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RFID in U.S. Libraries

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*A Recommended Practice of the
National Information Standards Organization*

Prepared by the
NISO RFID Revision Working Group

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Foreword

NISO RFID Revision Working Group Charge

The original NISO RFID Working Group was formed in 2006 to focus on the use and implementation of radio frequency identification (RFID) technologies in U.S. libraries. In January 2008, NISO formally published the Recommended Practice, *RFID in U.S. Libraries* (NISO RP-6-2008). Since that time, there have been new developments with regard to RFID implementation in the larger book industry as well as in other countries, including the U.K., Denmark, the Netherlands, and Australia. After the publication of NISO RP-6-2008, the International Organization for Standardization (ISO) Working Group on RFID in Libraries (ISO TC46/SC4/WG11) produced a three-part standard (ISO 28560) governing the encoding of data on RFID tags for item management in libraries. This work has resulted in ambiguities between the original NISO publication and the final ISO publications. One of the goals of the NISO RFID Revision Working Group is to eliminate these ambiguities.

This revision includes input from RFID hardware manufacturers, solution providers (software and integration), library RFID users, distributors and processors, and related organizations. This revision to the 2008 Recommended Practice was necessary to bring the advice from NISO in line with international standardization efforts. It will also provide United States implementers of RFID tags in libraries sufficient guidance to conform to the ISO work.

Among the goals of this revision and the original document were the following:

- To review existing RFID standards, assess the applicability of this technology in U.S. libraries and across the book publishing supply chain, and promote the use of RFID where appropriate.
- To examine and assess privacy concerns associated with the adoption of RFID technologies in libraries.
- To investigate the way RFID may be used for the circulation or sale of books and other media in the United States and make recommendations.
- To focus on security and data models for RFID tags, along with issues of interoperability and privacy.
- To create a set of recommendations for libraries with regard to a tag data model and other issues, with the specific goals for this revision of:
 - a. Reviewing and updating information in the original document.
 - b. Ensuring conformance between the approved ISO standard and the NISO recommended practice.
 - c. Creating a set of recommendations for a U.S. data model standard.
 - d. Providing specific examples to make implementation easier for manufacturers and libraries.

Outcomes

The NISO RFID Revision Working Group document recommends a set of practices and procedures to ensure interoperability among U.S. RFID implementations. All sections of the original 2008 document have been reviewed and updated to reflect changes in practices for protection of personal privacy, support advanced functionality, facilitate security, protect against vandalism, and allow the RFID tag to be used in the entire lifecycle of the book and other library materials.

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This Recommended Practice includes:

1. A checklist (for libraries and vendors) that can be used to evaluate the degree of conformance with the ISO 28560. This checklist is available at http://biblstandard.dk/rfid/docs/conformance_28560-2.pdf
2. A set of recommend practices and procedures to ensure interoperability among U.S. RFID implementations.
3. A list of suggestions to reduce the impact of migrating from non-conforming systems to conforming systems or running with “mixed” tag systems (older tags and newer conforming tags).

These NISO recommendations for best practices promote procedures that:

- a. Allow an RFID tag to be installed at the earliest point in the lifecycle of the book and used throughout its lifecycle from publisher/printer to distributor, jobber, library (shelving, circulating, sorting, re-shelving, inventory, and theft deterrence), and interlibrary loan, and then on to secondary markets such as secondhand books, returned books, and discarded/recycled books.
- b. Allow for true interoperability among libraries; that is, a tag in one library can be used seamlessly by another, even if they have different suppliers for tags, hardware, and software.
- c. Protect the personal privacy of individuals while supporting the functions that allow users to reap the benefits of this technology.
- d. Permit the extension of these standards and procedures for global interoperability.
- e. Remain relevant and functional with evolving technologies.

Early RFID implementers are at considerable risk because of the lack of interoperability of proprietary vendor systems. As RFID providers and libraries adopt tags with the data model recommended in this recommended practice, true interoperability that allows libraries to procure the tags, hardware, and software from independent providers and distributors to use with all tags can become a reality.

The data model outlined in this document is an essential first step. This model is a key precursor to a world in which a library can procure tags from different vendors, merge collections containing tags from different vendors, and, for the purposes of interlibrary loan, read the tags on items belonging to other libraries.

Even with a data model, there are other barriers to interoperability and plug-and-play capabilities. They include:

- a. Vendor-specific encrypting and encoding of the data.
- b. Proprietary security functions, which are an advantage when considering hackers, thieves, etc., but are a detriment to interoperability (see [Section 3](#)).
- c. Software or firmware that is system dependent and can only be used with specific tags.

The ideal is that RFID tags compliant with the data model can be usable by other RFID vendors. With standards recommended in this document, interoperability and the ability to embed tags into books at manufacture is within reach.

For libraries already heavily invested in RFID, [Section 4](#) addresses issues related to migration or upgrading of tags to be compliant with the data model.

In this report, The NISO RFID Working Group is providing its best insights into these complex issues and a possible way forward.

