recorded inputs/data to be routed to other organizations for review
2.	Ability to coordinate with additional disciplines and teams during work execution
3.	Ability to share task status with relevant organizations

The eWP system must provide the ability to generate a quality assurance (QA) record of the completed work package (i.e., the work instructions and all documentation associated with a work order) in an industry standard format with the option of additional formats. Table IX provides the functional requirements for Records.

Table IX. Functional Requirements – Records

Functional Requirements – Records	
1.	Ability to generate a Quality Assurance record
2.	Ability to identify document types not required to be retained as Quality Assurance records
3.	Ability for waiting period between task completion and archiving
4.	Ability to supply the appropriate metadata from eWP system to allow for efficient record retention and retrieval
5.	Ability to capture data points recorded in the work package

The entire issued work package (i.e., the work instructions and all documentation associated with a work order task) must be loaded on the mobile device to enable the application to work regardless of network connectivity mode. This is known as “store and forward”. The mobile device must have the capability to automatically connect to a wireless signal when in range and receive information from the client eWP system. The mobile device should have the ability to manually refresh information from the client eWP system. Tables on data sheets should be functional in the end device with the ability to display out of range conditions as user inputs information. The eWP client should have a dashboard that can be filtered, sorted and grouped by date range, department, work team, work leader, individual assigned, device assigned. The eWP dashboard should display approved work, unapproved work, returned work, and issued work. The functional requirements for Information Technology are listed in Table X.

Table X. Functional Requirements – Information Technology

Functional Requirements – Information Technology	
1.	The eWP mobile application must work in Connected or Dis-Connected wireless mode
2.	Ability to display and use the work package on dedicated mobile devices
3.	Ability to use a calibration sheet on a mobile device
4.	Provide a dashboard for each role with role specific information displayed

5.	Ability to support multiple form factors
6.	Ability to incorporate a calculator to the eWP application
7.	Ability to incorporate forms from external party
8.	Ability for eWP system to interface with legacy systems
9.	Ability to interface with mobile device management system
10.	Ability to manually sync the mobile device
11.	Ability for the eWP system to adjust status in the Enterprise Asset Management system
12.	Ability for the eWP system to adjust status in Work Management System and/or work control systems

The system should provide the ability to both capture and track the status of the work throughout the work package process. The captured information can be used for dashboards as well as for trending and planning purposes. The dashboards will be beneficial in an outage or system work window where real-time updates could be shared with control teams. The functional requirement identified for Statistics is listed in Table XI.

Table XI. Functional Requirements – Statistics

Functional Requirements – Statistics	
1.	Ability to capture and track work package status

3 PATH FORWARD

A need for a set of functional requirements for advanced and dynamic smart documents was also identified by the NEWPER members. The development of the requirements for advanced and dynamic smart documents became a parallel activity within the initiative. Two sets of requirements were developed for the advanced and dynamic smart documents; a set of high level requirements, and a set of detailed functional requirements. These requirements will be published as a Procedure Professionals Association standard in 2017. The requirements are currently being reviewed by the standards committee.

Examples of high level requirements for advanced and dynamic smart documents are; 1) Optimized for human performance, 2) Optimized for worker efficiency, 3) Optimized for navigation, and 4) Digital data entry with backend system data utilization. The detailed functional requirements for advanced and dynamic smart documents are grouped into different categories, such as step types, branching and referencing, data management, attachments and tables, and record requirements. Below are five examples of detailed functional requirements identified for advanced and dynamic smart documents.

1. Provides the ability to perform the appropriate portion of a Smart Document (either partially or completely executed).
2. Provides the ability for a specific data entry occurrence to be configured to automatically populate the same data in multiple locations throughout the Smart Document.
3. Provides the ability for calculations to be set up and performed based on entered data.
4. Provides the ability to always know what step is the Active Step and its position within the Smart Document.
5. Provides the ability to easily navigate to any section or attachment.

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5 REFERENCES

1. Electric Power Research Institute, *Improving the Execution and Productivity of Maintenance with Electronic Work Packages*. TR-3002005363, Palo Alto, USA (2015).
2. Nuclear Energy Institute, *Delivering the Nuclear Promise: Advancing Safety, Reliability, and Economic Performance*. Washington D.C., USA (2016).
3. J. Oxstrand & A. Bly, *Computer-Based Procedures for Field Workers - FY16 Research Activities* (INL/EXT-16-39984), Idaho Falls, USA (2016).
4. J. Oxstrand, *Functional Requirements for an Electronic Work Package System* (INL/EXT-16-40501, NITS-16-01), Idaho Falls, USA (2016).