Northwest Marine Technology, Inc.
Decimal Coded Wire Tag™

Introduction

In April 1998 Northwest Marine Technology announced its intention to offer five new formats for the coded wire tag. The primary difference of the new formats is that data will be written in decimal rather than binary. This change is expected to ease the task of reading the tag, decreasing cost and increasing data reliability. A byproduct of the change is additional code capacity.

The primary design goal for the Decimal Coded Wire Tag Project is data reliability, achieved mainly by data replication. The second goal is ease of readability and has been the focus of recent efforts and changes. Finally, NMT intends to maintain compatibility with current data management. The new formats are consistent with the binary tag, and NMT does not intend to replicate codes between binary and decimal encoding.

In 2012 NMT changed the format of the Sequential Tag to enhance data reliability. This paper documents the *Decimal Coded Wire Tag* designs as of 10 April, 2012.

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Changes affecting all formats

Master word replaced

The binary tag uses a master word to mark the beginning of the data and the direction in which the bits are to be read. The *Decimal* tag will use a flag character to orient the reader. The flag character will be placed to the left of the first digit of the agency code. See Appendix A for the appearance of the flag character.

Digits and spacing

Digits will be imaged in a 7 X 10 matrix. Each character will be separated from any other by at least two blank rows or columns. Blanks will not be written in any data position. Zeros will be used instead. See Appendix A for the appearance of each decimal digit.

Code capacity

The *Decimal* code capacity is greater than binary code capacity. NMT expects to issue codes in the expanded ranges in the normal course of business. See Appendix B for a summary of the code capacities.

Standard tag

Standard tags are 1.1 mm (0.042 in) long and 0.25 mm (0.010 in) in diameter. *Decimal* and binary Standard tags are the same size.

The *Decimal* Standard tag will have three words (Agency, Data 1, Data 2) written on a single side of the tag. These words constitute the code for that tag. Each word will contain two digits.

For reliability and ease of use, the code will be replicated on four sides of the wire with the starting point offset by two character positions. This redundancy makes a tag readable no matter where it is cut.

NOTE:
Standard length *Decimal* Coded Wire Tags are not readable if cut shorter than standard length.

Figure 1 shows the layout for the *Decimal* Standard tag. This view shows a tag that is cut lengthwise and unrolled. Dashed lines show the space taken by a character. The notation D_{wc} indicates the c^{th} digit of data word w. For example, D_{12} is the second character of Data 1.

The gray bar below the diagram shows the nominal length of the tag.

Figure 1: *Decimal* Standard tag layout

Figure 2 shows a sample *Decimal* Standard tag. The data in the example is Agency = 16, Data 1 = 58, Data 2 = 09. Note the use of the leading zero for Data 2 to ensure that each data word has two digits. The white lines in the figure show the length of a Standard tag, and one possible cut.

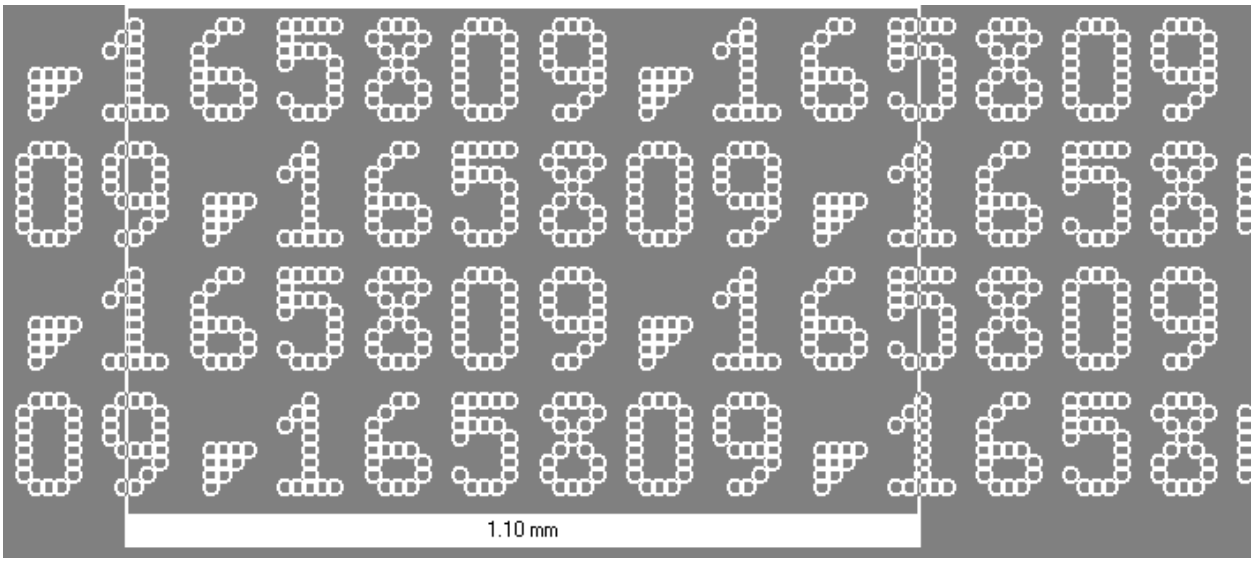


Figure 2: *Decimal* Standard tag example (16/58/09)

Table 1 compares the features of the binary and *Decimal* format for the Standard tag. Note that the flag character replaces the binary master word. Code capacity increases from 4,096 to 10,000 unique codes per agency.

