Determining Scale Parts Compatibility

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Back to Table of Contents

Background

Many scales are comprised of multiple NTEP approved components. The weighing element, the indicator, and the load cells can all be exchanged or replaced during the life of a scale. Because of this, an inspector must be able to determine if these components are compatible.

The information that follows was published in the "NCWM – NEWS" 2012 Issue 3 and 2013 Issue 1.

Information

Blank forms can be found at:
http://www.ncwm.net/resources/dyn/files/1102163z4702c008/_fn/2012_Attachment_I_Class_III_Worksheet.doc

And:
http://www.ncwm.net/resources/dyn/files/1102164zd96655ab/_fn/2012_Attachment_I_Class_IIIL_Worksheet.doc

Contact your supervisor if you have questions.

Mixing & Matching Main elements of a scale how to determine Compliance - Part 1

In the last article (2012 Issue 2) we looked at the different main elements of a scale and NteP certificates for those main elements. We reviewed NIst handbook 44 (hB44) scales Code terminology for an indicating element not permanently attached to weighing and load- receiving element, weighing and load- receiving element not permanently attached to indicating element, main element, and load cells for which an NteP Certificates of Conformance (CC) had been issued. We left off with h44 marking requirements specified in scales Code tables s.6.3.a. and s.6.3.b. for main elements of a scale and the importance of initial verification when a field inspector must determine if the elements are interfaced together properly to comply with hB44 requirements.

To help the inspector with the determination of compliance when separate main elements are married together, worksheets were developed back in the mid 1980's, one for Class III scales and one for Class IIIL scales, so the worksheets are not new. In fact I remember Nist releasing the worksheets at least twice through newsletters. NCWM is now working to post blank worksheets for downloading and use, and example completed worksheets on the NCWM website to aid the W&M community. Some states report that they require their registered service personnel to complete a worksheet when a new Class IIIL system is installed for use in their jurisdiction. This column takes us through the completion of a worksheet for a Class IIIL electromechanical vehicle scale. As one would expect, NteP evaluators must also verify compliance with handbook 44 marking requirements and the

compliance of separate main elements to other handbook 44 requirements when systems and main elements are evaluated. The example worksheet used with this column is an actual scale system evaluated by the Maryland NteP Laboratory.

The *NIST Handbook 44* definition of a weighing element is "that portion of a scale that supports the load-receiving element and transmits to the indicating element a signal or force resulting from the load applied to the load-receiving element." *NIST Handbook 44* defines the load-receiving element as "that element of the scale that is designed to receive the load to be weighed; for example, platform, deck, rail, hopper, platter, scoop." so, when we use the term weighing and load-receiving element we mean the combination of the weighing element and the load receiver, such as the weighbridge and deck of a vehicle scale.

It is highly recommended that regulatory officials complete the worksheet upon initial inspection of a newly installed scale and modified scale installations, where one or more of the main elements have been replaced. T he intent of the worksheet is to complete the top section (boxes numbered 1 through 45) first. Manufacturer's Id, model, serial number, NteP CC number, accuracy class and nmax should be marked on all three main elements, however, please be advised that Note 11 in table s.6.3.b. allows most required markings to be in an accompanying document rather than on the load cell. Additional markings for the indicating element include: nominal capacity, value of d and CLC. Additional markings for the weighing element include: nominal capacity, CLC and emin. Additional information required for the load cell include: vmin and single (s) or multiple (M) cell certification by NteP. Now we can certainly understand the intent of hB44 marking requirements found in table s.6.3.a. of the scales Code. With this information we can fill in the boxes on the top portion of the worksheet with the exception of boxes 19, 43, 44 and 45, which are not marking requirements. It will take a little more effort but it is information we need to answer the 5 suitability questions on the bottom of the worksheet.

- Box 19 requires us to determine the number of divisions (n) for which the scale system being inspected is set up. this is done by dividing the capacity (200 000 lb) by the division size (20 lb), so 10 000 n in this case. [technical note: handbook 44 states that the number of n is determined by dividing the capacity by the verification scale division (e). table able s.6.3.b., Note 4 requires a marking of "e" only if different from "d", which is very unlikely, especially for large capacity scales.]

