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HUMAN PERFORMANCE BENEFITS GAINED BY DYNAMIC INSTRUCTIONS COMPARED TO SMART PDFS

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In recent years multiple nuclear utilities have deployed an electronic work management solution to replace the traditional paper-based processes. There are several benefits of electronic work management solutions compared to paper processes, such as a more streamlined review and approval process. However the utilities also hoped the new solution would support the worker in conducting his job more efficiently, correctly, and safely in addition to a streamlined approval process. Unfortunately, the industry is now realizing that the existing solutions are failing to achieve the expected improvements in overall work execution.

The electronic work management solutions present the work instructions as an electronic copy (i.e., a portable document format (PDF)) of the paper instruction. The PDF versions used in these electronic work management solutions have some ability for data input, notes, and mark-ups, but they do not provide many additional benefits compared to using paper. Researchers at Idaho National Laboratory (INL) investigated going beyond smart PDFs from a human factors perspective. In close collaboration with multiple utilities they investigated how to present instruction content and how to design the interaction with the instruction to improve the workers performance and efficiency. Their solution is a dynamic presentation of the instruction that guides the worker through the correct path. A well-designed solution has the opportunity to vastly reduce the risk of human errors in the field. This paper will describe in detail how the design concepts improve human performance.

I. INTRODUCTION

All tasks conducted in a nuclear power plant are guided by procedures, which helps ensure safe and reliable operation of the plants. One main goal of the nuclear industry is to minimize the risk of human errors. To achieve this one has to ensure tasks are correctly and consistently executed. This is partly achieved by training and by a structured approach to task execution, which is provided by procedures and work instructions. There are

many different types of users and types of procedures within the nuclear utility, for example; operating procedures, administrative procedures, field operating procedures, and maintenance procedures.

This paper focuses on workers in the field, e.g., field operators and maintenance technicians. Procedures are used in the nuclear industry to direct these field workers' actions in a proper sequence. The governing idea is to minimize the reliance on memory and choices made in the field. However, the procedure document may not contain sufficient information to successfully complete the task. Therefore, the field worker might need to carry additional documents such as turnover sheets, operation experience, drawings, and other procedures to the work site.

Depending on the task, the amount of documents the field worker needs to bring to the work site can be enormous and cumbersome. Even though the paper process has helped keep the industry safe for decades, there are limitations to using paper. Paper procedures are static (i.e., the content does not change after the document is printed), difficult to search, and rely heavily on the field worker's situational awareness and ability to consistently meet the high expectation of human performance excellence.

In order for a paper procedure to be applicable to the constantly changing environment in the plant, the procedure has to be written to encompass multiple different scenarios. This makes the paper procedure bulky and hard to navigate, which forces the field worker to search through a large amount of irrelevant information to locate information applicable to the task at hand. This can take up valuable time the field worker could have spent on task execution, and it can potentially lead to unintentional deviations and errors. Other challenges related to use of paper procedures are management of multiple procedures, place keeping, finding the correct procedure for a task, and relying on other sources of additional information to ensure a functional and accurate understanding of the current plant status.

To address the limitations of paper procedures, improve efficiency, and enhance performance, Idaho National Laboratory (INL) researchers developed a computer-based procedure (CBP) concept. The CBP

system provides a dynamic instruction and streamlined work process to direct the field worker through the task execution, which will help them focus on the task at hand rather than on the process. The CBP guides the field worker seamlessly through the logical sequence of the procedure. In addition, the CBP system makes use of the inherent capabilities of the technology, such as incorporating computational aids, easy access to additional information, just in time training, and digital correct component verification. A CBP system offers a more dynamic means of presenting procedures to the field worker, displaying only the relevant steps based on operating mode, plant status, and task at hand. A dynamic presentation of the procedure guides the field worker down the path of relevant steps based on current conditions. Since the majority of a field worker's tasks are currently being conducted in an error-prone manual fashion, the key features listed below improve performance and reduce errors by reducing the field worker's workload and inherently reducing the risk of incorrectly marking a step as not applicable and the risk of incorrectly performing a step that should be marked as not applicable. Some of the key functionality of the CBP system are;

Automatic place-keeping. The CBP system highlights the active step (i.e., the step being conducted). Other steps are shown, but the field worker can only take actions related to the active step. This function makes it easy for the field worker to stay on the specified path. This built-in procedural adherence has proven to reduce the amount and severity of human errors².

Simplified step logic. A conditional step in a procedure is a step that is based on plant conditions or a combination of conditions to be satisfied prior to the performance of an action. The CBP removes complexity from step descriptions by presenting conditional statements as simple questions. For example, statements such as "IF starting pump A, THEN perform the following..." are presented as "What pump do you want to start; Pump A or Pump B?" Depending on the answer, the procedure will take the field worker to either a step with the actions needed to start Pump A or the step with the actions needed to start Pump B.

Correct Component verification. There are multiple ways correct component verification can be implemented and improved by using technology. Researchers at INL have explored digital correct component verification (CCV) via barcodes, optical character recognition, and manual input. When using barcodes or optical character recognition, the system will match the input with a component database. If the correct component is verified, the field worker will be able to continue on with the step. If the correct component is not verified, the field worker will have to find the correct component before being able to proceed through the procedure.

A nuclear industry CBP solution that is targeted to increase the performance and efficiency of field workers is not currently deployed in any nuclear power plants. However, the nuclear industry has been transitioning toward electronic work management solutions and abandoning timely and costly paper-based work processes. The current electronic work management solutions on the market present the procedure to the field worker by using various versions of electronic documents (i.e., a portable document format (PDF) document with hyperlinks and overlays) to streamline work processes, route the documentation to the relevant reviewers, gather approval signatures to authorize work, and efficiently archive the documentation when work in the field is complete.

The field workers access and use these electronic procedures on handheld devices. However, research has shown that using electronic procedures on handheld devices only marginally improves the workers' performance compared to the traditional paper procedures. In some cases, using electronic documents on a handheld device can even be less effective than using paper. The research conducted at INL provided evidence that transitioning from paper or electronic documents to a CBP solution would dynamically guide the field worker through the correct task execution and increase human performance and worker efficiency. In addition, the Procedure Professionals Association published an industry standard in 2017 based on the INL research outcomes¹.

In order for a CBP system to be a viable option to the nuclear industry it has streamline work process not only for procedure execution, but in work planning, scheduling, and procedure development. The CBP solution must seamlessly encompass the process from start to finish. The dynamic capabilities and the computational capabilities in the CBP system will enhance performance and efficiency during the execution of the procedure. A successful CBP system will include a procedure conversion framework to provide capability to convert the tens of thousands of existing procedures into a structured data format, an authoring tool to be used when writing new procedures, and a commercial grade, well-designed, graphical interface for the field workers. In addition, for the CBP system to reach its full potential it needs to be integrated with other applications such as an electronic work package system and other plant systems. The CBP system needs to be able to effectively communicate with other applications to check available equipment, current plant status, access additional information, and to easily update plant systems with information gained throughout the procedure execution. This is critical as no plant currently has this ability. Even the utilities that have adopted an electronic work management system with the PDF versions that contain data input abilities are not able to receive real time data

analytics. This is due to the inherent inability for PDF documents to communicate with other systems. In fact, when using electronic documents (PDFs) on handheld devices all the data gathered still needs to be manually recorded into spreadsheets when the task is complete. These spreadsheets are then handed over to the engineers to use for trending and tracking.