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Section 1: Use of RFID in Libraries

1.1 Overview

Libraries use RFID tags on books and other items to provide identification during check-out, check-in, inventory, and for theft deterrence. Benefits of adoption may include:

- a. Reduction of staff manual processes, errors, and repetitive motion
- b. Enhanced customer experience through fast and private self check-outs
- c. Reduction of staff and patron time spent in finding items
- d. Integrated security functionality

While costs continue to decrease due to mass adoption, current RFID implementations require an initial investment and ongoing expense, particularly in the case of a parallel implementation of automated materials handling. While there is a growing body of anecdotal and published reports on return on investment, the rationale for implementation today is usually based on such criteria as:

- a. Reduction in the percentage of staff time spent on check-out
- b. Reduction in the percentage of staff time spent on check-in
- c. Shift in the volume/percentage of check-outs handled by staff versus patrons
- d. Increase in circulation handled without additional staff
- e. Customer satisfaction with check-out and check-in processes
- f. Speed and accuracy of check-in
- g. Efficiency of automated materials handling with RFID
- h. Speed and accuracy of inventory
- i. Consolidation of security functionality eliminating the need for separate magnetic strip or lock boxes
- j. Potential for future opportunities to utilize RFID tag data
- k. Reduction or avoidance of worker's compensation costs from repetitive strain injuries

1.2 Tagging in Libraries

Libraries typically buy pre-programmed tags or have their distributors apply and program tags prior to shipment. While this is an increasing trend for new items, in-library application is still required for retrospective conversions of existing items and new books, media, periodicals, donated materials, and other items not procured through a distributor. In the longer term, source tagging at item manufacture is anticipated.

Retrospective conversions can be processed wherever there is a PC with barcode scanner, programming software, and an RFID reader. The conversion procedure is straightforward and should take only a few seconds per item. The task can be performed by non-technical staff or volunteers. Some vendors also offer dedicated tagging and programming stations with touch screens, automated tag dispensing, and portability for in-stack use, with rates of conversion approaching 500 items per hour with two-person teams. Consideration must be given to the cost of buying or renting dedicated stations and their space requirements. Some vendors will quote a per-item price for third party conversion services as an alternative.

1.3 Self Check-Out

Self check-out stations, or kiosks, are generally proprietary touch-screen devices composed of an RFID reader, barcode scanner for library cards, receipt printer, interface software, and, if the library's integrated library system (ILS) does not offer a compatible self check-out module, NCIP (ANSI/NISO Z39.83) or SIP2 protocol software to communicate with the library's ILS application or database. Some vendors configure stations to allow users to view their library accounts, pay fines, and manage their accounts, and nearly all systems provide a basis for staff override in the event of patron difficulty.

It is also possible to procure components or a generic kiosk and outfit it with an RFID reader, barcode scanner, and necessary software inexpensively, but this approach requires that the self check-out functions are embedded in the ILS software. This has been done in several U.S. public libraries. Most self check-out systems today use client software on the self check-out unit which communicates with the server software of the ILS, and use the NCIP or SIP2 protocols. There has also been some development of web applications and APIs that may communicate more directly with the ILS.

Self check-out stations allow multiple items to be stacked on the reader for instant and simultaneous check-out. The number of items that can be stacked for simultaneous check-outs depends on the read range of the antenna, and the type of items. (DVDs, CDs, and books on CD with their metal substrates reduce the number of items that can be so stacked.) Various means have been developed to try to aid in the success of multiple item check-out, including anti-collision software and barriers or boxes to limit the height of items in the stack. In order to simplify the process and limit any possible errors that may affect the patron experience, some libraries allow only single item self check-out. This also provides a familiar experience for patrons who use retail self check-outs.

Self check-out stations have been largely counted as successful and while untagged items or patron circumstances—e.g., excessive fines, expired cards, address checks, and other blocks on cards or limits on material types—may still require a staff intervention or check-out, some libraries report seeing self check-out rates range from 30 to 99% of total transactions. Key factors mentioned in high rates of self check-out are intuitive, easy-to-use stations; placement of the self-check stations near to but not immediately adjacent to the staffed circulation desk; small footprints to allow for multiple station placement; encouragement and promotion by staff; friendly loan and fines policies; and self pick-up of items on hold. Examples of user-friendly loan and fine policies might include allowing patrons to pay fines at the self check-out station using a credit card, debit account, or PayPal, or increasing the threshold at which self check-out use is blocked due to fines.

Due to concerns regarding decreased read range on metallic content materials, some libraries add various alternative security measures to those materials, which may or may not affect self-check rates. Generic locking cases require staff intervention. Some vendors offer integrated self-check lock boxes that may be automatically unlocked once checked out. The additional cost and usability factors of these measures, or those of a media jukebox, must be evaluated by each library. (For more on security issues, see [Section 3](#).)

1.4 Check-In, Including Manual, Conveyor, and Sorting Systems

Whether check-in takes place manually or via an automated process, RFID significantly streamlines the check-in of returned items. When check-in takes place manually, RFID also significantly reduces staff repetitive motions.

Conveyor and sorting systems are becoming more prevalent in libraries with the advent of RFID technology. The RFID reader is either mounted in a return chute or over/under a section of a conveyor belt. The item passes over or under an RFID reader—long enough to read the content on the tag, turn on the security, and communicate with the library's ILS. The item is then sorted into bins or onto shelving carts according to item type, location code, or other information. This is particularly valuable for sorting items on hold into specified bins. Systems typically have anywhere from three to fifteen bins or carts, though larger systems utilize a much larger number of bins. It should be understood that RFID return chutes without or with limited sorting capability will require manual intervention to perform accurately, for

example to sort for holds. Their main advantage would be in fast updating of patron records to allow checking out more of a limited collection and the ability to provide check-in receipts automatically.

Manual check-ins are made significantly easier, faster, and more ergonomically friendly with RFID because fewer fine motor movements are required to place an item on a reader than to read the barcode with a scanner. For those using multi-item processing, more books can be checked in at one time. Again, some mechanism for communicating with the ILS, whether it is NCIP, SIP2, web service, or proprietary API, is required to process transactions using data obtained via RFID.