	Binary	***Decimal***	
Word	**Capacity**	**Digits**	**Capacity**
Master	1	**Flag**	1
Agency	64	2	100
Data 1	64	2	100
Data 2	64	2	100

Table 1: Format comparison for Standard tags

Half-length tag

Half-length tags are 0.5 mm (0.021 in) long and 0.25 mm (0.010 in) in diameter. They are designed for use when fish size (less than approximately two grams) cannot accommodate a larger tag. *Decimal* and binary Half-length tags are the same size.

In order to keep compatibility with the binary tag, the *Decimal* Half-length tag will have five words (Agency, Data 1, Data 2, Data 3, Data 4). The flag character will replace the master word.

The Agency word will be two digits long. The four data words will be only one digit each. In order to fit the data on the tag, the words will be written on two longitudinal rows. The row with the flag character will contain the two digits of the agency and Data 1. Aligned below it will be Data 2, Data 3 and Data 4. The code will be repeated once and offset to gain reliability.

Figure 3 shows the layout for the *Decimal* Half-length Tag. It shows the tag cut lengthwise and rolled out. Dashed lines show the space taken by a character. The gray bar below the diagram shows the length of the tag.

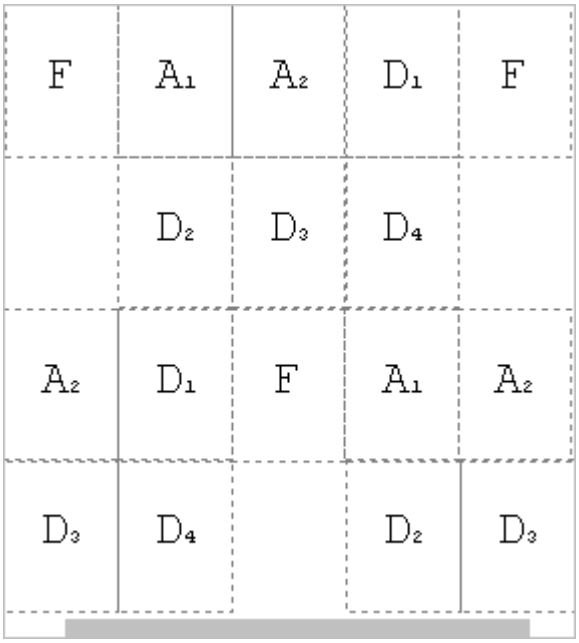


Figure 3: *Decimal* Half-length tag layout

Figure 4 shows an example of the *Decimal* Half-length tag. The example shows Agency = 16, Data 1 = 5, Data 2 = 8, Data 3 = 0 and Data 4 = 9. The white lines in the figure show the size of the half-length tag, and one possible tag cut.

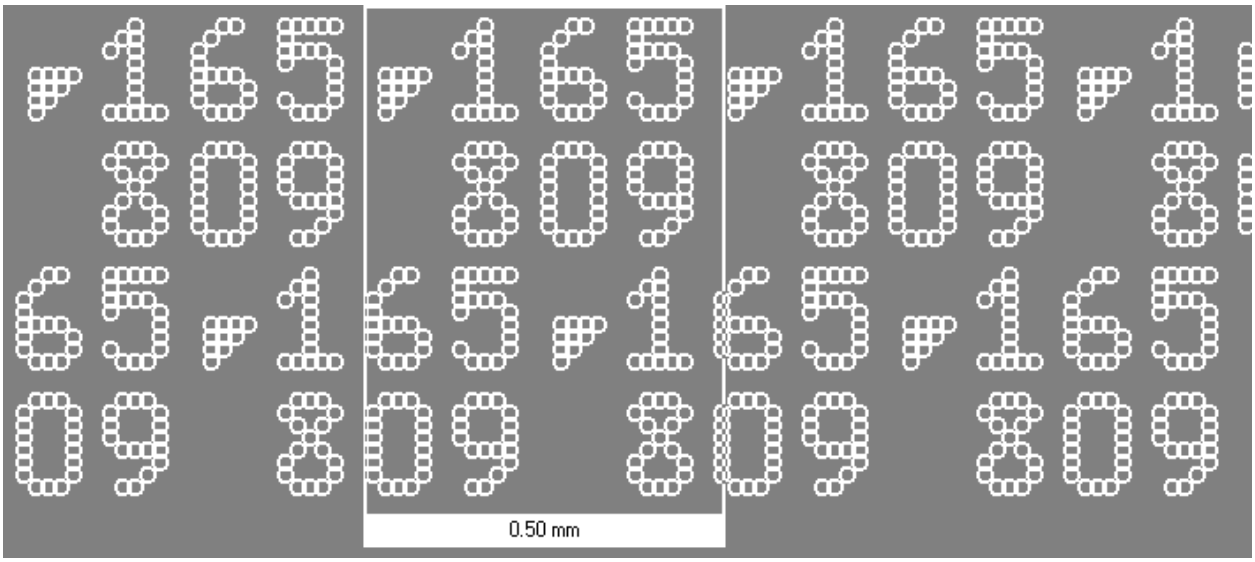


Figure 4: *Decimal* Half-length tag example (16/5/8/0/9)