II. CBP SUPPORTS AND IMPROVES PERFORMANCE

The field workers' procedure use and adherence can be improved by using CBPs. A dynamic instruction and streamlined work process to guide the worker through the task execution will help them focus on the task at hand rather than on the process³⁻⁵.

Human performance tools can be seamlessly integrated into the CBP, which will enable the worker to apply the tools without taking focus away from the task. In addition to procedure use and adherence most utilities use a basic set of Human performance tools, which contains tools such as pre-job brief, three-way communication, phonetic alphabet, place keeping, self-checking, independent verification, concurrent verification, stop when unsure, and post-job brief. The use of all these tools is integrated into the CBP system. As described previously, the CBP will guide the worker through the procedure. The steps are automatically "place-kept" and, unless overridden, the system will not let the worker conduct steps out of sequence.

The CBP system has an integrated pre-job brief (PJB) capability, which enables the worker to review the task, highlight critical steps, and provide relevant operating experience (OE). The PJB is a tool to think through the task and plan how to perform the job as safely and efficiently as possible. During this PJB the worker reviews the procedure and discusses the task execution with the supervisor. Traditionally, the PJB is conducted using paper copies, which adds at-risk behavior such as ignoring OE, covering irrelevant OE, or not addressing critical actions. Using a CBP system, additional information such as just-in-time training, drawings, other relevant procedures, and photos of expected outcomes can be accessed directly from the PJB.

The CBP can remind the worker to identify abnormal conditions and potential safety hazards at the work site before proceeding with the task. This inspection is usually referred to as the Two Minute Rule or Take a Minute and is required to be conducted when the worker arrives at the work site. To add additional support to identify abnormal conditions, the CBP system provides photos and other supporting information of the expected conditions. If an unexpected condition is identified, the worker can easily share information, such as photos and videos about the condition with the supervisor. Decision about how to proceed can be made while the worker is still in the field.

Three-way communication, used to ensure mutual understanding, can be enhanced by utilizing the CBP system. This type of communication is used to verify the status of plant systems and components, direct actions to be performed, and can include limitations and cautions. The ability to easily share procedures and other information with other people ensures that both parties are looking at the same information throughout the communication. This also reduces the importance of using the phonetic alphabet when communicating unit or equipment specific information.

Capabilities in the CBP system streamline the process of peer-checks as well as independent and concurrent verifications. These checks and verifications are important Human performance tools to ensure that the actions were correctly executed and the expected outcome was achieved. Notifications about upcoming verification are sent to the verifier at predetermined trigger points in the procedure. The verifier will get information about task, location, and estimated time the verification is needed, thus streamlining the work process and reducing waiting times. In addition, concurrent verification could potentially be conducted remotely using the shared procedure and video capabilities.

The worker is required to verify the current revision of the procedure, ensure that the sequence of steps is followed, and that steps are only marked as not applicable when approved. All of these are automatic capabilities and built in to the CBP system. Place-keeping techniques are required to indicate steps that are either completed or not applicable. The most common technique is a circle slash. Place-keeping is used to prevent inadvertently skipping steps, unintentionally marking steps as not applicable, or conducting steps out of order. Place-keeping is an automatic function in the CBP system. The worker can only take action on the active step. However, all previous and future steps are visible. When the step is completed the system moves to the next step, which becomes the new active step. Hence, steps cannot be unintentionally conducted out of sequence. With supervisor's approval the worker can override the system if steps need to be performed out of order.

Figure 1 provides an example step where the worker is directed to close a series of valves. For each valve the worker needs to conduct a CCV and then make sure the valve is left in the closed position. The CBP gives the worker visual feedback on actions to take to complete the step, such as conduct the CCV and close the valve. The worker also gets feedback on whether the CCV was successful, i.e., the correct component was verified, and the As Left conditions.

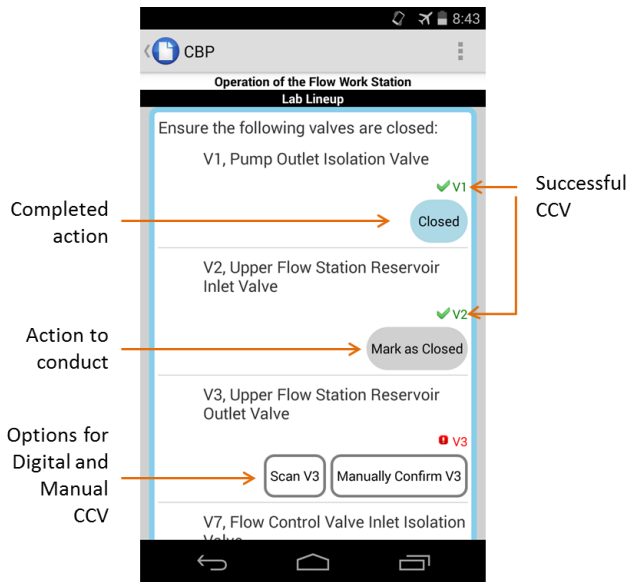


Fig. 1. Example of a valve lineup step including CCVs.

The content in the procedure will be updated based on the current situation and information to allow the worker to focus on the task at hand rather than spending a great effort on understanding the procedure and its content. Context sensitivity implies that the procedure will be updated based on current operation mode, plant conditions, as well as decisions made and values recorded previously in the task execution. The CBP system will guide the worker through the logical sequence or path of the procedure based on user input, previous actions or decisions, or plant status information. When the necessary information is available to the CBP, the procedure system should evaluate step logic and determine appropriate action or path forward. This shifts the burden of the evaluation to the system rather than the field worker. The procedure system can either prompt the worker of the relevant conditions needed to make a decision, or acquire the conditions from previous actions/decisions in the procedure or from a plant information database.

One example of how to implement context sensitive cues is to use them embedded in the procedure steps. Research shows that non-invasive context sensitive cues in steps serve an effective, yet subtle reminder of the task at hand and actions required of the worker². Another example of context sensitive cues is alerting the worker if the as found state is not within the accepted criteria. The systems should also provide information about the as left condition when the step is completed. Figure 2 shows how the left as equipment state is recorded and presented in the previously conducted step text. This allows the worker to go back and review previous actions to ensure they were conducted properly.