1.5 Inventory Systems

RFID technology can make such routine tasks as shelf reading, inventory control, and item location considerably faster. Early RFID-based inventory systems were limited in the reliability of their high-speed scanning of shelved items. Newer systems with faster reading protocols allow for improved accuracy.

Typical hardware offered by vendors includes an inventory wand and reader module attached to a battery-powered computer with wireless capabilities. Items on a shelf can be inventoried by moving the handheld wand along item spines.

Challenges to reliability include thin items, items in direct contact with metal shelf dividers, covers, or pages with metallic ink or foil content, multiple adjacent items with tags placed in the same location, and any media items with metal content, e.g., CDs and DVDs.

1.6 Support for Interlibrary Loan (ILL)

While RFID is not necessary for ILL, it could be a powerful force for efficiency. For libraries with ILL modules built into their ILS, RFID holds the promise of streamlining staff operations. A key requirement for interlibrary RFID use is compliance with a national or internationally accepted data model. Once a compliant environment is achieved, the receiving library staff can quickly read the unique identifier on the tag and attach it to the bibliographic record received from their bibliographic network. This would signal that the item is received and would allow automated procedures to occur, from patron notification to self pick-up and self check-out. A current benefit of RFID in some ILL processes, even before introducing standardization, includes being able to easily circulate ILL items by temporarily affixing a programmed tag to the item once it arrives at the borrowing institution. This not only enables self check-out, but also self pick-up of holds.

1.7 RFID Standards in Libraries

Several standards are available to assist with interoperability in the area of RFID in Libraries. These can be divided into two broad categories: Technology Standards and Application Standards. Technology standards define the chips used in the tags and the readers used in RFID, and how they pass information back and forth. Application standards define how the technology is applied to a particular industry—in this case Libraries. The role of the application standards for RFID is to define how data is stored on the chip in the tag. This definition then allows system designers to produce systems that can properly encode and read the tags, even when multiple providers are involved.

There are two International Standards Organization (ISO) / International Electrotechnical Commission (IEC) technology standards pertinent to library RFID tags and readers: ISO/IEC 15693, *Information technology – Radio frequency identification for item management – Unique identification for RF tags*, and ISO/IEC 18000-3, *Information technology – Radio frequency identification for item management – Part 3: Parameters for air interface communications at 13,56 MHz, Mode 1*. These two standards define the wireless interface and communication protocols between RFID tags and readers. Libraries have broadly adopted the ISO/IEC 18000-3 Mode 1 standard. It is important to note, however, that these technology standards view libraries as one niche application in a global industrial landscape. There are many other uses for these RFID standards. Further details on RFID standardization are contained in [Appendix A](#).

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When one talks about ISO/IEC standards, it is useful to understand the technical committees and subcommittees, because they have a bearing on how the work gets done and also upon who the stakeholders are. ISO/IEC 15693 is the responsibility of JTC1 (Joint Technical Committee on Information Technology), SC17 (Subcommittee 17, Cards and personal identification). All the ISO/IEC 18000 series standards are the responsibility of JTC1, SC31 (Subcommittee 31, Automatic identification and data capture techniques), WG4 (Working Group 4, Radio frequency identification for item management).

The two standards, though related, are not equivalent. ISO 18000-3 Mode 1 has additional features, and some of the features that are optional now are likely to be upgraded to requirements. The rules for Application Family Identifier (AFI) (discussed in [3.2](#)) are fundamentally different. Although the same basic chip design platform is used, the library community, as it moves forward with standardization, needs to ensure that the tags it uses have the required features. Having said all this, the chip and tag vendors might still refer to an ISO 15693 tag as being acceptable for library applications. They may very well be right—the only real test is a check on the supported features. The safest position will be to focus on the ISO 18000-3 Mode 1 standard, as this standard is maintained for item management applications.

Additionally, ISO JTC1/SC31/WG4 is also responsible for ISO/IEC 15961 and 15962. ISO/IEC 15961, *Information technology – Radio frequency identification (RFID) for item management – Data protocol: Application interface*, deals with the commands and responses between the application and encoder. ISO/IEC 15962, *Information technology – Radio frequency identification (RFID) for item management – Data protocol: Data encoding rules and logical memory functions*, deals with the process of converting printable characters or those that appear on a screen into a compacted form for encoding on the RFID tag. The encoding rules also provide a way of distinguishing between data elements using object identifiers and, particularly, the Relative-OID as discussed in Section [2.6](#). Ultimately, these standards, along with the Danish Data Model (DS/INF 163-1, *RFID-data model*) form the basis for the application standards regarding the encoding of data on tags for the three-part standard ISO 28560, *Information and documentation – RFID in libraries*.

The ISO 28560 application standards are controlled by TC46 (Information and documentation), SC4 (Technical interoperability), WG11 (RFID in Libraries), and are focused on the application of RFID to library needs. ISO 28560-1, *Information and documentation – RFID in libraries – Part 1: Data Elements and general guidelines for implementation*, deals with the definitions of the data elements that may be encoded onto RFID tags in the library application. ISO 28560-2, *Information and documentation – RFID in libraries – Part 2: Encoding based on ISO/IEC 15962*, defines an encoding method for compacting data elements into objects and placing them on RFID tags for use in libraries which utilizes the encoding rules defined in the existing standard, ISO/IEC 15962. ISO 28560-3, *Information and documentation – RFID in libraries – Part 3: Fixed Length Encoding*, defines an encoding method for placing data elements on RFID tags for use in libraries which has its basis in the Danish Data Model.