Table 2 compares the features of the Half-length tags. Note that the code capacity for the *Decimal* tag is 10,000 per Agency instead of 32,768. However, there are 100 agency codes available instead of 16 so the total capacity is increased from 524,288 to 1,000,000

	Binary	***Decimal***		
Word	**Capacity**	**Digits**	**Capacity**	**Notes**
Master	1	**Flag**	1	
Agency	16	2	100	
Data 1	8*	1	10	***** 8 bit used for parity
Data 2	16	1	10	
Data 3	16	1	10	
Data 4	16	1	10	

Table 2: Format comparison for Half-length tags

1½-length tag

1½-length tags are 1.6 mm (0.062 in) long and 0.25 mm (0.010 in) in diameter. 1½-length tags contain the same data words as the Standard tag. This tag is designed for use in larger specimens or to allow easier magnetic detection.

Each of the three data words (Agency, Data 1 and Data 2) contain two digits. Data capacity is the same as the Standard tag**.**

NOTE:
1½-length *Decimal* Coded Wire Tags are not readable if cut shorter than 1½-length.

Figure 5 shows the layout of the 1½-length tag. It shows the tag cut lengthwise and rolled out. Dashed lines show the space taken by a character. The notation D_{wc} indicates the c^{th} digit of data word w. For example, D_{12} is the second character of Data 1.

The gray bar below the diagram shows the nominal length of the tag.

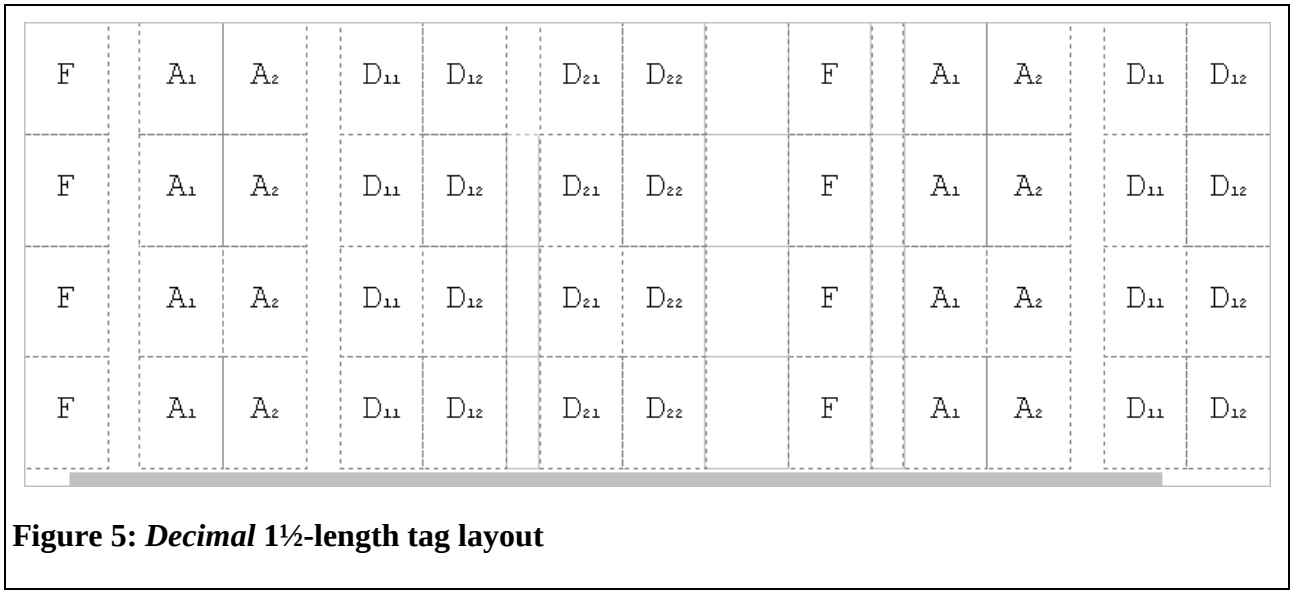


Figure 5: *Decimal* 1½-length tag layout

Figure 6 shows a sample of the *Decimal* 1½-length tag. The example shows Agency = 16, Data 1 = 58 and Data 2 = 9. The white lines in the figure show the size of the tag, and one possible cut.

