Measurement News

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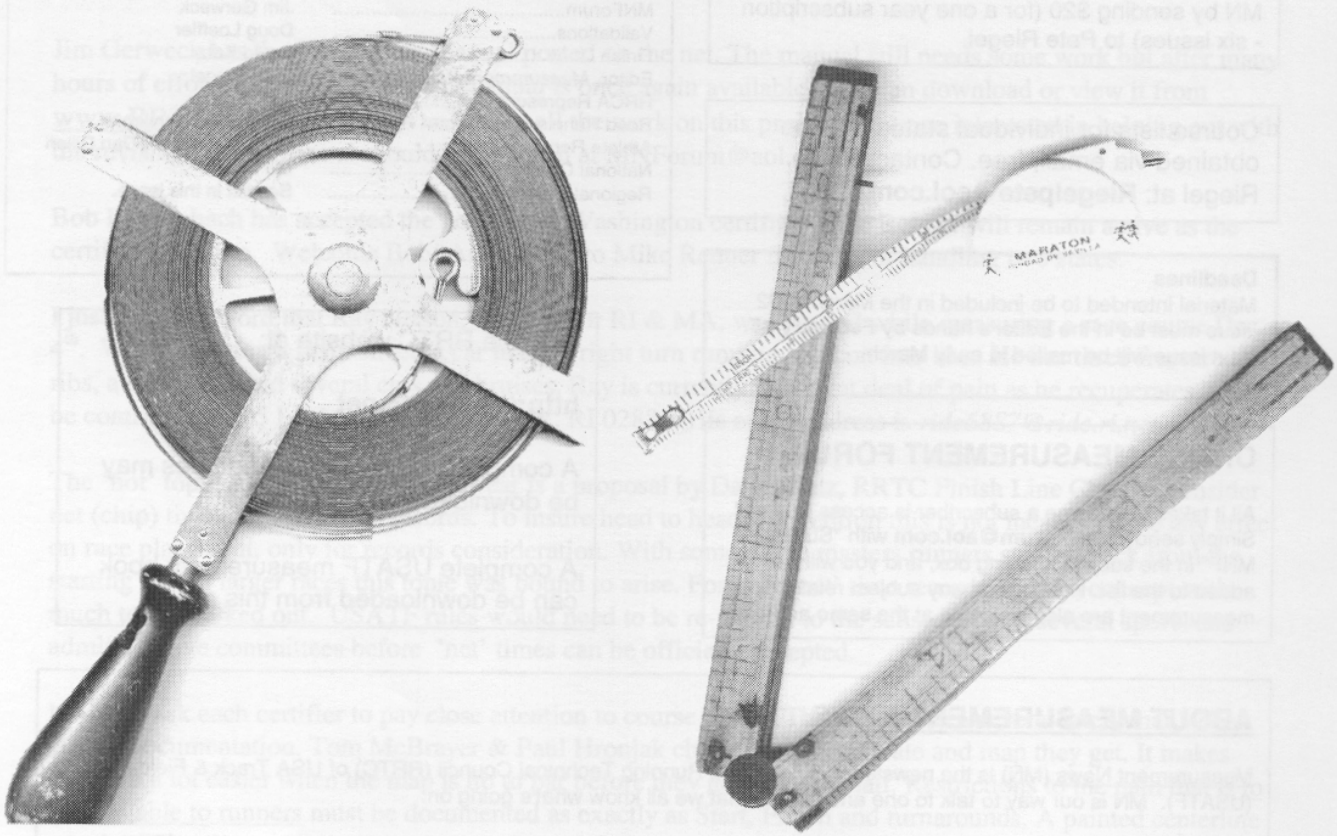
The Great Tape Stretch



On November 3, 2001, Mike Wickiser and Pete Riegel compared 33 steel tapes against a standard, calibrated tape. Tapes were provided by 20 measurers, and included tapes made in 4 countries. The raw data appeared in November *Measurement News*. A complete report may be seen in this issue.