- Box 43 asks us to determine the number of sections in the scale being tested. hB44 defines a scale section as the "part of a vehicle, axle-load, livestock, or railway track scale consisting of two main load supports, usually transverse to the direction in which the load is applied." [technical note: Another way to state the formula is the number of load bearing points divided by 2. For an example, see hB44, scales Code, Paragraph N.1.3.3.2., which includes an excellent illustration of a three section platform scale.]

- Box 44 requires us to determine how many load cells are utilized in the scale being inspected. [technical note: table s.6.3.b., Note 7 states that it is acceptable to use a load cell with a single cell (s) designation in a multiple cell application but a load cell with a multiple cell (M) designation can only be used in multiple cell applications. Compliance with the requirement should also be verified.]

- Box 45 requires the recording of the scale multiple. this information is only applicable to mechanical lever system weighing elements when used with a load cell in an electro- mechanical system installation and is not required to be marked. It will likely be necessary to obtain this information from the manufacturer of the weighing element or the installing agency. [technical note: see the hB44 definition for "multiple of a scale" and scales Code paragraph s.5.4.]

Now that we have completed all the boxes on the top portion of the worksheet we can work to answer the five suitability criteria questions on the bottom of the worksheet.

- Question 1 requires us to compare the emin value marked on the weighing element [Box 32] with the division size for which the system under inspection is set-up [Box 16]. the emin value is the smallest division for which the weighing element complies with applicable requirements so the system cannot use a division size less than the value. In this case the value marked on the weighing element (20 lb) is less than or equal to the system division size (20 lb), so the scale system meets the requirement and we check yes in Box 9 of the worksheet.

- Question 2 requires us to look at the nmax value for each individual main element [Boxes 37, 38 and 39] and compare the smallest value to the number of divisions for the system [Box 19]. The nmax is the maximum number of divisions for which the element complies with applicable requirements and is stated

on the NteP CC. In this case all three elements had an nmax of 10 000 and the system was also set up for 10 000 divisions, so the scale complies and we check yes. [Another example could be a system where the nmax values for the main elements were not the same. Suppose we had nmax values for the indicator = 10 000, weighing element = 5000 and load cell = 6000. In that case it could be possible for the three elements to be interfaced together but only if the system were set up for 5000 divisions or less because the limiting factor would be the 5000 maximum number of divisions value for the weighing element.]

- Question 3 is looking for compliance with hB44, scales Code, paragraph s.6.1., which requires the marked nominal capacity for the system [Box 13] to be less than or equal to the CLC times the number of sections [Box 43] minus 0.5. As a formula, this is stated as Capacity < CLC x (N – 0.5). Looking at our example worksheet we see that 200 000 lb is less than 450 000 lb, so it meets the requirement.

- Questions 4 and 5 require a determination of the appropriate relationship of the load cell verification value (vmin) to the scale division. The requirement is traceable to hB44, scales Code, paragraph s.5.4. Notice that we only need to answer one of the suitability criteria questions on the worksheet per scale system. Use the suitability criteria 4 formula if the scale does not have a lever system (fully electronic) or suitability criteria 5 formula if the scale has lever system and uses a load cell or cells (electro-mechanical). In this case we have an electro-mechanical system and question 4 is not applicable. Question 5 tells us to compare the v min value for the load cell used, which is required to be less than or equal to the division size of the scale divided by the square root of the number of load cells x the scale multiple. As a formula, this can be stated as vmin < d ÷ (√N x scale multiple). so we look at the value in Box 24 (0.04 lb) and make sure it is less than or equal to Box 16 (20 lb) ÷ the square root of Box 44 (the square root of 1 is 1) x value in Box 45 (280: 1 is 280). When we plug those numbers into the formula it results in 0.04 lb < 0.071 lb, so the load cell complies with the requirement.