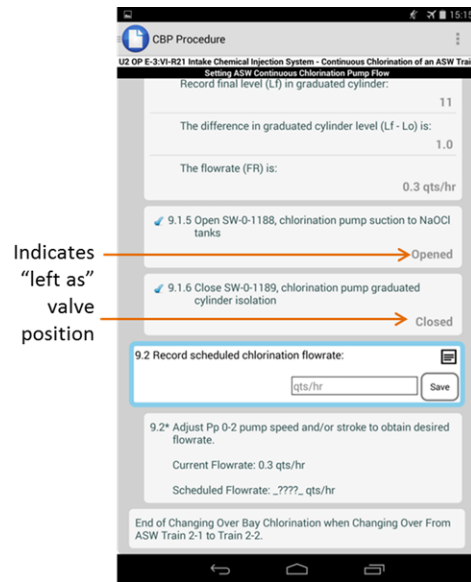


Fig. 2. Example of context sensitive as left information.

The CBP system should be context-sensitive anywhere that the necessary information is available. As discussed in detail in the Design Guidance for Computer-Based Procedures for Field Workers⁶, context sensitive cues should be considered to communicate the items discussed above as well as equipment states, step instructions, decision points and branching, and for notes, cautions, and warnings.

One of the main design principles for CBPs is the principle of simplified step logic. Simplified step logic is achieved by removing complexity from step descriptions by presenting conditional statements, such as IF/THEN, WHEN/THEN, AND, and OR statements, as straightforward questions. For example, the statement “IF starting Pump A THEN perform the following...” would be presented as “What pump do you want to start; Pump A or Pump B?” Depending on the answer the procedure will take the worker to either a step with the actions needed to start Pump A or the step with the actions needed to Pump B.

Figure 3 and Figure 4 illustrate how a former IF/THEN statement is presented as a Yes/NO question in the CBP. In this example, the worker needs to identify if any cells are jumped.

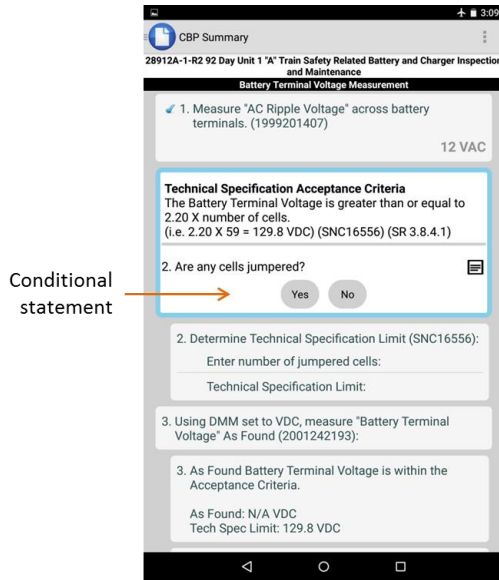


Fig. 3. Example of a conditional statement presented as a question.

As seen in Figure 4, the worker noted that no cells are jumpered. Based on this input the CBP system determines the next applicable step. This step becomes the new active step, which is indicated by the blue border.

The section of steps that are not applicable based on the decision will automatically be marked as such. Hence, the worker can focus on the actual task at hand and not become burdened by deciding which steps are not applicable and marking them as such. This minimizes the risk of the worker incorrectly identifying whether steps are applicable or not. The CBP should guide the worker to the next applicable step when the current action step is completed.

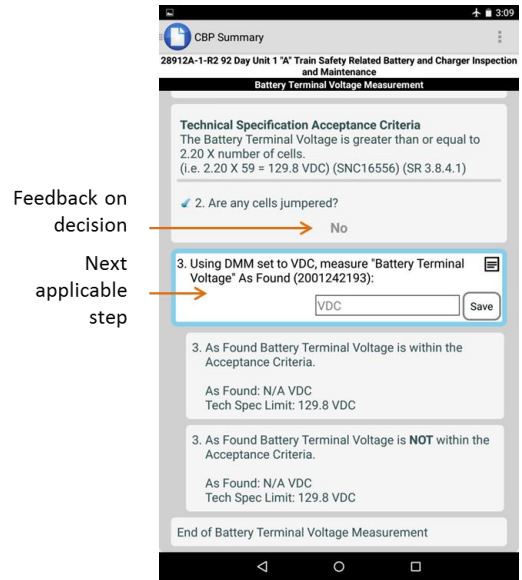


Fig. 4. Example of how the CBP guides the worker to the next applicable step.

The automatic tracking of who did what and when increases the accountability of the worker. The system will not let the worker mistakenly conduct steps out of the intended order or skip steps unless it is a conscious decision to override the system. This will ensure that the procedure is followed as intended, which means the supervisor knows the workers will not cut corners and the workers know that they will have evidence of correct task execution in the case of an audit.

Finding relevant information at the time it is needed is much easier and faster when using CBPs. All information the worker needs is right at their fingertips. With a CBP, accessing information is as simple as using a search engine rather than looking something up in a catalog. The CBP system will gather and compile the relevant information in one place, which enables the worker to get all the information needed without spending time navigating through multiple cross-references. The ease of searching and finding information reduces the need to bring additional documents to the field just in case they might be needed.

It is important to find a balance between automation and keeping a high level of worker's situational awareness. The best way to make sure the worker is in the loop is to assign the control of the pace and path through the procedure to the worker. To achieve this while still leveraging the computational power of a digital device the procedure system needs to provide worker information about decisions made and the values/data points used by the system to make the decision. In addition, the CBP should clearly state which actions were taken in previously conducted steps to provide a quick overview of

the path taken. This overview will support the worker when assessing the decision made by the system.

In addition, the worker should have the option to go back and revise previous input and/or decisions. If an allowable revision, the path through the procedure should be updated. However, there will be situations where revision of a decision could have impact on current equipment status. Revision of such step should only be allowed with supervisor's approval.

The capabilities of the CBP system will help reduce time to execute the task. For example, data sheets and tables will be automatically populated with values recorded throughout the task execution, which removes the time spent on going back and forth between the procedure step and data sheets. Additional information needed to complete a step (e.g., drawings, photos, operational experience, and just-in-time training) is directly accessible from the step in the procedure rather than in an appendix. This too reduces the time spent on going back and forth between sections in the procedure.

Even though humans have many strengths there are items or situations where technology can be used to further enhance human performance. For example, technology is more reliable when calculations need to be performed and recorded. The CBP has a built in capability to conduct calculations and automatically compares values against technical specifications and other relevant criteria, which will minimize the risk of mistakes associated with these types of actions. Allocating calculations to the computerized support rather than the field worker does not only increase the success rate for the task, it also relieves the cognitive burden on the worker.

Today, most of the calculation mistakes are caught by a peer-checker, but occasionally a mistake goes unnoticed. If the value does not meet the criteria the CBP system notifies the worker and provides guidance on how to address the situation.

The CBP system has the capability to conduct digital CCVs by scanning equipment identification tags or barcodes. This digital CCV will prevent events that occur due to actions taken on a wrong component. These can occur because the worker incorrectly identifies the component before the activity is started or because the worker continues an activity on the wrong component after an interruption such as a phone call or being paged. Several Human performance tools are in place to prevent these types of events, for example flagging and operational barriers, self-checking, and first checks. All of these techniques aim to remind the worker to make sure the action is conducted on the correct component. The CBP system matches the scanned component with the expected component. If there is a match (i.e., the correct component is verified) the worker can proceed with the task. If the match is unsuccessful, the CBP system will notify the worker and the correct component has to be

successfully identified and verified before the system allows the worker to proceed. The same technology is used for first checks. The worker scans the location identifier and/or the equipment identification tag to verify correct unit and component.