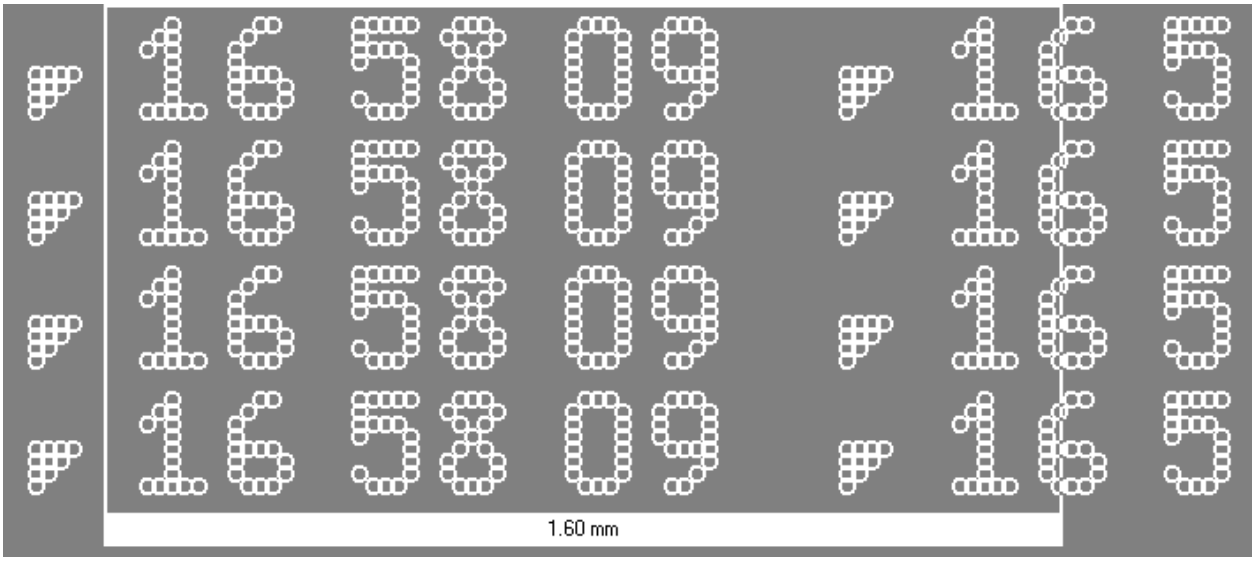


Figure 6: *Decimal* 1½-length example (16/58/09)

Table 3 compares the features of the 1½-length tags. The code capacity increases from 4,096 to 10,000 per agency.

	Binary		***Decimal***
Word	**Capacity**	**Digits**	**Capacity**
Master	1	**Flag**	1
Agency	64	2	100
Data 1	64	2	100
Data 2	64	2	100

Table 3: Comparison of 1½-length tags

Sequential tag

NOTE:
In the spring of 2012, NMT redesigned the sequential tag to enhance readability in situations where the tag was damaged. By rotating every other sequence number, it may be possible to read a damaged tag that contains two sequence numbers.
For documentation of tags made prior to April 2012, see appendix C

Sequential tags are 1.1 mm (0.042 in) long and 0.25 mm (0.010 in) in diameter. *Decimal* and binary Sequential tags are the same size. Sequential tags are designed for use where identification of small batches, or individual specimens, is desired.

NOTE:
Sequential *Decimal* Coded Wire Tags are not readable if cut shorter than standard length.

The *Decimal* Sequential tag has three words (Agency, Data 1, Data 2) written along the axis of the tag in two rows, followed by a sequence number written along the circumference. The formatting of the Sequential tag ensures that one entire Sequence number is always available. To resolve the ambiguity created when two complete Sequence numbers are readable, the convention is that the lesser number be used.

In order to ensure that a batch or individual is uniquely identified, the tagger must archive a reference tag between each batch.

Figure 7 shows the layout of the Sequential tag. It shows the tag cut lengthwise and rolled out. Dashed lines show the space taken by a character. The flag character (F in Figure 7) points to the most significant digit of the Agency code and the Sequence. The notation D_{wc} indicates the c^{th} digit of data word w. S_{nd} indicates the d^{th} digit of sequence n. For example, D_{12} is the second character of Data 1 and S_{24} is the 4^{th} digit of sequence number 2.

The gray bar below the diagram shows the nominal length of the tag.