As we can see, use of the worksheet for initial verification can not only help us determine that the installation meets h44 suitability criteria, but also that all required markings were available. NteP is providing this information because of the large number of requests for guidance from the states, installation agencies, service agencies and manufacturers. hopefully, this article has helped you understand the importance of initial verification and NIst handbook 44 marking requirements to determine if the elements are interfaced together properly to comply with applicable requirements. upcoming newsletter articles will provide worksheet examples of a Class IIIL fully electronic scale and a Class III hopper scale. If you would like to discuss the content of this column contact Jim Truex at jim.truex@ncwm.net.

— Jim truex, NteP Administrator

NTEP Worksheet - Class IIIL

	Markings	Indicating Element		Weighing Element		Load Cell(s)	
Information Found on the Device Identification Plate, Badge, or Display	Manufacturer	1	Rice Lake	2	Webster scale	3	Rice Lake
	Model	4	920i	5	PV7050511	6	RL20000B (1000lb)
	Serial Number	7	112345	8	W54321	9	LC78910
	Class III, III/IIIL, IIIL	10	III/IIIL	11	IIIL	12	IIIL
	Capacity	13	200,000	14	200,000		N/A
	"d" Scale Division Value	16	20	17	N/A		N/A
	"n" for the System (divide box #13 by box #16)	19	10000	20	N/A		N/A
	"Vmin" Verification Scale Division	---------->		---------->		24	0.04
	"CLC" Concentrated Load Capacity (Vehicle Scale Only)	25	100,000	26	100,000		N/A
	"See Cap" Section Capacity (Livestock Scale Only)	28	NA	29	NA		N/A
	"e min" Minimum Scale Division	->		32	20		N/A
Found on CC	CC Number	34	01-088A5	35	12-059	36	98-044A1
	"n max" Maximum Number of "d"	37	10,000	38	10,000	39	10,000
Info From Site	Single Cell (S) or Multiple Cells "M"	>		41	----->	42	S
	Number of Sections ---------->	43	5	Number of Load Cells "N" --------->		44	1
	*Note: If the Weighing Element is a Lever System, Enter the Lever (Scale) Multiplier Here:---------->					45	280

Suitability Criteria

	emin < or = to d					**Meets Requirements**		
1	Enter # from Box 32			Enter # from Box 16		Yes	No	N/A
46	20	< or=	47	20	→	X		
	"n" (for the system) < or = to nmax (smallest of any one element)							
2	Enter # from Box 19			Enter in Box 49 (smallest # from box 37 or 38)				
48	10,000	< or =	49	10,000	→	X		
	Capacity < or = to CLC (# of sections - 0.5)							
3	Enter # From Box 13			Enter in Box 51 (calculate # from box 25 times (# from box 43 minus 0.5)				
50	200,000	< or =	51	450,000	→	X		
	Vmin < or = to ("d" / (sq. rt of "N")) This is for a Full Electronic Scale							
4	Enter # From Box 24			Enter in Box 53 (Box 16 divided by sq.rt of Box 44)				
52	0.04	< or =	53	20	→			
	Vmin < or = to ("d"/(sq. rt. "N" x scale multiple)) This is for Electro-mechanical Lever Systems							
5	Enter # From Box 24			Enter # in Box 55 (divide Box 16 by Sq.Rt of Box 44 times Box 45)				
54	0.04	< or =	55	0.0714	→	X		

NteP: Mixing and Matching Main elements of a scale-how to determine Compliance/Part II

NTEP Article: Mixing and Matching Main Elements of a Scale – How to Determine Compliance / Part II.

In the 2012 Issue 2 article we looked at the different main elements of a scale and NTEP certificates for the main elements. We reviewed NIST handbook 44 (h44) scales Code terminology for an indicating element not permanently attached to weighing and load receiving element, weighing and load receiving element not permanently attached to indicating element, main element, and load cells for which an NteP Certificates of Conformance (CC) had been issued.

In the 2012 Issue 3 article we discussed the use of NteP worksheets to help the inspector with the determination of compliance when separate main elements are married together. That article took us through the completion of a worksheet for a Class IIIL electromechanical vehicle scale. This article will take us through the completion of a worksheet for a Class IIIL fully electronic vehicle scale. The example worksheet used with this article is an actual scale system evaluated by the Ohio NteP Laboratory.