Most tasks in the field requires the worker to read a value and record it in the procedure. There are multiple reasons for why the worker might incorrectly capture the value. For example, the worker might be distracted by a pager message or a coworker might ask a question. Computerized tools can be used to minimize the risk of invalid input. The CBP system should ensure the requested value is recorded and that the input format is valid. The CBP system should also alert the worker when the recorded value either is in violation of an accepted range or if it is outside the technical specification.

The computerized support provided in the CBP system will help reduce time to execute the task by automatically populating data sheets with recorded values. In addition, input from previous completed tasks can be displayed in the active procedure as appropriate. The CBP system should also be able to automatically generate trends and plots needed to support the worker during the task execution.

The CBP system will provide task status updates to the supervisor. Therefore, the supervisor does not need to contact the worker while at the work site to get status updates. This real time status updates, or near real time if full wireless coverage is not available, will provide the supervisor a better understanding of the work status and allow him/her to optimize the scheduling of resources.

In the event the worker encounters an unexpected condition or for other reasons questions the continuation of the task execution, the worker can discuss the condition with the supervisor without leaving the field. The supervisor can receive supplemental information (e.g., photos and videos) from the worker, which will help assess the situation. In most cases (unless there is a major issue) the situation can be resolved based on the information shared and the worker can continue the task. Currently in plants, the worker has to leave the work site to consult the supervisor and the supervisor might have to go to the work site to assess the situation before a decision can be made. All of which will result in an unnecessary time delay. Not only can a CBP system ensure shared situational awareness between the field worker and the supervisor, but the ability to share information directly between the field and a remote location will improve communication between different organizations, such as maintenance, auxiliary operators, chemistry, and vendors or other stakeholders. In addition, the CBP system can help reduce time spent waiting for quality control, independent verification, or to line-up a concurrent verifier. At predefined trigger points in the procedure, notifications will be sent to personnel

notifying them that they are needed for a specific task in a certain location in the plant at an estimated time.

In addition, automatic notification triggers within the CBP system informs the control room when conditions are met for a hand-off. The system will notify the field worker when work can be initiated in the field as well as notifying the control room when the field worker reaches a point where the control room needs to take action. This reduces the time needed for hand offs between the control room and the field.

III. FIELD TESTS AT NUCLEAR POWER PLANTS

A review of the past thirty years of CBP research and development, including chapter 8 of NUREG-0700⁷, NUREG/CR-6634⁸, and IEEE standard 1786⁹, revealed that the existing guidance is tailored toward control room procedures and may not be entirely applicable to field instructions. The Idaho National Laboratory researchers concluded that the existing documentation does not sufficiently address CBPs for field workers. For example, the existing guidance focuses on issues related to embedding process information in the CBP and how to handle soft control available through the CBP system. These are important issues for control room CBPs, but are not likely to be aspects of field CBPs due to the fact that many field CBPs address locally controlled equipment. Further, the existing guidance does not address ways to facilitate procedural compliance, or how to support coordination in the field. To address these gaps, a CBP system was developed with the purpose to identify and evaluate underlying design concepts and to develop design guidance for CBP specifically for field workers⁴.

Between 2012 and 2016 the INL researchers conducted CBP research as a part of the U.S. Department of Energy Light Water Reactor Sustainability Program. Together with the nuclear industry the researchers investigated the possibility and feasibility of replacing current paper procedures with CBPs.

The researchers explored ways to use advanced technology to design a CBP prototype to include dynamic presentation of the procedure content, context driven job aids, and integrated human performance tools. All of these innovations help the field workers focus on the task at hand rather than the tools. The CBP prototype was developed from a user perspective and proved to increase efficiency and improve human performance^{5, 10-13}. The researchers sought input from across the nuclear industry and researchers actively collaborated with and/or received valuable feedback from Ameren, Arizona Public Service, Dominion, Duke Energy, Energy Northwest, Exelon Nuclear, First Energy, NextEra, Pacific Gas & Electric, SCANA, South Texas Project, Southern Nuclear, Talen Energy, Tennessee Valley Authority, and Xcel Energy. All of which were members of the Nuclear Electronic Work Package – Enterprise Requirements

initiate, which was facilitated by the INL researchers¹⁴. This widespread collaboration helped to ensure the CBP concept was not only effective at enhancing efficiency and reducing error, but also applicable to the industry at large.

IV. CONCLUSIONS

The nuclear industry faces the opportunity to gain great improvements to both safety and human performance by leveraging technology and its inherent capabilities. However, these benefits are not automatically gained by installing a new system. Utilizing new technology may introduce new opportunities for errors. It is therefore important to understand the current work processes and the user needs, and to design a solution which provides improvements to the work process and addresses the user needs.

The INL research activities demonstrated several benefits, including increased efficiency and improved human performance by using automatic place-keeping and the ease of moving between and within procedures. Dynamic instructions and simplified step logic were identified as highly desirable features. Context-sensitive cues in the procedure proved to increase the worker's focus on the task at hand. Digital component verification proved to reduce the risk of manipulating an incorrect component. Photos of components included in procedure steps increased efficiency and reduced the risk of human error. Computational aids, such as performing calculations based on worker inputs, were proven to reduce the risk of human errors.

An effective field worker interface will address the limitations and challenges of paper procedures, incorporate strengths of the existing process, and add additional functionality that is available when using digital devices. In addition, the CBP should be easy to use, allow for flexibility of use, and prevent human error.

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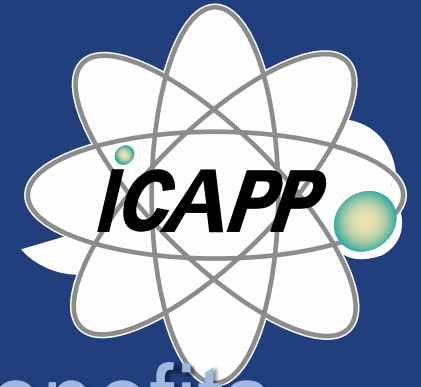
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ANS Meeting

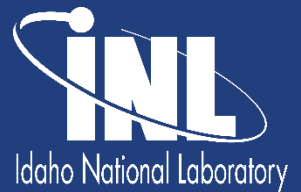
2018 International Congress on Advances in Nuclear Power Plants



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Gained by Dynamic Instructions
Compared to Smart PDFs

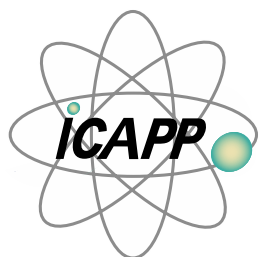
Katya Le Blanc

Human Factors Scientist

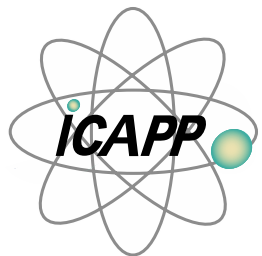


Team

- Johanna Oxstrand
 - Johanna.Oxstrand@inl.gov
- Rachael Hill
 - Rachael.Hill@inl.gov
- Katya Le Blanc
 - Katya.leblanc@inl.gov



Paper Procedure Process



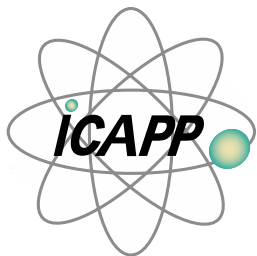
Paper Procedure Process

- a. (Concurrent Verification required)
Record equipment tag numbers and physically locate the proper Unit and Train battery chargers per Attachment 1.