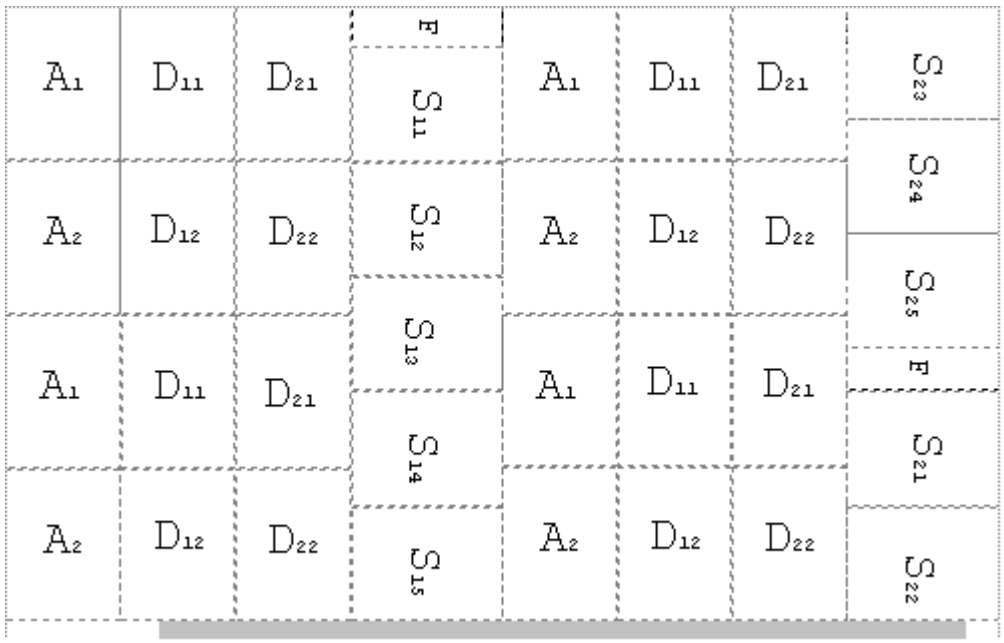


Figure 7: *Decimal* Sequential tag layout

Figure 8 shows a sample of the *Decimal* Sequential tag. The example shows Agency = 16, Data 1 = 58, Data 2 = 9, and sequence = 146. The white lines in the figure show the length of the tag and one possible cut. Note the position of the modified flag character. The flag points to the most significant digit of the Agency code and the Sequence. The white lines in the figure show the size of the tag, and one possible cut.

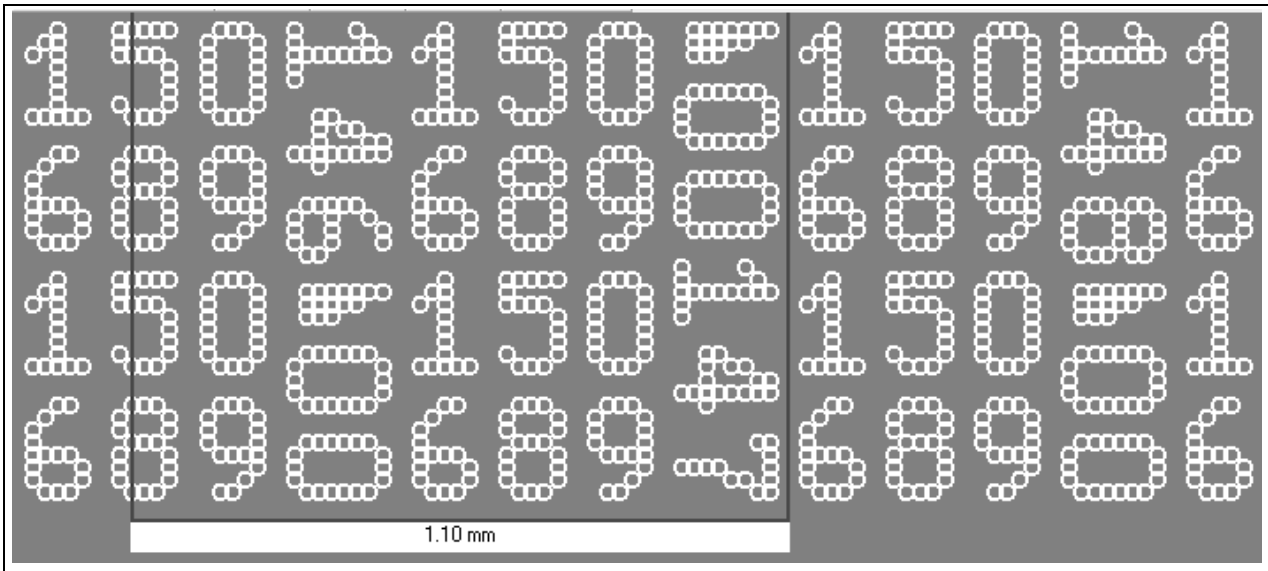


Figure 8: *Decimal* Sequential tag example (16/58/09/146)

Table 4 compares the features of the binary and *Decimal* format for the Sequential tag. Note that the flag character replaces the binary master word, and that the sequence number replaces Data 3 and Data 4.

	Binary	***Decimal***		
Word	**Capacity**	**Digits**	**Capacity**	**Notes**
Master	1	**Flag**	1	
Agency	64	2	100	
Data 1	64	2	100	
Data 2	64	2	100	
Data 3	*	N/A		*Combined with Data 4
Data 4	16,384	N/A		Combined with Data 3
Sequence	N/A	5	100,000	

Table 4: Format comparison for Sequential tags

Agency Tag

Agency tags are 1.1 mm (0.042 in) long and 0.25 mm (0.010 in) in diameter. They are batch coded with two Agency digits, but do not contain the Data 1 and Data 2 codes. The Agency tag is designed for projects where the information required is related to the presence or absence of a tag in a fish**.**

NOTE:
Agency *Decimal* Coded Wire Tags may not be readable if cut shorter than standard length.

Figure 9 shows the layout of the Agency tag. It shows the tag cut lengthwise and rolled out. Dashed lines show the space taken by a character. The gray bar below the diagram shows the length of the tag.

Figure 9: *Decimal* Agency tag layout

Figure 10 shows a sample of the *Decimal* Agency tag. The example shows Agency = 16. The white lines in the figure show the size of the tag.