It is highly recommended that regulatory officials complete the worksheet upon initial inspection of a newly installed scale and modified scale installations, where one or more of the main elements have been replaced. The intent of the worksheet is to complete the top section (boxes numbered 1 through 45) first. Manufacturer's Id, model, serial number, NteP CC number, accuracy class and n_{max} should be marked on all three main elements. However, please note that note 11 in table s.6.3.b. allows most required markings to be in an accompanying document rather than on the load cell. Additional markings for the indicating element include: nominal capacity, value of d and CLC. Additional markings for the weighing element include: nominal capacity, CLC and e_{min}. Additional information required for the load cell include: v_{min} and single (S) or multiple (M) cell certification by NteP. At this point, we see and understand the intent of h44 marking requirements found in table s.6.3.a. of the scales Code. With this information we can fill in the boxes on the top portion of the worksheet with the exception of boxes 19, 43, 44 and 45, which are not marking requirements. It will take a little more effort but it is information we need to answer the 5 suitability questions on the bottom of the worksheet.

- Box 19 requires us to determine the number of divisions (n) for which the scale system being inspected is set up. this is done by dividing the capacity (200 000 lb) by the division size (20 lb), so 10 000 n in this case. [technical note: handbook 44 states that the number of n is determined by dividing the capacity by the verification scale division (e). Table S.6.3.b., Note 4 requires a marking of "e" only if different from "d", which is very unlikely, especially for large capacity scales.]

- Box 43 asks us to determine the number of sections in the scale being tested. H44 defines a scale section as the "part of a vehicle, axle-load, livestock, or railway track scale consisting of two main load supports, usually transverse to the direction in which the load is applied." [technical note: Another way to state the formula is the number of load bearing points divided by 2. For an example, see h44, scales Code, Paragraph N.1.3.3.2., which includes an excellent illustration of a three section platform scale.] In this case we have 10 load cells, so five sections.

- Box 44 requires us to determine how many load cells are utilized in the scale being inspected; in this case 10. [technical note: table s.6.3.b., Note 7 states that it is acceptable to use a load cell with a single cell (s) designation in a multiple cell application but a load cell with a multiple cell (M) designation can only be used in multiple cell applications. Compliance with the requirement should also be verified.]

- Box 45 asks us to record the scale multiple. This information is only applicable to mechanical lever system weighing elements when used with a load cell in an electromechanical system installation and is not applicable in this case.

Now that we have completed all the applicable boxes on the top portion of the worksheet we can work to answer the five suitability criteria questions on the bottom of the worksheet.

- Question 1 requires us to compare the e_{min} value marked on the weighing element [Box 32] with the division size for which the system under inspection is set-up [Box 16]. The e_{min} value is the smallest division for which the weighing element complies with applicable requirements so the system cannot use a division size less than the value. In this case the value marked on the weighing element (20 lb) is less than or equal to the system division size (20 lb), so the scale system meets the requirement and we check yes in the box on the worksheet.

- Question 2 requires us to look at the n_{max} value for each individual main element [Boxes 37, 38 and 39] and compare the smallest value to the number of divisions for the system [Box 19]. The n_{max} is the maximum number of divisions for which the element complies with applicable requirements and is stated on the NteP CC. In this case all three elements had an n_{max} of 10,000 and the system was also set up for 10 000 divisions, so the scale complies and we check yes. [Another example could be a system where the n_{max} values for the main elements were not the same. suppose we had n_{max} values for the indicator = 10 000, weighing element = 5000 and load cell = 6000. In that case it could be possible for the three elements to be interfaced together but only if the system were set up for 5000 divisions or less because the limiting factor would be the 5000 maximum number of divisions value for the weighing element.]

- Question 3 is looking for compliance with h44, scales Code, paragraph s.6.1., which requires the marked nominal capacity for the system [Box 13] to be less than or equal to the CLC times the number of sections [Box 43] minus 0.5. As a formula, this is stated as **Capacity $\leq$ CLC x (N – 0.5)**. Looking at our example worksheet we see that 200,000 lb is less than 270 000 lb, so it meets the requirement and we check yes.

