AAMI WHITE PAPER

Optimizing the CMMS *Work Order Type* Field

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Advancing Safety in Health Technology

ABOUT AAMI

The Association for the Advancement of Medical Instrumentation (AAMI), a nonprofit organization founded in 1967, is a diverse alliance of more than 10,000 members from around the world united by one critical mission—supporting the healthcare community in the development, management, and use of safe and effective medical technology. AAMI serves as a convener of diverse groups of committed professionals with one common goal—improving patient outcomes. AAMI also produces high-quality and objective information on medical technology and related processes and issues. AAMI is not an advocacy organization and prides itself on the objectivity of its work.

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Introduction

Computerized maintenance management system (CMMS) software has become essential for healthcare technology management (HTM) program operations. Sophisticated CMMS databases enable the collection of vast amounts of data and the ability to assign work and document regulatory compliance, and offer the promise of providing actionable management information.

However, frontline HTM professionals may regard their interaction with the CMMS as an onerous data entry chore. Managers of HTM programs sometimes struggle to derive useful insights from the mountains of data despite the tremendous capabilities that CMMS suppliers have built into their products.

In response to this challenge, the Association for the Advancement of Medical Instrumentation (AAMI) has continued to sponsor a "CMMS Collaborative" project among CMMS suppliers. The project started with an assumption that better use of existing CMMS software would make it easier to get accurate data into the database and useful information out of it.

Background

As HTM professionals, we are familiar with the lack of standardization in CMMS configuration. All modern CMMS software contains the fundamental fields that are needed for basic HTM program operations. Unfortunately, HTM programs differ widely in how they configure those fields.

In some cases, the chosen configuration makes it difficult for HTM professionals to enter data and to extract information. That limits the ability of the HTM program to operate economically in its efforts to provide safe and effective medical technology for patient care.

More broadly, the lack of standardization makes it virtually impossible for the HTM community to engage in benchmarking. Performance metrics from one HTM program often cannot be compared to metrics from another HTM program. Moreover, this puts the HTM community in a weak position relative to regulatory and accreditation agencies. Without performance metrics that are representative of HTM programs across the country, the HTM community cannot support its assertions about what works and what doesn't. Effective advocacy requires good data.

Over the years, the HTM community has engaged in informal debates—also known as "flame wars"—without much progress toward consensus. Organizations like AAMI and ECRI have offered benchmarking tools that were not widely used, largely because HTM programs had difficulty providing consistent data. AAMI has also developed formal standards such as ANSI/AAMI EQ56:2013, *Recommended practice for a medical equipment management program,* with limited impact on HTM program operations.

With these considerations in mind, a group of leading CMMS suppliers (Table 1) met informally at the 2019 AAMI Exchange with AAMI representatives and a small number of HTM thought leaders. The purpose of the meeting was to discuss the feasibility of a collaborative effort and a new approach to standardization.

Table 1. Participating CMMS Suppliers

Company	CMMS
Accruent	TMS
EQ2	HEMS
MediMizer	MediMizer
Nuvolo	Nuvolo
Phoenix Data Systems	AIMS
TMA Systems	WebTMA

The new approach to be taken by the CMMS Collaborative was more of a "build it and they will come" effort. Suppose the leading CMMS suppliers could reach a consensus about the best way to configure key CMMS fields. They would rely on their vast experience with data collection and their strong working relationships with clients: Offer useful tools to HTM professionals and they'll use them.

A project charter was written to define the rules of engagement and scope of work: standardization of selected CMMS fields. CMMS suppliers would support their clients through reconfiguration of existing CMMS installations and as part of new CMMS implementations. AAMI would provide administrative and financial support to the project.

We learned two things early in our discussions:

1. HTM program managers—the clients of the CMMS suppliers—look to the CMMS suppliers for advice on how to configure their databases. They say, "Tell me the best way to set up my CMMS."

2. CMMS suppliers—who offer tremendous flexibility in database configuration—look to HTM program managers for direction in database configuration. They say, "We can set it up any way you want it."

The practical objective then became development of recommendations for CMMS database configuration that were feasible from the perspective of the CMMS suppliers and responsive to the needs of HTM professionals for easy data input and useful information output.

In the fall of 2020, AAMI published the first output of the CMMS Collaborative—*Optimizing the CMMS Failure Code Field*.[1]

The purpose of the *Failure Code* field is to document the reason that a medical device was unable to achieve its clinical objective of diagnosis, treatment, or monitoring. This would include obvious failures that blocked achievement of a clinical objective and latent (hidden) failures that could have (and eventually would have) blocked achievement of a clinical objective.