It is the recommendation of the NISO RFID Revision Working Group that ISO 28560-2 be adopted in the United States for Library RFID Applications. The remainder of this document will provide additional implementation advice based on that recommendation.

Section 2: NISO Data Model and U. S. Profile for ISO 28560-2

2.1 Introduction

The intent of this section is to outline a data model that should satisfy the needs of libraries in the U.S. The main goal of the model is to provide interoperability for libraries so investments in RFID can be made with confidence that they will be able to read tags on items from many other libraries, and so that they will have choices in purchasing RFID equipment and tags in the future.

The goal of interoperability is achieved by following standards and by making sure that the data on the tag is in a standardized format and is used consistently. The specifications contained in the NISO data model provide flexibility for some feature differentiation among the vendors by allowing for optional data, and by not specifying controls on how the data can be used. It also provides a minimum set of the data objects that must be provided to perform the most basic of library functions using RFID equipment. The ultimate intention is that RFID tags programmed by one vendor in compliance with the data model will be usable by another RFID vendor without any reprogramming.

There are several data models in use in different parts of the world, including those created by groups in the Netherlands, Denmark, United Kingdom, Finland, France, and Australia. A few countries in Europe have adopted the Danish model (see <http://www.en.ds.dk/3196>), in some cases with important variations. Some individual libraries in the U.S. have also adopted the Danish model.

The following sub-sections discuss the choice of ISO 28560-2; the remainder of section 2 describes the implementation of ISO 28560-2 for use with RFID in libraries in the United States.

2.1.1 Rationale for the Choice of ISO 28560-2

In late 2007, the initial NISO RFID Working Group published a best practice document (*RFID in U.S. Libraries*, NISO RP-6-2008) recommending data encoding using methods defined in ISO/IEC 15962. Similar approaches were then recommended by the United Kingdom and Australia, and this approach has been standardized on a global basis in ISO 28560-2, with data elements defined in ISO 28560-1. Simultaneously, the Danish model has been adapted to create ISO 28560-3, again with data elements defined in ISO 28560-1.

When the NISO RFID Revision Working Group began its chartered discussions in 2010, it considered whether to recommend adoption of all parts of the ISO 28560 family for use in the U.S., or whether to recommend a single encoding method. The following impacts of this decision were considered:

- Interoperability – Despite advances by RFID providers in the management of collections using multiple RFID tag data formats, and seeing future requirements for interlibrary borrowing, the need for interoperability is best served by recommendation of a single standardized format for the U.S.
- Ambiguity – Forcing individual library systems to select one of two recommended formats was viewed as an unnecessary burden. An implicit part of the working group's charge was to provide an informed recommendation for libraries wishing to invest in the benefits of RFID technology. To abdicate this responsibility would limit the benefits of the technology and would make it less accessible to the library community.
- Legacy – Some portion of the libraries in the U.S. have already adopted the Danish data model. Many others are using proprietary models. To truly comply with either of the ISO encoding methods requires some reprogramming of the tags for any of these libraries. Thus the decision to recommend one and only one of the ISO encoding schemes does not represent an unnecessary burden to particular libraries based on previous choices—all tags require some reprogramming to comply.

After discussion it is the considered collective opinion of the NISO RFID Revision Working Group that the interests of U.S. Libraries are best served by standardizing on just one of these encoding methods for use

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in the U.S. and, as indicated previously, the Working Group recommends the ISO 28560-2 method, based on ISO/IEC 15962.

2.1.2 Selection of ISO 28560-2 over ISO 28560-3

The choice of ISO 28560-2 over ISO 28560-3 was made after considerable deliberation and is based on the following factors:

- **Efficiency** – The ISO 28560-2 support of variable length encoding generally requires less memory space on the tag for equivalent tag content, compared with ISO 28560-3. The tag content key field immediately informs the software of all the data that exists on the tag. This can improve system performance by decreasing the size of data that is read from and written to the tag (though it does require the RFID system to manage the fact that the precise location of a data element on the tag is not predetermined). Avoiding unnecessary reads to the tag, will ultimately lead to faster material handling
- **Flexibility** – The ability to pick and choose the fields that will be encoded on an RFID tag and ignore the rest (barring the two mandatory fields) is important to U.S. libraries. This flexibility allows different libraries to use different parts of the data model and yet be consistent with the U.S. profile for ISO 28560-2. Different regions of the country or different types of libraries can have their own profiles (sub-profiles of the U.S. profile) to better serve the needs of their communities. The implementation of ISO 28560-3 in the U.S. makes sense only if there is a requirement for backward compatibility with the Danish model.
- **Security** – Locking of data, if desired by the library, can be selected for individual data elements in ISO 28560-2, where the entire basic block must be locked in ISO 28560-3, if locking is to be employed.
- **Future compatibility** – Future changes to the standards, through the addition of new data elements, is more streamlined in ISO 28560-2 and does not rely on version numbering, which can be complicated in ISO 28560-3 by the above constraint on locking. (Note that addition of new data elements must be undertaken by ISO.)

This direction is consistent with the approach recommended by the first NISO RFID Working Group and the RFID Revision Working Group concurs with the choice of ISO 28560-2 encoding over backward compatibility with the Danish model.