- Questions 4 and 5 require a determination of the appropriate relationship of the load cell verification value (v_{min}) to the scale division. The requirement is traceable to h44, scales Code, paragraph s.5.4. Notice that we only need to answer one of the suitability criteria question on the worksheet per scale system. use the suitability criteria 4 formula if the scale does not have a lever system (fully electronic) or suitability criteria 5 formula if the scale has lever system and uses a load cell or cells (electro- mechanical). In this case we have a full electronic system and question 5 is not applicable. Question 4 tells us to compare the v_{min} value for the load cell used, which is required to be less than or equal to the division size of the scale divided by the square root of the number of load cells in the scale. As a formula, this can be stated as $\mathbf{v_{min} \leq d \div (\sqrt{N})}$. so we look at the value in Box 24 (2.0 lb) and make sure it is less than or equal to Box 16 (20 lb) ÷ the square root of Box 44 (the square root of 10 is 3.16). When we plug those numbers into the formula, it results in 2.0 $\leq$ (20 ÷ 3.16). 2 is less than 6.33, so the load cell complies with the requirement and we check yes on the worksheet.

Use of the worksheet for initial verification can not only help us determine that the installation meets h44 suitability criteria, but also that all required markings were available. NteP is providing this information because of the large number of requests for guidance from the states, installation agencies, service agencies and manufacturers. Hopefully this article has helped you understand the importance of initial verification and NIst handbook 44 marking requirements to determine if the elements are interfaced together properly to comply with applicable requirements.

NTEP Worksheet - Class IIIL

	Markings	Indicating Element		Weighing Element		Load Cell(s)	
Information Found on the Device Identification Plate, Badge, or Display	Manufacturer	1	Cardinal Scale	2	Cardinal Scale	3	Cardinal Scale
	Model	4	225	5	100070-PSC	6	CBC50K
	Serial Number	7	I54321	8	W78910	9	LC12345
	Class III, III/IIIL, IIIL	10	III/IIIL	11	IIIL	12	III/IIIL
	Capacity	13	200000	14	200000		N/A
	"d" Scale Division Value	16	20	17	N/A		N/A
	"n" for the System (divide box #13 by box #16)	19	10000	20	N/A		N/A
	"Vmin" Verification Scale Division	---------->		---------->		24	2
	"CLC" Concentrated Load Capacity (Vehicle Scale Only)	25	60000	26	60000		N/A
	"See Cap" Section Capacity (Livestock Scale Only)	28	NA	29	NA		N/A
	"e min" Minimum Scale Division	---------->		32	20		N/A
Found on CC	CC Number	34	01-011A6	35	12-063	36	11-094
	"n max" Maximum Number of "d"	37	10000	38	10000	39	10000
Info From Site	Single Cell (S) or Multiple Cells "M"	---------->		41	---------->	42	M
	Number of Sections ---------->	43	5	Number of Load Cells "N" - ---------->		44	10
	*Note: If the Weighing Element is a Lever System, Enter the Lever (Scale) Multiplier Here:---------->					45	

Suitability Criteria

	emin < or = to d					Meets Requirements		
1	Enter # from Box 32			Enter # from Box 16		Yes	No	N/A
46	20	< or=	47	20	→	X		
2	"n" (for the system) < or = to nmax (smallest of any one element)							
	Enter # from Box 19			Enter in Box 49 (smallest # from box 37 or 38)				
48	10000	< or =	49	10000	→	X		
3	Capacity < or = to CLC (# of sections - 0.5)							
	Enter # From Box 13			Enter in Box 51 (calculate # from box 25 times (# from box 43 minus 0.5)				
50	200000	< or =	51	270000	→	X		
4	Vmin < or = to ("d" / (sq. rt of "N")) This is for a Full Electronic Scale							
	Enter # From Box 24			Enter in Box 53 (Box 16 divided by sq.rt of Box 44)				
52	2	< or =	53	6.33	→	X		
5	Vmin < or = to ("d"/(sq. rt. "N" x scale multiple)) This is for Electro-mechanical Lever Systems							
	Enter # From Box 24			Enter # in Box 55 (divide Box 16 by Sq.Rt of Box 44 times Box 45)				
54	N/A	< or =	55	N/A	→			