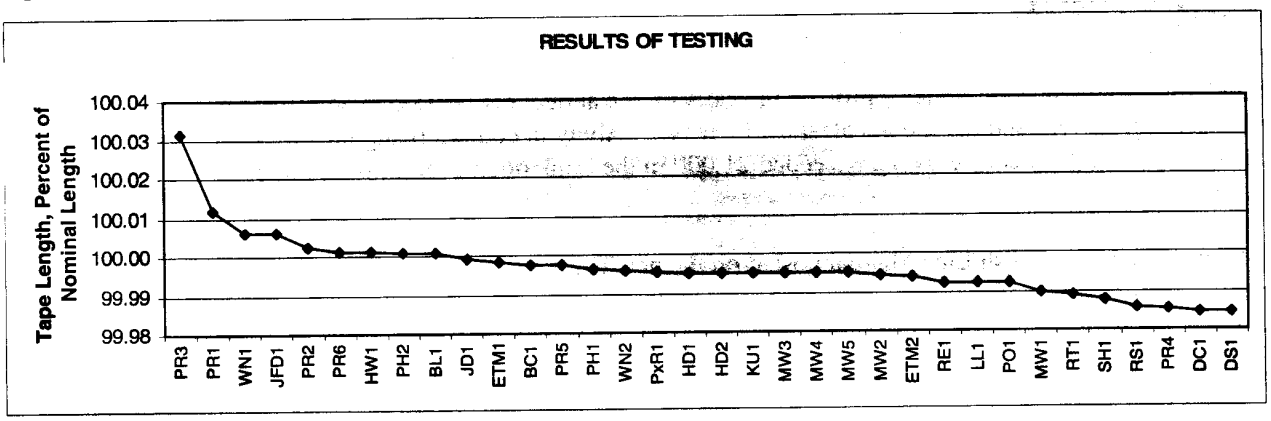
Above left is tape PR3 (Lufkin 30 m surveyors' tape), while on the right is shown an old carpenter's rule and a souvenir tiny tape from the Seville Marathon, picked up by Joan Riegel in her travels as Race Administrator for the 1992 US Olympic Trials Marathon. The tiny tape may seem inadequate for course measurement, but a track measurement was once submitted by someone who used a yardstick! The application was sent back for more work.

THE GREAT STEEL TAPE COMPARISON

By Pete Riegel and Mike Wickiser

SUMMARY

Thirty-three tapes, obtained from 21 measurers, were checked against a calibrated tape. Tape lengths varied from 99.984 to100.032 percent of nominal length under 50 N (11 lb) tension. Median length was 99.995 percent of nominal. Individual tape lengths are shown in the figure and table below:



Tape Types

The tapes had several lengths and kinds of scales imprinted on them:

- tapes with feet, inches, and 1/8 inch markings
- tapes with feet, tenths of feet, and hundredths of feet markings
- tapes with metres, centimetres and millimetre markings
- Tapes with links and 1/10 link markings. (note: 100 links = 66 feet)

Tapes came in a variety of lengths:

- 100 feet
- 100 feet/30 metres
- 103 feet
- 30 metres
- 50 metres
- 50 metres/164 feet
- 60 metres
- 165 feet
- 200 links
- 200 feet

The zero marks were sometimes offset 30 to 50 cm from the end, or were at the very end of the tape or pull ring.

The full length of the tapes sometimes carried an extra small distance (one 30 m tape had its end at 30.5 m). Tapes were all made of steel, and were either

TEST RESULTS
LENGTHS OF SUBMITTED TAPES
AT 50 N TENSION

Maker	Owner	Code	Tape Length Percent of Nominal	Nominal Length	Test Result Metres	Test Result Feet	Test Result Links
Stanley	Riegel	PR3	100.032	30 m	30.009		
Leitz-Eslon	Riegel	PR1	100.012	103 ft		103.012	
Unknown	Nicoll	WN1	100.006	200 links			200.013
Stanley	Delasalle	JFD1	100.006	50 m	50.003		
Lufkin	Riegel	PR2	100.003	30 m	30.001		
Lufkin	Riegel	PR6	100.001	100 ft		100.001	
Lufkin	Watts	HW1	100.001	100 ft		100.001	
Lufkin	Hronjak	PH2	100.001	100 ft		100.001	
Lufkin	Lang	BL1	100.001	100 ft		100.001	
Rabone Chesterman	Disley	JD1	99.999	50 m	50.000		
Sears Craftsman	McBrayer	ETM1	99.998	100 ft		99.998	
Lufkin	Conway	BC1	99.997	30m/100 ft	29.999	99.997	
Lufkin	Riegel	PR5	99.997	30m/100 ft	29.999	99.997	
Lufkin	Hronjak	PH1	99.996	100 Ft.		99.996	
Keson	Nicoll	WN2	99.996	200 ft.		199.992	
Lufkin	Riddell	PxR1	99.996	50m/164 ft	49.998	163.993	
Lufkin	Hudson	HD1	99.995	100 ft		99.995	
Lufkin	Hudson	HD2	99.995	100 ft		99.995	
Stanley	Ungurean	KU1	99.995	100 ft		99.995	
Lufkin	Wickiser	MW3	99.995	100 Ft.		99.995	
Lufkin	Wickiser	MW4	99.995	100Ft.		99.995	
Lufkin	Wickiser	MW5	99.995	100Ft.		99.995	
Keson	Wickiser	MW2	99.994	165 ft		164.990	
Lufkin	McBrayer	ETM2	99.994	30m/100 ft	29.998	99.994	
Lufkin	Eichler	RE1	99.992	30 m	29.998		
Lufkin	Lacroix	LL1	99.992	50m/164 ft	49.996	163.987	
Lufkin	Oerth	PO1	99.992	50m/164 ft	49.996	163.987	
Stanley	Jones	MW1	99.990	30m	29.997		
Rabone Chesterman	Thurston	RT1	99.989	60 m	59.993		
Stanley	Hubbard	SH1	99.988	100 ft		99.988	
Rabone Chesterman	Scardera	RS1	99.986	100 ft		99.986	
Stanley	Riegel	PR4	99.985	30m/100 ft	29.996	99.985	
Sokkia/Eslon	Connolly	DC1	99.984	100 ft		99.984	
Sears Craftsman	Shepan	DS1	99.984	100 ft		99.984	
		Average	99.997				
		Std Dev	0.009				
		Median	99.995				
		High	100.032				
		Low	99.984				