"A" Charger Tag Number 1-1806-B3-CAA 1AD1CA
 "B" Charger Tag Number 1-1806-B3-CAB 1AD1CB
 jo
 Initial

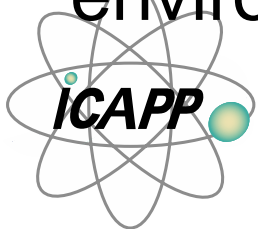
ATTACHMENT 1 Sheet 1 of 3

1-1806-B3-CAA 1AD1CA	CB R852	1-1806-B3-BYA 1AD1B	CB B54
1-1806-B3-CAB 1AD1CB	CB R852	1-1806-B3-BYA 1AD1B	CB B54
1-1806-B3-CBA 1BD1CA	CB R847	1-1806-B3-BYB 1BD1B	CB B49
1-1806-B3-CBB 1BD1CB	CB R847	1-1806-B3-BYB 1BD1B	CB B49
1-1806-B3-CCA 1CD1CA	CB R855	1-1806-B3-BYC 1CD1B	CB B56
1-1806-B3-CCB 1CD1CB	CB R855	1-1806-B3-BYC 1CD1B	CB B56
1-1806-B3-CDA 1DD1CA	CB R848	1-1806-B3-BYD 1DD1B	CB B44
1-1806-B3-CDB 1DD1CB	CB R848	1-1806-B3-BYD 1DD1B	CB B44
1-1806-B3-CN1 1ND1CA	TB LVL 1	1-1806-B3-BN1 1ND1B	TB1 BR 215
1-1806-B3-CN2 1ND1CB	TB LVL 1	1-1806-B3-BN1 1ND1B	TB1 BR 215
1-1806-B3-CN3 1ND2CA	TB LVL 1	1-1806-B3-BN2 1ND2B	TB1 BR215
1-1806-B3-CN4 1ND2CB	TB LVL 1	1-1806-B3-BN2 1ND2B	TB1 BR215
1-1806-B3-CN5 1ND3CA	CB R408	1-1806-B3-BN3 1ND3AB	CB 409
1-1806-B3-CN6 1ND3CB	CB R408	1-1806-B3-BN3 1ND3AB	CB 409



Paper Procedures

- Labor intensive
- Error prone
 - Administrative errors
 - Signing off steps
 - Lost workpackages
 - Operational Errors
 - Placekeeping
 - Right action on wrong component
- Static information in dynamic environment



6. **INSTRUCTIONS**

6.1 Swapping an ASW Pump and CCW Heat Exchanger Train

NOTE: In steps with two columns, only one column is performed. Use the same column throughout the section. Use the left-hand column to swap from Train A to Train B, OR the right-hand column to swap from Train B to Train A.

6.1.1 Before continuing, ensure that the system is in one of the following configurations:

ASW Pump 2-1 running and CCW HX 2-1 in service	ASW Pump 2-2 running and CCW HX 2-2 in service
--	--

6.1.2 IF in service, THEN secure continuous chlorination to the in-service ASW suction bay PER OP E-3:VI, "Intake Chemical Injection System - Continuous Chlorination of an ASW Train":

ASW Bay 2-1	ASW Bay 2-2
-------------	-------------

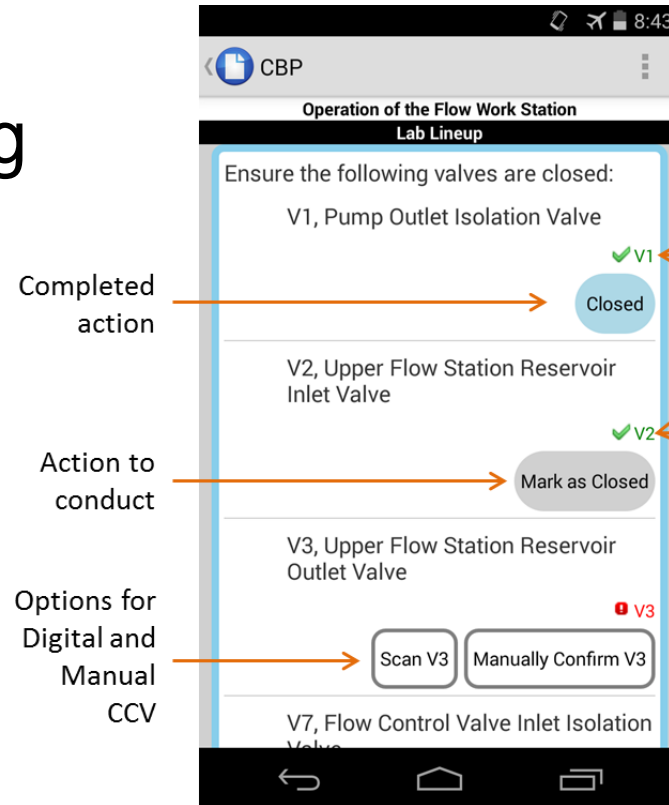
6.1.3 Prior to continuing, direct the Aux Building Watch to ensure the following:

- Ensure that no liquid radwaste discharge is in progress.
- IF a liquid radwaste discharge permit was authorized during the shift, THEN ensure that the discharge has been completed.