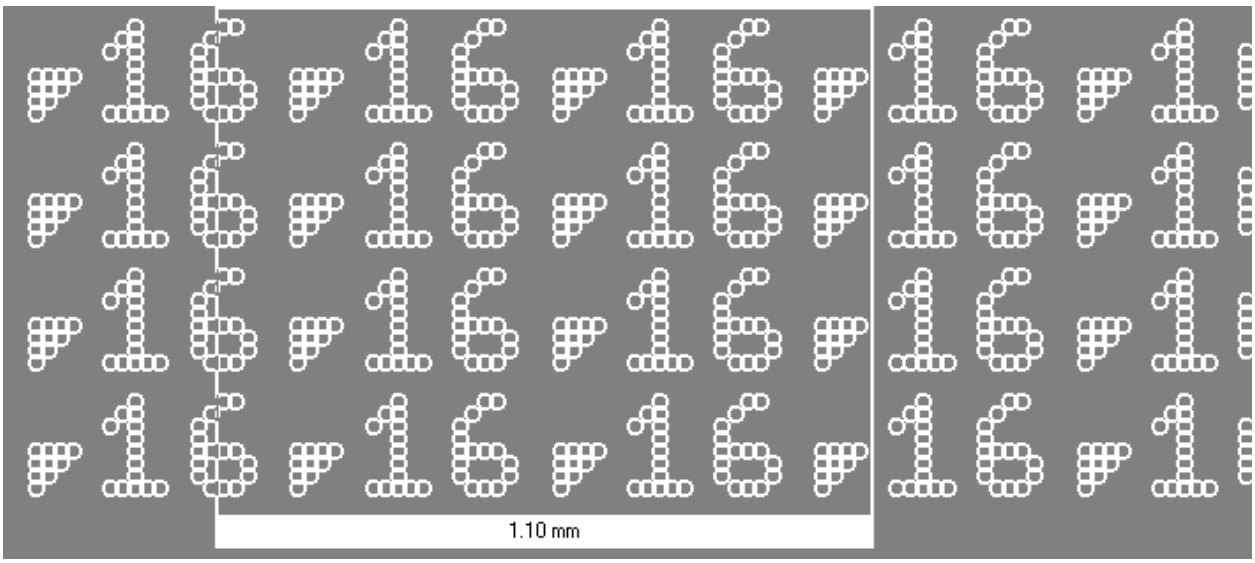


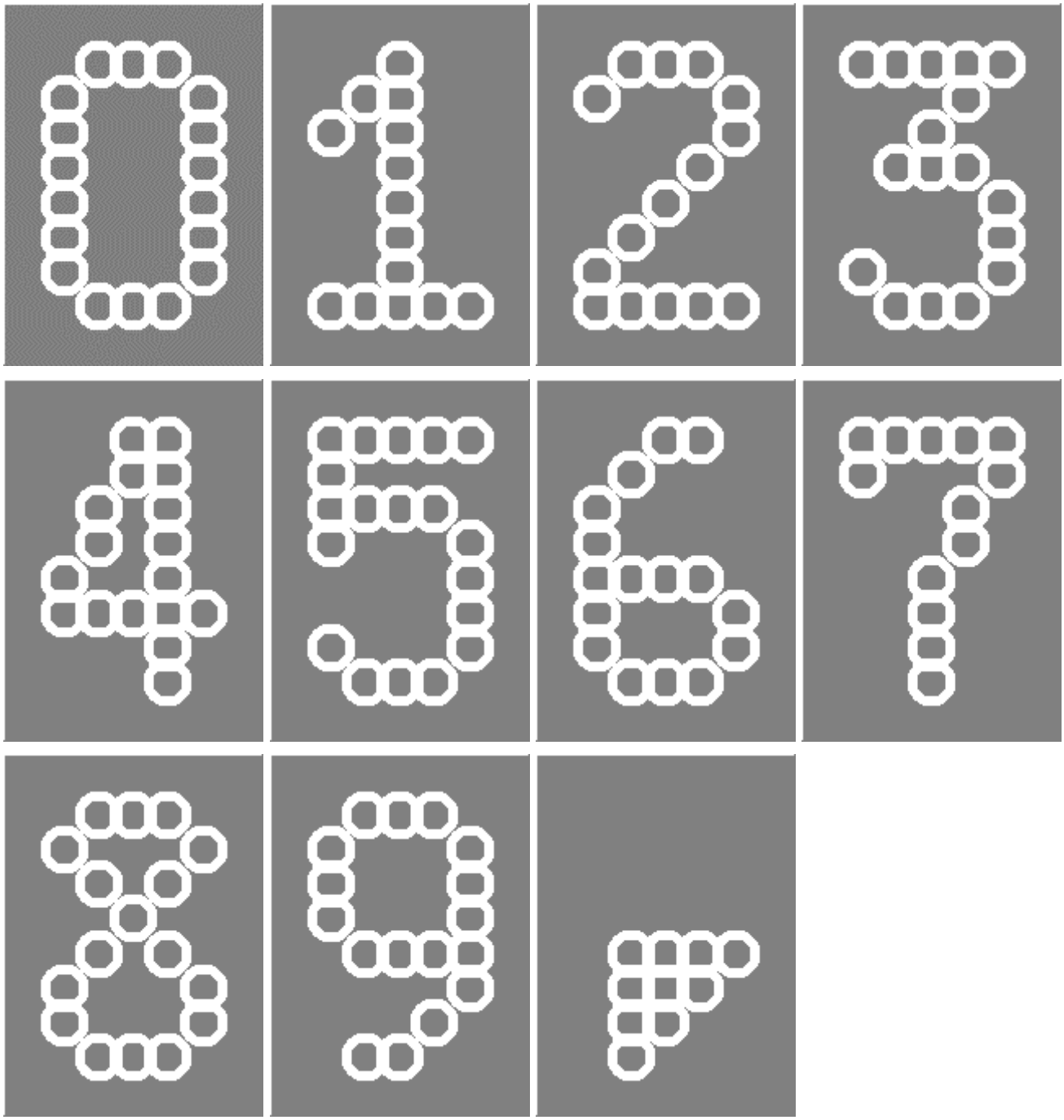
Figure 10: *Decimal* Agency tag example (16)