The principles described above provide guidance for differentiating between types of failures. Additionally, it was determined that failures related to use (e.g., misuse, abuse) should be differentiated from technical failures. This differentiation enables HTM management decisions that address user competency versus planned maintenance (PM) effectiveness. Other required points of differentiation include failures caused by environmental conditions or utility systems, as well as situations in which the problem cannot be verified (i.e., could not duplicate). The CMMS Collaborative's recommended *Failure Code* field options are summarized in Table 2.

Table 2. *Failure Code* Field Options

Option	Definition	Examples
Accessory or Disposable Failure ✓	Failure of device accessory or disposable, not a failure of the device itself.	ESU footswitch. Infusion pump cassette.
Calibration Failure ✓	Failure of a device to meet calibration parameters, requiring recalibration.	Need to adjust low-battery alarm trigger point.
Component Failure (Battery) ✓	Failure of the battery that provides power for device operation.	Battery fails to hold a charge. Battery reconditioning fails.
Component Failure (Not Battery) ✓	Failure of a device component other than the battery.	Infusion pump pressure sensor. Device power cord. Device display.
Failure Caused by Maintenance ✓	Failure of a device resulting from maintenance activities.	Physical damage during maintenance. Overvoltage during testing.
Failure Caused by Abuse or Negligence	Failure of a device resulting from damage caused by intentional misuse or negligent use.	User drops defibrillator. Patient damages infusion pump.
Network or Connectivity Failure	Functional failure external to device from failure of network or connectivity.	Network connection not accessible. Infusion pump library not updated.
Software Failure	Functional failure of a device resulting from malfunctioning software.	Infusion pump software malfunctions. Physiological monitor required rebooting.
Use Error (Use Failure)	Failure of a device to support achievement of a clinical objective.	User error. Infusion pump programming error.
Failure Caused by Utility System	Functional failure of a device resulting from failure of or access to a utility system.	Electrical power. Medical gas or vacuum. Ventilation.
Failure Cause by Environmental Factor	Functional failure of a device resulting from an environmental factor.	Excessive ambient temperature. Excessive relative humidity.
Failure Could Not Be Identified	Reported failure could not be reproduced or identified by testing.	Inaccurate or incomplete report of failure. Intermittent device failure.
Failure Not Diagnosed—Device Not Repaired	Reported failure indicated that testing or repair was unwarranted.	Device replacement was more cost-effective than testing or repair.
No Failure Associated with the WO	There was no failure associated with the work order (included for completeness).	PM work order completed normally. PM work order could not be completed.

✓ = PM-related failure

WO = work order

The *Work Order Type* Field

The CMMS Collaborative project members reconvened in 2021 to begin the second phase of work—standardization of *Work Order Types*. The decision to focus on *Work Order Types* was driven by analyses completed in the first phase of the project and supported by recognition of the importance of effective design and implementation of an alternate equipment maintenance (AEM) program. The ability to distinguish between maintenance and non-maintenance work activities was also determined to be critical for enabling effective management of HTM staffing and budgets.

All comprehensive CMMS databases contain multiple options for describing the type of work to be completed and documented—i.e., the *Work Order Type*. An audience poll conducted during an AAMI HTM*Live!* webinar confirmed our assumptions about how *Work Order Types* are defined and documented (Table 3).[2]

Table 3. AAMI HTM*Live!* Webinar Polling Question 1

Responses	What *Work Order Types* do you have in your CMMS? (If applicable, select more than one answer.)
29%	Planned maintenance
24%	Corrective maintenance
24%	Projects
12%	Support
12%	Training

The *Work Order Type*, as conceptualized for this project, is intended to be a high-level categorization of all work activities carried out by HTM personnel. At the highest level, it differentiates between maintenance and non-maintenance activities. In general, maintenance *Work Order Types* are associated with a specific asset where an asset is defined as a single line item in the CMMS. Consequently, the labor and material costs associated with a maintenance work order will be attributed to (associated with) the particular CMMS asset. Alternatively, non-maintenance *Work Order Types* are not typically associated with a single asset. In some cases, they are associated with specific individuals or groups of individuals, as in the case of HTM technical training.