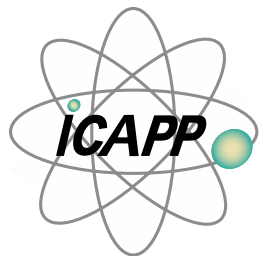
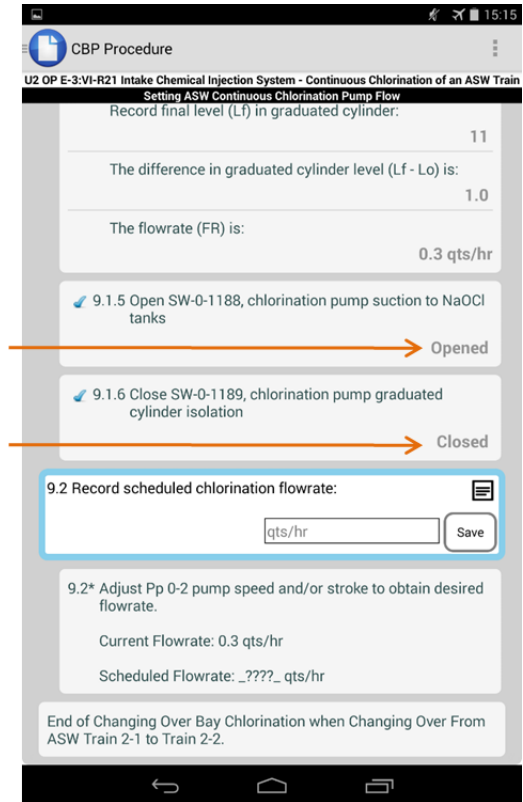
Dynamic Instructions

- Automatic Placekeeping
- Simplified Step Logic
- Correct Component Verification
- Context sensitive presentation of steps
- Calculations



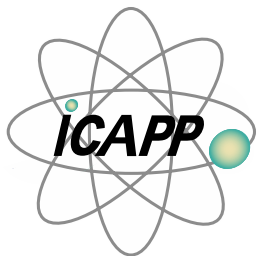
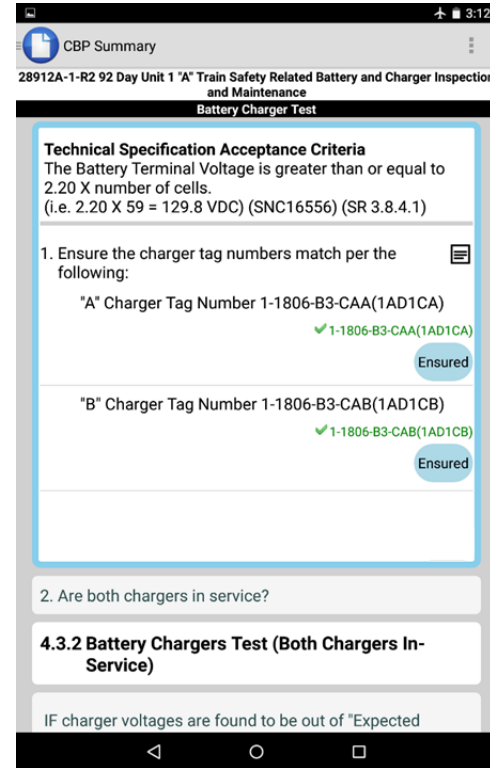
Successful
CCV

Indicates
"left as"
valve
position



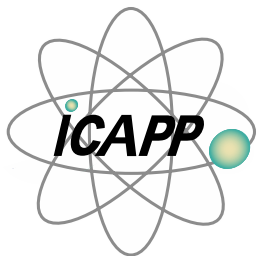
Benefits of Dynamic Work Instructions

- Reduced errors
 - Fewer corrective actions
 - Less retraining
 - Reduced risk



Benefits of Dynamic Work Instructions

- Reduced errors
- Reduced labor costs
 - Fewer administrative tasks
 - Less waiting
 - Less “chasing status”

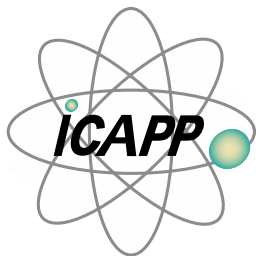


Benefits of Dynamic Work Instructions

- Reduced errors
- Reduced labor costs
- Reduce paper handling costs
- Attract, train, and retain next generation of workers

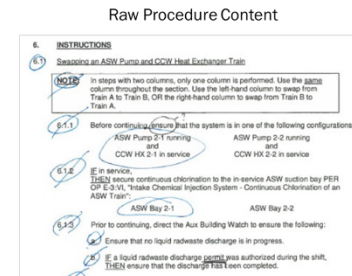


70% of the workforce is retiring in the next five years



Benefits of Dynamic Work Instructions

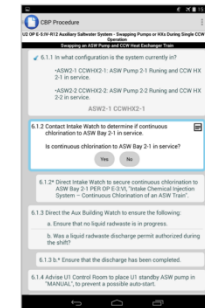
- Reduced errors
- Reduced labor costs
- Reduced paper handling costs
- Attract, train, and retain next generation of workers
- More efficient managing of procedures and related content
 - Less time on formatting
 - Easier procedure updates



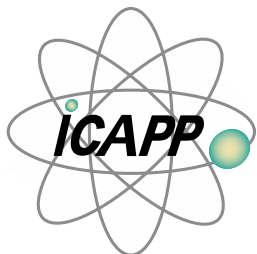
Structured Data

- <Section>
- <Note>
- <Step Number>
- <Conditional Step>
- <Component ID>
- <Action Verb>
- <Conditional Step>

ELINA



40-60% of a procedure writer's time is spent formatting text



Benefits of Dynamic Work Instructions

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PAPER PROCEDURE

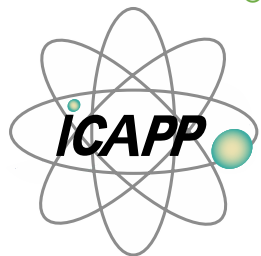


Manual transcription of recorded data

Dynamic Instructions

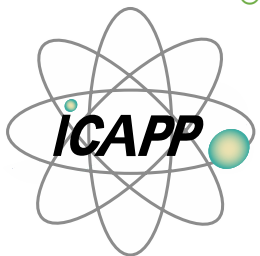
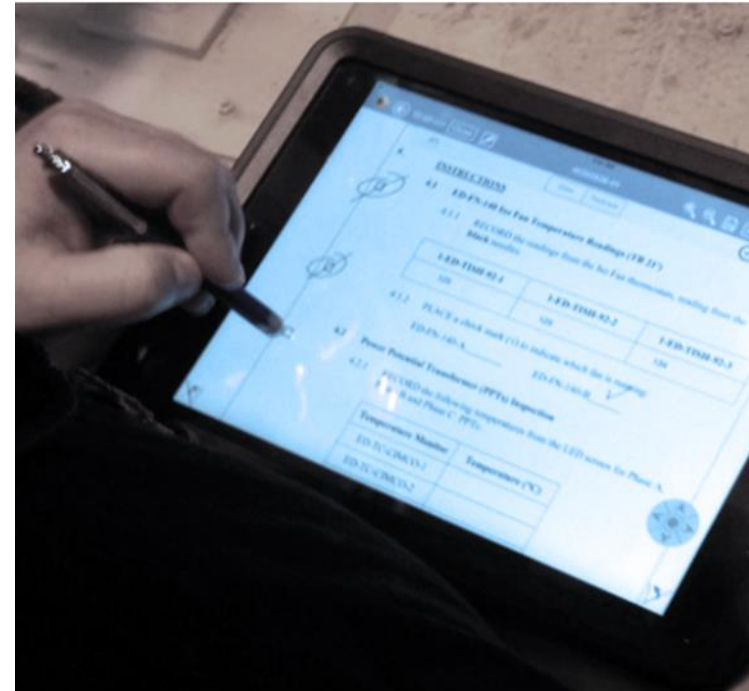