2.2 Data Objects

When discussing the possibilities for recording data on RFID tags, it is important to consider that while the variety of data that might be written on a tag is virtually unlimited, the amount of data is rather restricted. First, there is the capacity of the tag itself, which is not under the control of the library but rather is determined by the chip and tag manufacturers. Second, there is the utility of the information on the tag; that is, how the data will be used and what value it will bring to the application. Third, it is important to keep the read time of the tag as short as possible. In some cases, more than one read may be required to retrieve all the necessary data from the tag. All of these issues in some way limit the amount of data that should be stored on the tag.

Broadly speaking, there are two general options for the data on the RFID tags. The minimalist approach is one safe option. In this option, one would simply choose to place the Unique Item Identifier (such as a barcode) and disallow most everything else. All data required to support system functionality would have to be looked up in an associated database, such as a library's ILS. For obvious reasons, this approach is most attractive to privacy advocates. At the other extreme are those that would put as much data on the tag as space and cost considerations would allow. The goal of this second approach is to allow the system to function with minimum interaction with the ILS.

In the development of a U.S. Profile for compliance with ISO 28560, the NISO RFID Revision Working Group considered the merits of several data elements, and resisted the exclusion of elements that were considered potentially useful in the future. Some of these data elements have generated privacy or other

concerns in the past, and the working group felt that while libraries should consider those concerns when making decisions about the use of the data elements, these should not be specifically excluded since their acceptability or utility may change over time.

The recommendations for this U.S. data model include the addition of the owner library identifier in combination with the primary item identifier to create a nationally unique item identifier. Additional data elements are optional, or in a few cases excluded. While not adhering to the absolute minimalist approach, this gives the library flexibility to have a smaller or larger data set based on individual local requirements.

2.2.1 Advantages of Looking Up Data in the ILS

Generally speaking, storing duplicate information on both the tag and in the ILS is a questionable practice as it creates a data maintenance and consistency issue. Data, particularly data that changes frequently, must be synchronized and updated in two places. Additionally, storage of data on the tag adds the cumbersome requirement of having the physical item in hand to make an update. So libraries are cautioned against this practice, although sometimes there are good reasons for employing it.

When there is a choice between storing data on the tag or in the ILS, one advantage of storing it in the ILS is the speed of accessing that data, which may be higher than the speed of reading the data from the tag.

Another advantage of storing the data in the ILS is the tag memory requirement. Database storage is relatively inexpensive compared to the memory on RFID tags. Keeping the size of data on the tags relatively small allows manufacturers the opportunity of producing tags with less memory, thereby reducing the tag costs to the library.

2.2.2 Advantages of Storing Data on the Tag

One of the advantages of storing data on the tag is in situations where, because of design or because of system failure, there is no connectivity to an ILS or that connection is lost for a period of time. An example of this might be the storage of a status of “non-circulating” on tags for reference materials so that during an ILS outage the material would not circulate on a self check-out station.

Another advantage of storing data on the tag is to provide functionality that might not be directly supported by an ILS. Upstream from the library, suppliers or publishers may add data to be used by a receiving library, but not particularly by the ILS. Individual library practice may also require adding information not defined by the recommended model. The data model allows for this usage by defining three data objects, Local Data A, Local Data B, and Local Data C (see Section [2.5](#)).

As a general rule, there are three categories of data that may be stored on the tag:

- The minimum amount of data to support the RFID system at a national level. In the data model below, this category includes both the Primary Item Identifier and the Tag Content Key.
- Data on the tag that enhance the operation—for example, data from suppliers that can assist with receiving functions, or data indicating that the item is part of a set and that other items are necessary to complete the transaction.
- Back-up data that allows the RFID system to function independently of the ILS.

All three categories are considered in the recommended model below.

2.3 Mandatory and Optional Data Objects

The practical application of the ISO 28560 family of standards for *RFID in Libraries* demands not only that a country ideally settle on one encoding method for best interoperability, but also that a profile be defined that identifies which data elements are mandatory or optional, which data elements should be locked, and any data elements which should not be encoded. The subparts of this section comprise the U.S. profile for ISO 28560.

Mandatory elements are those that are truly required to either make an RFID system function or to enable interoperability. These elements must be encoded on every tag so that systems can be designed counting on their presence. In some cases, an element is only mandatory if the library uses that particular identifier, e.g. an ISIL code. These elements are marked “Mandatory if applicable.”

Optional elements are those which may provide extended functionality or which may provide alternative sources for information that is already in the ILS. Optional elements should be supplemental data, in that the most basic functions of library operation can be performed without use of this data. In any case, the total amount of data is limited by the memory capacity of the tag, over which the library community has little or no control.

The Working Group’s recommendations for each data object’s designation as mandatory or optional appear in the Data Model table, below, in the column labeled “Category”. Additionally, where the ISO 28560 family defines a data element that this document is recommending as not to be encoded in the U.S., that data element is designated as “excluded”.

2.4 Locked vs. Unlocked

Most modern tags with read and write capability also offer the ability to write data onto the tag and then to protect that data against further modification. This capability is typically called “locking,” and is generally non-reversible. There are also tags that provide an additional feature that allow locks to be password controlled so that equipment with the password can unlock them, rendering the lock non-permanent. Some tags offer this feature as a part of an accepted standard, while others offer it as a proprietary add-on feature. This data model makes recommendations on whether different data objects should be locked or unlocked.

2.4.1 Locking Pros and Cons

Locking data on RFID tags offers advantages and disadvantages to a library, so a considered approach is warranted. This section will discuss some of the most apparent benefits and disadvantages of tag data locking:

2.4.1.1 Advantages

- a. Locking protects the locked data from inadvertent or intentional modification by an entity with an RFID reader.