Table 5 compares the features of the binary and *Decimal* format for the Agency tag. Note that the flag character replaces the binary master word.

	Binary		***Decimal***
Word	**Capacity**	**Digits**	**Capacity**
Master	1	**Flag**	1
Agency	64	2	100

Table 5: Format comparison for Agency tags

Appendix A - *Decimal* CWT Digits



Appendix B - Summary comparison of formats

	Data	Binary	*Decimal*		
Format	**Word**	**Capacity**	**Digits**	**Capacity**	**Notes**
Standard	Master	1	Flag	1	
	Agency	64	2	100	
	Data 1	64	2	100	
	Data 2	64	2	100	
Half-length	Master	1	Flag	1	
	Agency	16	2	100	
	Data 1	8*	1	10	* 8 bit used for parity
	Data 2	16	1	10	
	Data 3	16	1	10	
	Data 4	16	1	10	
1½-length	Master	1	Flag	1	
	Agency	64	2	100	
	Data 1	64	2	100	
	Data 2	64	2	100	
Sequential	Master	1	Flag	1	
	Agency	64	2	100	
	Data 1	64	2	100	
	Data 2	64	2	100	
	Data 3	*	N/A		*Combined with Data 4
	Data 4	16,384	N/A		Combined with Data 3
	Sequence	N/A	5	100,000	
Agency	Master	1	Flag	1	
	Agency	64	2	100	

Appendix C - Sequential tags made before 10 Apr 2012

NOTE:
In the spring of 2012, NMT redesigned the sequential tag to enhance readability in situations where the tag was damaged. This appendix documents the design of tags made prior to 10 April 2012. For documentation of the current design, please see page 9.

Sequential tags are 1.1 mm (0.042 in) long and 0.25 mm (0.010 in) in diameter. *Decimal* and binary Sequential tags are the same size. Sequential tags are designed for use where identification of small batches, or individual specimens, is desired.

The *Decimal* Sequential tag has three words (Agency, Data 1, Data 2) written along the axis of the tag in two rows, followed by a sequence number written along the circumference. The formatting of the Sequential tag ensures that one entire Sequence number is always available. To resolve the ambiguity created when two complete Sequence numbers are readable, the convention is that the lesser number be used.

In order to ensure that a batch or individual is uniquely identified, the tagger must archive a reference tag between each batch. The binary Sequential tag requires two reference tags between each batch due to its use of Gray codes. Binary Sequential tags require a special program, or the use of tables to decode the Sequence. *Decimal* Sequential tags do not have this requirement.

NOTE:
Sequential *Decimal* Coded Wire Tags are not readable if cut shorter than standard length.

Figure 7 shows the layout of the Sequential tag. It shows the tag cut lengthwise and rolled out. Dashed lines show the space taken by a character. The gray bar below the diagram shows the nominal length of the tag. The flag character (F in Figure 7) points to the most significant digit of the Agency code and the Sequence. The notation D_{wc} indicates the c^{th} digit of data word w. S_{nd} indicates the d^{th} digit of sequence n. For example, D_{12} is the second character of Data 1 and S_{24} is the 4^{th} digit of sequence number 2.