	Tension as Marked	Marked Tension lb	Percent of Nominal at 50 N (11 lb)	Percent of Nominal As Marked	Nominal Length Feet	Test Result Feet
RS1	15 lbf	15	99.986	99.991	100	99.991
WN2	2kgf	4.4	99.996	99.984	200	199.967

Tapes had marked tension of 50 N, or had no marked tension, or had other tension marked. Two tapes, RS1 and WN2, had other marked tensions. This chart shows the tested length at their marked tensions.

unpainted, painted, or covered with plastic or nylon. Tapes were wound either in open, surveyor-type reels or in closed, hardware-store type reels.

BACKGROUND

The idea for this exercise occurred to the authors in early October. There have been several tape comparisons done in the past, but methodology and/or conditions were such that results were not completely satisfactory. We thought it would be of benefit to check out as many different tapes as we could get, under identical conditions, and see what we found.

We hoped to get an idea of how much variation in tape length we could reasonably expect. As a secondary goal, we wanted to give each person who helped, by supplying a tape, an estimate of the length of his tape.

A call for tapes was posted in *MNForum*, and shortly after that Pete traveled to Bristol, England, for a meeting. John Disley (Great Britain) and Jean-Francois Delasalle (France) had seen the notice, and Pete was able to bring back a steel tape from each of them. Upon his return Pete found that a pile of tapes had arrived, and they continued to come. Mike had also received some tapes. Rodolfo Eichler gave Pete a tape at the Brazil seminar held in October. Canadians (Bernie Conway, Laurent Lacroix, Patrick Riddell) sent tapes. In order to be able to publish the raw data in November *Measurement News*, we decided to do the work on Saturday, November 3, 2001.

Unknown to Pete, Mike had made some inquiries of NIST (National Institute of Standards and Technology, formerly National Bureau of Standards) relating to our exercise. Some of the material is included herein.

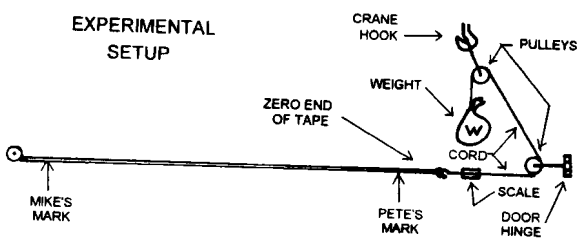
Mike found a suitable building in which to do the work, a vehicle garage in Cuyahoga Falls, Ohio. We wanted to do the work indoors to eliminate the effect of varying temperature and sunlight on the tapes.

EXPERIMENTAL METHOD

The Standard Tape: In 1984 Pete bought a steel tape from Watts Engineering, a surveying firm in Columbus. The owner, Mr. Harley Watts, was kind enough to help Pete check his tape against a tape that had been calibrated by the National Bureau of Standards (NBS). Recalling this event, Pete called Watts Engineering, and they found the standard tape in their showcase containing old measurement tools, unused for many years. Pete rented this tape for the comparison. It is denoted as "HW1" and has a calibrated length of 100.001 feet for its indicated length of 100.00 feet. On the tape box is marked in big black letters "Not for field use under any circumstances!" Before the days of electronic measurement the tape was used to calibrate their working tapes.

In addition, tape PR3 was calibrated at the Stanley factory in 1996. Stanley's calibration indicated a tape length of 30.00987 metres. This compares well with our test result of 30.00948 metres, giving reassurance that tape HW1 may be considered a reliable standard.