Consideration should be given to the potential for local staff or a borrowing library to inadvertently modify tag contents. Also as RFID readers become more common in devices carried by the general public, such as smartphones, there is the potential for inadvertent or intentional modification of tag contents. It is important to note that neither of these possibilities has manifested itself in any significant way in libraries to date, and RFID readers have been available to technically savvy individuals for years at fairly low cost. As they move into smartphones, however, the potential for misuse of the devices in a library increases.

2.4.1.2 Disadvantages

- a. Locking typically introduces some additional time and complexity in the tag programming process.

Before a library or service provider commits to locking data on a tag, it will want to be very certain that the data is correctly programmed. Even if these checks can be done completely automatically, they may involve additional read operations on the tag, which takes a small amount of time. If the checks must be done by staff, there is more potential for error, the training requirements are increased, and the overall processing time may be significantly increased. Service providers may pass this burden on to the library in the form of increased costs for the service provided.

- b. Locking prevents a library from modifying the locked content of a tag when it may be convenient to make a modification.

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Examples of instances where a library may want to make modifications to a tag include changes to primary item identifier or owning library identifier, or circulation status (if stored on the tag). If any of these data elements are locked and the library wishes to change them, the tag will likely require replacement. Library policy or procedures can be used to minimize the impact of these factors by either limiting the locked data to only particular data elements or by finding procedural alternatives to changing the data. For example, if the need to change an item identifier is based on the need to replace a damaged optical barcode label, the barcode label could be duplicated rather than adopting a new item identifier number from a new label.

- c. If the data is locked, the tag cannot be reprogrammed to conform to a new tag data standard.

This disadvantage is one often cited for proprietary or vendor-defined tag data formats. Despite significant efforts by the developing organizations, there is always the finite possibility that a standard will not perform well technically, or for other reasons it may not be well accepted and then the library will wish to reprogram to a different format in the future.

- d. The flexibility of encoding tags according to ISO 28560 brings a complication when locking of data is considered.

If a library or system implementer chooses to lock data in particular blocks of the tag such that there might be unlocked data surrounding the locked areas, the process of modifying tag contents becomes more challenging, as the system must steer the data elements around the locked data, which is an obstacle in this case.

2.5 U.S. Profile for ISO 28560 – RFID in U. S. Libraries

2.5.1 Summary

The model specifies a total of 26 data objects. Most of the elements are variable length. It is possible that additional data objects may be added later without compromising the integrity of the model and without rendering any applications obsolete. This is consistent with the data elements and the encoding specified in ISO 28560-1 and ISO 28560-2. [Table 1](#) below contains six columns. Together they represent the *U.S. Profile for ISO 28560 – RFID in U. S. Libraries*.

Table 1: U.S. Profile for ISO 28560 – RFID in U. S. Libraries

Data Object	Relative OID*	Formatting	Category	Main Purpose or Codes Used	Locked If Used?
Primary Item Identifier (unique item identifier)	01	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Mandatory	Item identification	Optional
Tag Content Key (also called OID Index)	02	Bit mapped code	Mandatory	Determining what other data is on the tag	No
Owner Library/Institution	03	Variable length. Max: 16 bytes	Mandatory if applicable	Identification – use ISIL code (ISO 15511)	Optional
Set Information (also called multi-part indicator)	04	{Total in Set / Part Number} structure. Max: 255 bytes	Optional	Item properties	Optional
Type of Usage	05	Fixed length. 1 byte	Optional	Item usage (coded list)	Optional

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Data Object	Relative OID*	Formatting	Category	Main Purpose or Codes Used	Locked If Used?
Shelf Location	06	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Support inventory – (LC Call Number, Dewey)	Optional
ONIX Media Format	07	Fixed length. 2 uppercase chars.	Optional	Item properties (ONIX code list)	Optional
MARC Media Format	08	Fixed length. 2 lowercase chars.	Excluded	Item properties (MARC code list)	N/A
Supplier Identifier	09	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Acquisitions processing	Not recom- mended
Order Number	10	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Acquisitions processing	Not recom- mended
ILL Borrowing Institution	11	Variable length. Max: 16 bytes	Optional	Support ILL – use ISIL code (ISO 15511)	No
ILL Borrowing Transaction Number	12	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	ILL transaction tracking	No
GS1 Identifier	13	Fixed length. Numeric field. 13 digits.	Optional	Identification	Optional
Alternative Unique Item Identifier (reserved)	14	Variable length.	Optional Should not be used until defined by ISO 28560.	Identification	Not recom- mended
Local Data A	15	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV, or UTF-8	Optional	For local or regional use	Optional
Local Data B	16	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV, or UTF-8	Optional	For local or regional use	Optional
Title	17	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV, or UTF-8	Optional	Identification	Optional

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Data Object	Relative OID*	Formatting	Category	Main Purpose or Codes Used	Locked If Used?
Product Identifier (local)	18	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Identification	Optional
Media Format (other)	19	Single octet (coded list).	Optional	Item properties (no code list defined)	Optional
Supply Chain Stage	20	Fixed. 1 byte	Optional	For multi-use (coded list)	No
Supplier Invoice Number	21	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Excluded	Acquisitions	N/A
Alternative Item Identifier	22	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Item identification	Optional
Alternative Owner Institution	23	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Mandatory if applicable	Item identification for codes not ISIL compliant	Optional
Subsidiary of an Owner Institution	24	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Item identification	Optional
Alternative ILL Borrowing Institution	25	Variable length. Alphanumeric. Character set = ISO/IEC 646 IRV	Optional	Support ILL – for non-ISIL code	No
Local Data C	26	Variable length Alphanumeric. Character set = ISO/IEC 646 IRV, or UTF-8	Optional	For local or regional use	Optional

*See Section [2.6](#).