Automatic data analytics and trending of recorded data



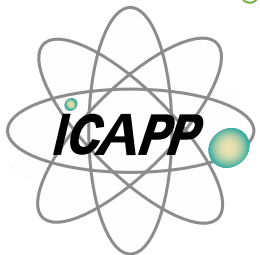
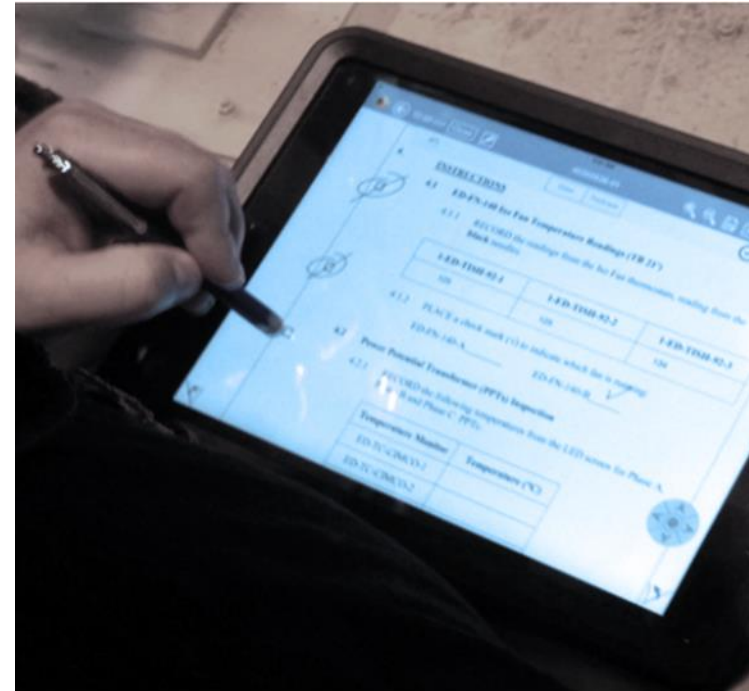
Benefits of Electronic Work Management with “Smart” PDFs?