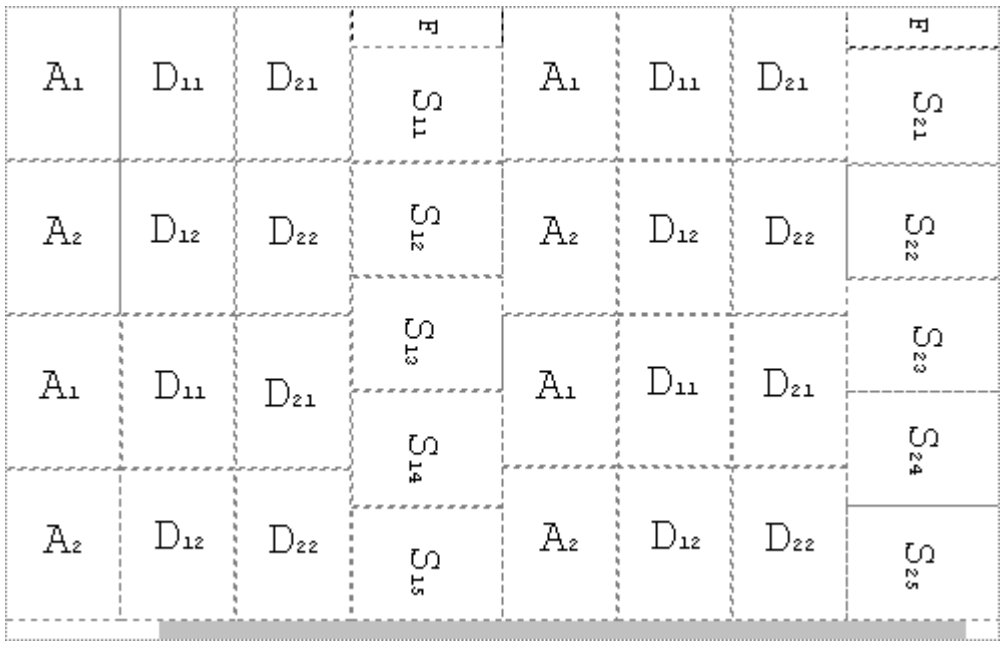


Figure 11: *Decimal* Sequential tag layout prior to 10 April 2012

Figure 8 shows a sample of the *Decimal* Sequential tag. The example shows Agency = 16, Data 1 = 58, Data 2 = 9, and sequence = 146. The white lines in the figure show the length of the tag and one possible cut. Note the position of the modified flag character. The flag points to the most significant digit of the Agency code and the Sequence. The white lines in the figure show the size of the tag, and one possible cut.

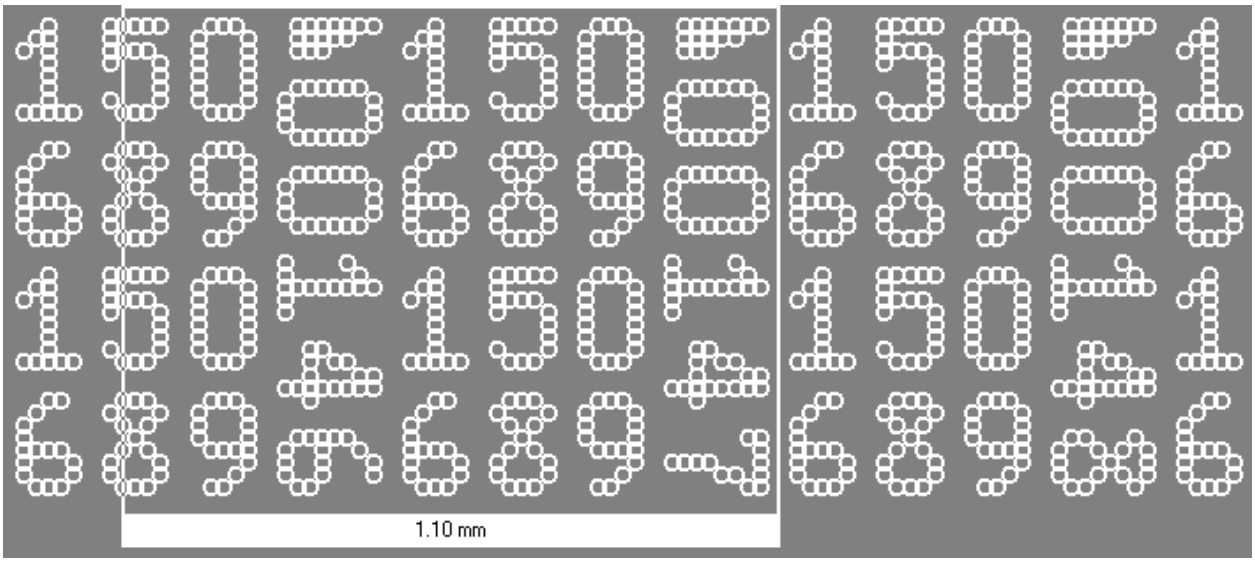


Figure 12: *Decimal* Sequential tag example (16/58/09/146) – Design prior to 10 April 2012

Table 4 compares the features of the binary and *Decimal* format for the Sequential tag. Note that the flag character replaces the binary master word, and that the sequence number replaces Data 3 and Data 4.

	Binary	***Decimal***		
Word	**Capacity**	**Digits**	**Capacity**	**Notes**
Master	1	**Flag**	1	
Agency	64	2	100	
Data 1	64	2	100	
Data 2	64	2	100	
Data 3	*	N/A		*Combined with Data 4
Data 4	16,384	N/A		Combined with Data 3
Sequence	N/A	5	100,000	

Table 4: Format comparison for Sequential tags

Appendix D – Revision History

September, 1999

The appearance of the standard tag format was changed after publication of the 15 April 1999 version of this document. The changes were made to increase the redundancy of the characters on the tag and to allow the entire code to appear on a single side of the tag. The prior design used an optimistic value for the readable length of a tag. Only sample tags were made with the older format.

December, 1999

The appearance of the digit eight was changed in order to avoid confusion with the digit zero. Only sample tags were made with the older character. The current appearance is shown in Appendix A.

February, 2000

The appearance of the sequential tag format was changed after publication of the 31 December 1999 version of this document. The changes were made to increase the redundancy of the characters on the tag. Only sample tags were made with the older format.

April, 2012

In the Spring of 2012, NMT redesigned the sequential tag to enhance readability in situations where the tag was damaged. By rotating every other sequence number, it may be possible to read a damaged tag that contains two sequence numbers.