2.5.2 Primary Item Identifier

Note: This element is referred to as Primary Item ID in this recommended practice, which reflects how it is commonly used in the U.S.

The Primary Item ID is the identifier that is used to uniquely identify an item within a particular library. Most typically this is the barcode on the item and is the identifier used in functions like circulation (both check-in and check-out) and inventory management. (See also [Section 5](#).)

To create an identifier that is nationally and potentially globally unique, the Primary Item ID can be used in combination with the Owner Library/Institution data element (see [2.5.4](#)).

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Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Mandatory	Variable length supporting full ASCII (ISO/IEC 646 IRV) character set (Expected length 16 bytes, but not limited in ISO 28560-2.)	Optionally locked when used in library; unlocked in upstream supply chain	In ISO 28560-2, this data element must be physically the first data element in the tag memory.

2.5.3 Tag Content Key (also called OID Index)

The tag content key is designed to allow RFID applications to determine very quickly what data, if any (other than the Primary Item ID), exists on the tag.

The content key is essentially a binary flag indicating data objects, starting at relative OID 3, that are present on the tag. Since the model has a total of 26 data objects and two of them are not represented in the key, only 24 bits are needed to flag the 24 additional data objects. It is necessary to maintain byte boundaries in encoding the data. Since there are exactly 24 additional data objects, only three bytes are needed. Note that if the data elements populated comprise only lower-numbered OIDs, it is not necessary to program the Tag Content Key to its full potential length.

EXAMPLE:

Assume that the tag has two additional data elements encoded on it. Further assume that the two elements are owner library/institution and GS1 product identifier. According to the model, these are the first and the 11th additional elements. Thus, the content key will be coded with 1 in the first and 11th position and zeroes elsewhere. The encoding therefore will be:

Code: 1000000000100000

Position: 1234567890123456
(showing 16 bits in use)

If no additional data fields are on the tag, then the code string will have all zeroes. An all zero string will tell the application that there is no other data on the tag, and this can be represented either as coded zeroes or as a truncated string. There is one other very important implementation detail presented below.

The mandatory nature of this data object is linked to the presence of additional data items on the tag. It allows a quick determination of which other fields are populated on the tag.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Mandatory (to comply with the profile, additional data is encoded)	Variable length – dependent on the encoded data set on the tag	Unlocked	Must be encoded directly after the Primary Item Identifier in the physical tag memory

2.5.4 Owner Library/Institution

This element is used to identify the owning library or other institution using an ISIL-compatible code. This identification is useful in ILL functions and in material flows in consortium networks where patrons are allowed to return borrowed books to any library in the consortium.

The combination of Owner Library/Institution and Primary Item ID can also form a globally unique identifier for an item.

RFID in U.S. Libraries

The ISIL is useful enough on a global basis that a library that does not have an ISIL compatible code should consider obtaining one before undertaking an RFID tagging project. If this is not possible, or is otherwise not desired, then a non-ISIL code may be encoded in the Alternative Owner Library data element. If the library has an ISIL, this element is required.

The ISIL Code is defined in ISO 15511, *Information and documentation – International Standard Identifier for Libraries and Related Organizations (ISIL)*. Part 1 of ISO 28560 clearly specifies that for interoperability purposes the ISIL code be used. This recommendation is carried forward in this Recommended Practice. More information about the structure of the ISIL code may be found at the Registration Authority for ISIL website: <http://biblstandard.dk/isil/structure.htm>.)

The reader should note that some commonly used library identifier codes are ISIL-compatible, including OCLC codes. (See <http://biblstandard.dk/isil/index.htm>.)

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Mandatory if applicable (i.e. if the organization has an ISIL-compatible code) Either this data element or the Alternate Owner Institution data element must be populated.	Variable length not to exceed 16 bytes with formatting as specified above	Optional to lock if used	Encoded according special rules included in ISO 28560-2

2.5.5 Set Information (also called multi-part indicator)

This data element is useful if several components (like a book and a map, a board game and a manual) or any multi-part item are circulated as a single unit.

There may be a single RFID tag on the items that are circulating or each separate item may have a tag of its own.

The set information is presented in two components: the total number of parts followed by the ordinal part number. If the total number of parts is nine or less, then the user data can be presented as a 2-digit code. If the total number of parts is between 10 and 99, then the user data is presented as a 4-digit code, with the lowest ordinal values shown as 00 to 09. If the total number of parts is between 100 and 255, then the user data is presented as a 6-digit code. In this case, if the ordinal value is less than 100, it is prefixed by leading zeros to create a 3-digit number. (See Section [D.3](#) in [Appendix D](#).)

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Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional (but Mandatory for multi-part items when RFID is used to assist with the management of the parts)	Variable length of one, two, or three bytes	Optional lock if used	N/A

2.5.6 Type of Usage

This data object provides information about the intended use of the item, e.g., whether circulating or reference only. For circulation purposes, the values can specify whether the item is allowed to circulate according to normal policies, or whether, in some cases, the item should receive special treatment, such as in an automated material handling systems. A full table of values can be found in ISO 28560-1.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Fixed length of 1 byte	Unlocked	N/A

2.5.7 Shelf Location

In the U.S., there are three primary methods of shelving books. These are:

- By Library of Congress (LC) call number
- By Dewey Decimal classification
- By type of material (like FIC for fiction), concatenated with some characters of the Author's Name (This method is used primarily in public libraries.)