- Reduced errors
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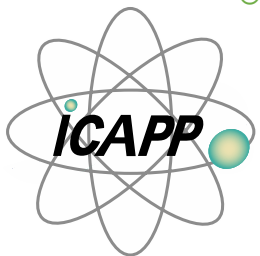
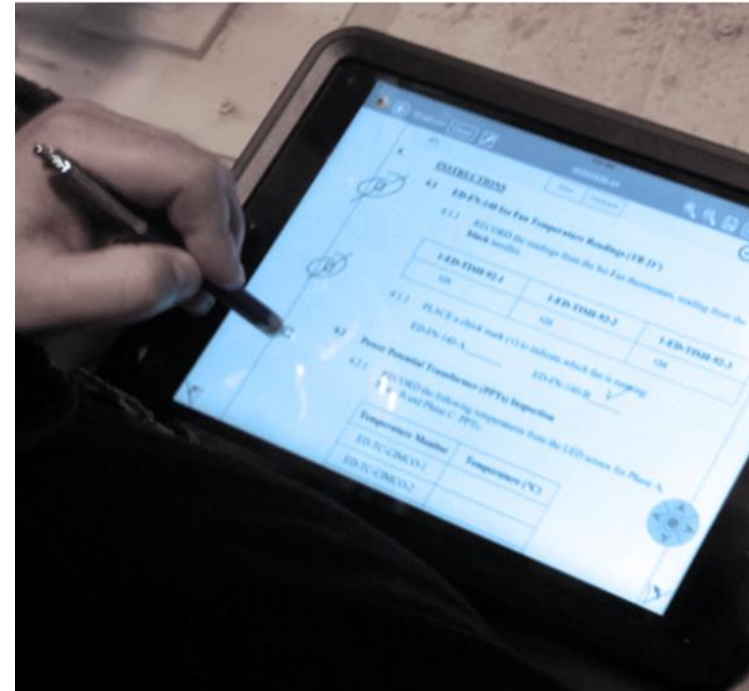
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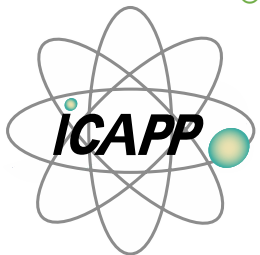
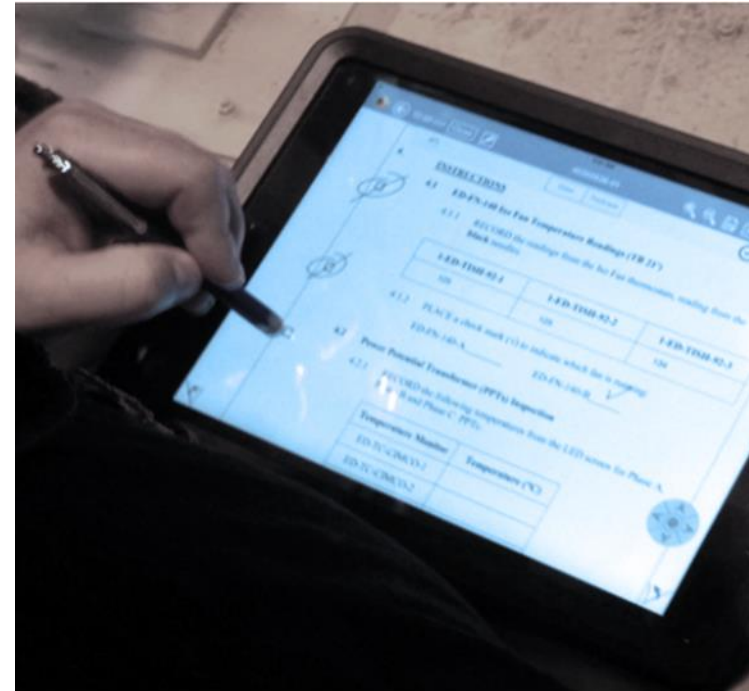
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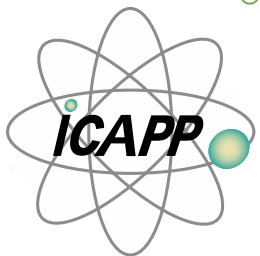
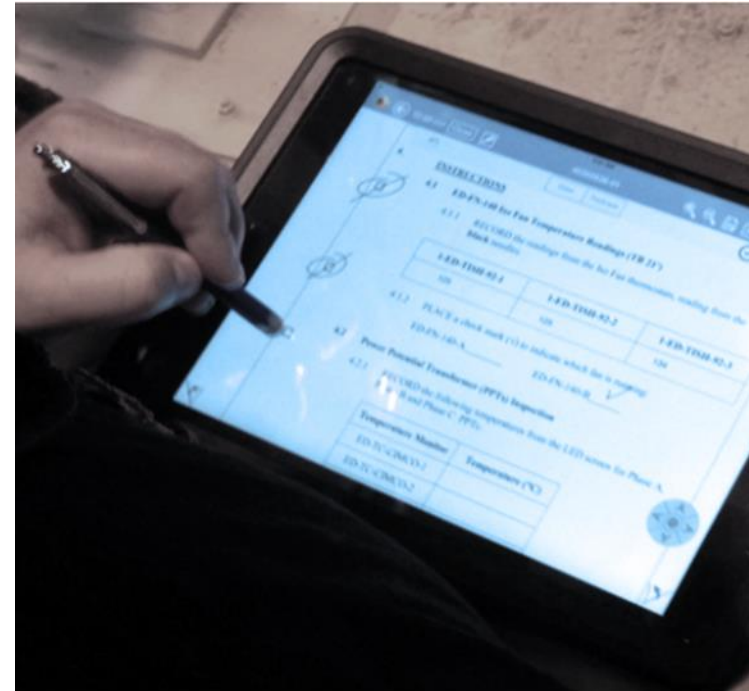
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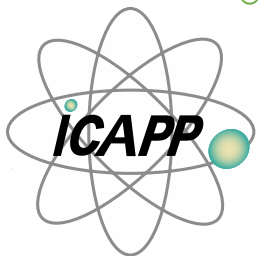
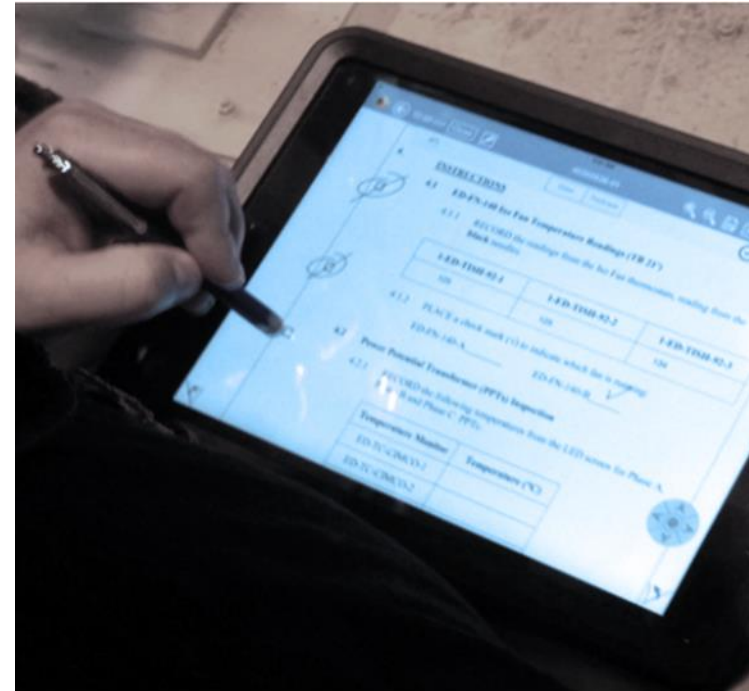
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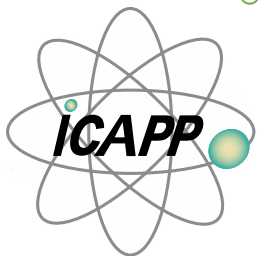
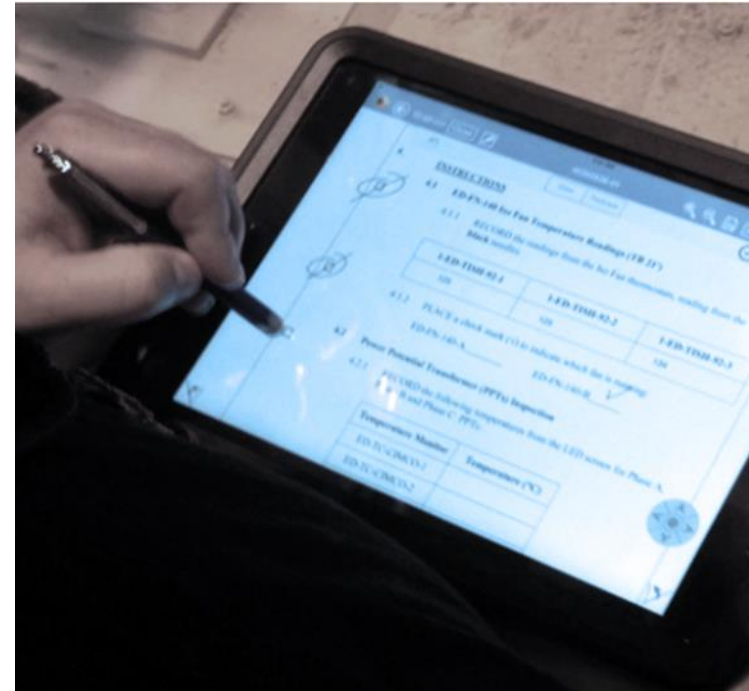
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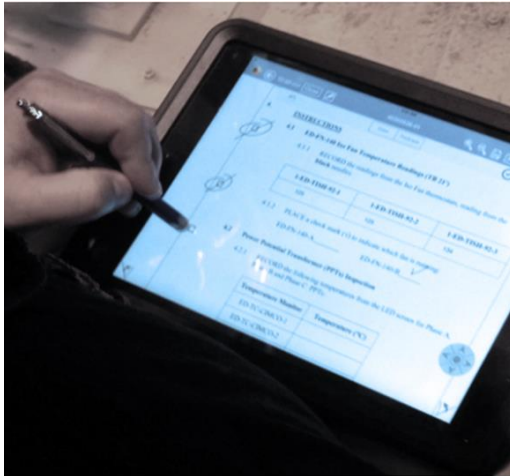


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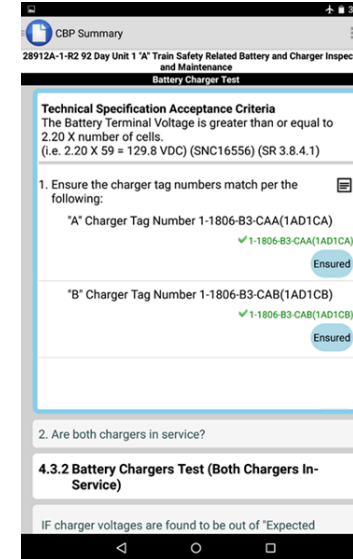
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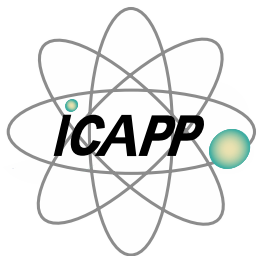
Conclusions



Reduces paper handling costs and may simplify approval and review of work packages



Dynamic instructions are required to achieve performance and efficiency gains promised by electronic work management



Thank you!

To Learn More:

<https://cbpdemo.inl.gov>