The decision was also driven by the fact that the HTM community have been rather inconsistent in how they use *Work Order Types*, how they configure them, what data they associate with them, and what is done with the data. It was agreed that the types and data associated with them could not readily drive management decision-making because of these inconsistencies. Therefore, as with the phase one failure codes, an early project task was to look at the different ways *Work Order Types* are used, as documented in various CMMS databases.

Supporting Analytics

Anonymized data was aggregated from more than 16 million work orders from the CMMS suppliers' databases to visualize how *Work Order Types* are being used. Additionally, the VA HTM Program Office provided their 45 Biomedical Engineering Uniform Work Actions (i.e., *Work Order Types*).[3]

The first thing we noticed was that thousands of entries were not relevant in the sense that the entries—although representing essential data—did not represent *Work Order Types* (e.g., "Duplicate"); therefore, they should not be used as *Work Order Types* but should instead be collected in other fields. Secondarily, several examples of similar wording and intent were also noted (e.g., preventive maintenance, preventative maintenance, planned maintenance, PM/SM).

As was the case with failure codes, it was important to define the purpose of *Work Order Types* in a manner that would be clear to frontline staff (i.e., technicians and engineers) and result in accurate data collection through the use of standardized options that are mutually exclusive and exhaustive.

The term "mutually exclusive" means that the options do not overlap and that there is only one appropriate choice. This contributes to consistency in data collection by reducing the number of potential choices about how to complete a particular work order. The term "exhaustive" means that the options cover all possible situations. To support comprehensive data collection, the *Work Order Type*—which is essential for its use in maintenance management—should be configured as a required-input field. This requirement can be made only if the options cover all possibilities. During the HTM*Live!* webinar, we asked how well the audience's existing *Work Order Types* met these database design criteria (Table 4).[2]

Table 4. AAMI HTM*Live!* Webinar Polling Question 2

Responses	How well do your *Work Order Types* meet these requirements? (If applicable, select more than one answer.)
27%	The purpose of the field is clearly defined.
32%	Options are non-overlapping (mutually exclusive).
32%	Options cover all possibilities (exhaustive).

In addition, the number of *Work Order Type* options needs to strike a balance between practicality (ease of use) and granularity (information detail). This requires a trade-off between too many choices (burdensome for technicians) and too few choices (lacking the degree of specificity needed for management decision-making). Our recommendations in the next section include a total of 10 *Work Order Type* options. Another HTM*Live!* audience poll (Table 5) suggests that this is an acceptable number.[2]

Table 5. AAMI HTM*Live!* Webinar Polling Question 3

Responses	Does the recommended list have a reasonable number [10] of options?
85%	A reasonable number of options
8%	Not enough options
8%	Too many options

Recommended Standardization of *Work Order Type* Options

The analytics described above provided guidance for differentiating between types of work orders. In particular, maintenance activities can be differentiated from non-maintenance activities. Both represent valuable contributions by the HTM department and should be reported as such. Additionally, work orders related to use (e.g., Support—Users) should be differentiated from technical training (e.g., Training—HTM Staff).

Another point of differentiation includes administrative activities and projects. For purposes of the CMMS Collaborative's work, a project was defined as an activity with a defined start and completion point (date) that is not PM or corrective maintenance. A project has a specific objective that is formally managed in terms of content, timeline, and deliverables. Costs associated with these activities may or may not be allocated to a particular asset.

The CMMS Collaborative group's recommended *Work Order Type* options are summarized in Table 6. For each option the table contains recommended terminology, a concise definition, and brief examples.

Table 6. *Work Order Type* Options

Name	Code	Aliases/Synonyms	Description
Planned Maintenance ✓	PM	• Scheduled maintenance • Preventive maintenance • Preventative maintenance	Used for a single CMMS asset, not multiple assets. Costs associated with these activities are allocated to a particular asset. Activities (what we do) include: • Device restoration • Safety & function testing/inspection Not used for: • Corrective maintenance discovered during PM • Incoming inspection • Safety & function testing after repairs or other unscheduled activities
Corrective Maintenance ✓	CM	• Repair • Unscheduled maintenance	Used for a single CMMS asset, not multiple assets. Costs associated with these activities are allocated to a particular asset. Circumstances for use: • Found during PM • Reported by equipment users (even if no deficiency is actually found) • Identified by HTM personnel (even if no deficiency is actually found) Activities (what we do) include safety & function testing to: • Identify and correct deficiencies • Confirm that equipment is safe & effective following CM Not used for: • Incoming inspection • Installation • Deinstallation, decommissioning, disposal • Recall & alert management • Software update/upgrade • Cybersecurity remediation