The LC call number is usually taken from *Library of Congress Classification* or from the *LC Classification Additions and Changes*. In the MARC 21 format, it generally includes subfields a and b (\$a and \$b).

The Dewey Decimal Classification number is usually taken from *Dewey Decimal Classification, Abridged Dewey Decimal Classification*, and/or *DC&: Dewey Decimal Classification Additions, Notes and Decisions*.

The purpose of this data object is to allow a library to specify its shelving method. Automatic sorting systems sometimes use a derived code, like a collection code, which is pulled from the ILS and used for sorting purposes. It could also be used in shelf-reading or inventory applications by a scanner in the library stacks area.

Alternatively, this field could be used for specifying exactly where the book is to be shelved—for instance, 3rd floor, shelf 14. This latter method of designation is not recommended, as a change in shelving location will require the handling and reprogramming of the tag.

Since this data object is to be used within the library, it is not necessary to identify whether the data object is an LC call number or a Dewey Decimal number or a number from some local numbering system. The classification system information could be configured into the system setup rather than obtained from the tag.

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Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Variable length	Unlocked if used	N/A

2.5.8 ONIX Media Format

This data object is used to specify the format of the media being circulated.

The NISO RFID Working Group recommends utilizing the media format codes from the *ONIX for Books Code List* produced by EDItEUR, which is widely supported by BISG (Book Industry Study Group) in the United States. These codes are included in List 7 of the Code List and referred to as Product Form Codes¹. ISO 28560-1 recommends use of the most current list.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Fixed length of 2 bytes	Optional lock if used	N/A

2.5.9 MARC Media Format

This data object is used to specify the format of the media being circulated.

It is the inclination of the NISO RFID Working Group to adopt the ONIX coding scheme for media format (see [2.5.8](#)), which is widely supported by BISG (Book Industry Study Group) in the United States. The MARC Media Format data element is excluded from use in the U.S.

Properties: Excluded

2.5.10 Supplier Identifier

This data object is designed to uniquely identify the supplier of the material in question. It consists of a supplier name, address, and postal code (or SAN (ANSI/NISO Z39.43)). Its definition is to be agreed between the supplier and the library.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Variable length	Locking not recommended	N/A

2.5.11 Order Number

This data object contains the library's order number against which the item was purchased.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Variable Length	Unlocked if used	N/A

¹ EDItEUR. *ONIX for Books Code Lists*. Available from: <http://www.editeur.org/14/Code-Lists/>

Note: List 7, Product form code, and List 150, Product form, have 111 codes in common. List 7 has 10 codes not included in List 150 and List 150 has 13 codes not included in List 7. According to EDItEUR, List 7 should suffice for RFID applications and it is the list recommended by the ISO 28560 Standard.

2.5.12 ILL Borrowing Institution

This element is used to identify the borrowing institution in an ILL transaction.

The coding scheme should be identical to the owner library/institution described in Section [2.5.4](#), except that this data object is always unlocked.

Properties:

Requirement	Fixed or Variable	Locked?	Encoding
Optional	Variable length not to exceed 16 bytes with formatting, as specified in 2.5.4 above	Unlocked if used	Encoded according to special rules defined in ISO 28560-2

2.5.13 ILL Borrowing Transaction Number

In addition to the ILL Borrowing Institution data element (see [2.5.13](#)), there is an additional data element that will facilitate the tracking of ILL transactions. In interlibrary loan transactions in the U.S., the process generally has the following steps:

- The library customer or patron identifies some material that s/he wishes to borrow, and works with library staff to arrange for an ILL search.
- The library staff at the borrowing library use ILL management software to access a catalog of items owned by other libraries and select some candidate lending libraries for the item. The ILL management software generates an ILL transaction identifier, often a numeric identifier of seven or eight digits.
- The ILL management software initiates contact with the first candidate lending institution, requesting a loan of the item, identified bibliographically.
- The candidate lender looks at the request and, if it is able to fill it, responds affirmatively. If it is not able to fill the request, it responds negatively and the ILL management software sends the request to the next candidate lending institution on the list.
- When a candidate lender indicates that it can source the item, the ILL management software stores a record and generates an ILL slip containing the transaction identifier, the bibliographic identifier, the borrowing library information, the lending library information, and the patron information. The ILL slip accompanies the item as it travels from the lending library to the borrowing institution.
- When the borrowing library receives the item, it generally creates a temporary record in its integrated library system (ILS), using a “dummy” or temporary item identifier. The library uses bibliographic information from the ILL management software to populate the record.
- The library patron is notified and picks up the item, which is sometimes packaged in a bag or with an attached slip, but which has the dummy item identifier attached in some way.
- At the end of the loan, the patron returns the item to the borrowing library, which notes on the temporary record that the item is returned, and sends it back to the lending library.

The one common piece of data between the borrowing library and the lending library is the ILL Borrowing Transaction Number, generated by the ILL management software system. All other data regarding the ILL transaction can be obtained from the ILL slip or through management software, based on that ILL transaction identifier.

It is feasible (and desirable) that, in the future, an ILL Borrowing Transaction Number could be read electronically and used to automatically update a temporary ILS record with data regarding the item and transaction, eliminating part of the manual labor associated with the transaction and reducing costs.