Name	Code	Aliases/Synonyms	Description
Training—HTM Staff	TRAINING		Used to document HTM personnel technical training and professional development. Costs associated with these activities are not allocated to a particular asset. Activities (what we do) include: • OEM/3rd-party technical training • Peer-to-peer technical training • Mentoring
Support—Users	SUPPORT		Used to provide non-maintenance support to users. Costs associated with these activities may or may not allocated to a particular asset. Activities (what we do) include: • Rounds—informal check-in with users • Training on specific medical devices/system
Project	PROJECT		An activity with a defined START and COMPLETION point (date) that is not PM or CM. Has a specific objective that is formally managed in terms of content, timeline, and deliverables. Costs associated with these activities may or may not be allocated to a particular asset. Activities may include meetings as well as technical work. • Installation • Deinstallation, decommissioning, disposal • Software update/upgrade • Construction/renovation • Medical device integration/interoperability
Administrative	ADMIN		Ongoing activities with no definitive START and COMPLETION point (date). Costs associated with these activities are not allocated to a particular asset. • Meetings (e.g., HTM department) • Capital equipment planning • Cleaning the workspace (HTM shop)
Cybersecurity ✓	CYBER		An activity specific to: • Mitigation • Breach response • Remediation
Recall & Alert Management ✓	RECALL		Initiated by the FDA and/or the OEM.
Incident Investigation[1]	ADVERSE EVENT		An event resulting in, or the potential for, harm or death of a patient, staff, visitor.
Incoming Inspection ✓	INCOMING		Activity required to complete a performance verification and add (enter) equipment asset into MEMP and CMMS; any device not already in the CMMS inventory: • NEW • Patient owned • Reactivated • Demonstration, loaned, rented

✓ = Maintenance-related *Work Order Type*

MEMP = Medical equipment management plan

OEM = Original equipment manufacturer

[1] IT Services uses the term "incident" to describe any failure whereas HTM uses the term to refer to situations when there is patient/staff harm or the potential for harm.

In a small number of work orders, there is a possibility that more than one *Work Order Type* could be applied. For example, meetings associated with a construction project could be coded as either PROJECT or ADMIN. To avoid confusion, the HTM department should be explicit in their definitions and consistent in their application. It is also worth noting that a number of aliases (similar terms) were found in the data. The use of aliases is fine because the objective is standardization of the concepts and less about the specific terminology. In addition to the aliases noted in Table 5, the following aliases are routinely used by prominent agencies:

- Centers for Medicare & Medicaid (CMS)—maintenance, inspection, and testing
- The Joint Commission (TJC)—inspection, testing, and maintenance (ITM)
- ECRI Institute—inspection and preventive maintenance (IPM)

Examples of Applying the Standardized *Work Order Type* Options

The *Work Order Types* can also be used for monitoring the performance of an AEM program. For example, the standard MTBF (mean time between failures) metric, which is calculated for failures of all types, can be supplemented by an $MTBF^{PM}$ (mean time between PM-related failures) metric that is based on work orders with PM-related failures (i.e., those failures that can be mitigated by better PM).[4] In addition, configuring the CMMS to flag PM-related failures can provide an early warning for emerging maintenance issues, allowing proactive adjustment of maintenance practices.

Appropriate use of *Work Order Types* also increases the sophistication and precision of HTM program management. Staffing and skill level requirements can be more accurately forecasted and managed based upon the mix of maintenance versus non-maintenance activities.

Conclusion

To facilitate adoption, the CMMS suppliers participating in this project have committed to working with existing clients to determine pathways and tools to transition from current platform configurations to ones that leverage this standardized list of *Work Order Types* as well as the standardized list of failure codes. Together, the *Work Order Types* and failure codes enable the sort of metrics and analytical work needed for HTM operations and performance improvements. Additionally, the CMMS suppliers will support new clients with platform configurations that immediately leverage the standards.

The CMMS Collaborative members gratefully acknowledge the contributions of many reviewers. We received numerous written comments and had many conversations, all thoughtful and based on hard-won experience. This document incorporates many of those contributions.

We also heard from several HTM professionals who plan to implement the CMMS Collaborative recommendations in their own CMMS databases. AAMI will monitor adoption of these standardized *Work Order Types* and failure codes throughout the HTM field and solicit feedback from those who have implemented them. If you have questions about how to implement either *Work Order Types* or failure codes, or have other feedback, please email HTM@aami.org.

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