Tape Tensioning: We had only two people to do the work. Anybody who has pulled a tape knows what a miserable job it is to try to pull the scale with the proper tension, and read the tape at the same time. Pete worked out a pulley, cord and weight arrangement which permitted constant tension to be maintained. Two sandbags were loaded to 11 pounds each (thus giving a force of 50 N each). One was hooked to the end of the



cord, and the cord led through two pulleys, one for horizontal guidance and the second located on a crane hook, so that the sandbag had room to rise. Mike pulled each tape until the sandbag rose from the floor. Pete checked the scale, and recorded the reading at his end of the tape. Mike relaxed, and the second sandbag was loaded onto the cord, and the process repeated.

Distance Measured: The distance chosen for measuring all the tapes was arrived at by trial and error, after seeing how well the tensioning system worked. The goal was to use a single distance that could be measured by all the tapes. After trying several tapes we found the final distance.

Reading the Tapes: Mike operated the reel end of the tapes, while Pete operated the zero end. Mike would pull until the tensioning sandbag rose, and hold exactly on an even increment. This was either 30 m or 97 feet, except for WN1, which was marked in links. Pete read the tape at the other end. With tapes graduated in millimetres or 1/100 feet it was simple to read to the nearest ½ mm or 1/1000 foot. If the tape was calibrated in 1/8 inches, Pete read to the nearest 1/8 inch, and added a note such as "+.3" indicating that 3/10 of 1/8 inch was to be added. This was found to be easier than trying to figure things to the nearest 1/128 inch.

Uncertainty of Readings: We estimate the uncertainty of reading length at ±0.5 mm. Observed tension varied from 10 to 12 pounds, or 21 to 23 pounds, presumably because of friction in the cord/pulley arrangement.

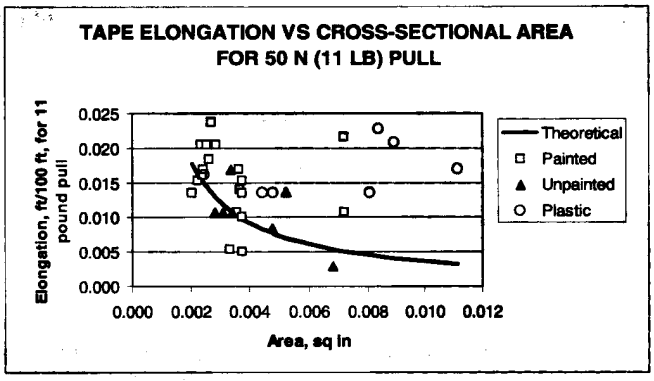
Calculation of tape Lengths: Calculation of lengths was based on the following assumptions:
- HW1 is considered to be the standard of accuracy.
- Other tapes have lengths relative to HW1 in inverse proportion to their measured distance.
- Each tape is evenly divided into its increments.

Little error is likely in the calculation of length of the 100 foot and 30 metre tapes. Slightly more error will be present in extrapolating to the lengths of the longer tapes.

DISCUSSION OF RESULTS

Effect of Tension on Tape Length: Tapes were tested at 50 N (11 lb) and 100 N (22 b). Other tensions, of course, will produce different tape lengths. Because of the small effect of tension on tape length, and the uncertainty of the readings, the authors do not propose any alteration from the 50 N (11 pound) tension by users, nor any reason why a "firm pull" or "tension by hand" should not be adequate. On average, a 100 foot tape stretched about 0.001 feet (0.016 in), per 1 lb tension. Thus small errors in applying tension to the tape do not cause significant error in final readings.

Comparison of tape elongation with elastic theory is shown at right (Assuming the modulus of elasticity to be 30,000,000 psi, typical for steel). The cross-sectional area was calculated from measurements of the thickness and width of each tape. Because we did not wish to damage the tapes, the measurements included the coating, whether paint or plastic. While paint added only a little to overall thickness, plastic was thicker. Thus the unpainted steel tapes showed the best agreement with what theory would predict.



Effect of Length on Measured Distances: If a tape is in error, as all are to some degree, measured lengths will be affected. If a 10 km course is measured using a tape having a length of 99.995 percent of its nominal length, the course will have a final length of 9999.5 metres. If the same tape is used in validation of a course with a true length of 10 km, it will indicate that the course is 10,000.5 metres long. Greater tape errors will produce greater disparities.

Information from NIST: Mike wrote to NIST and received a response from Mr. Charles Fronczek Jr. He sent Mike a copy of NIST's draft specification for tapes.

He also noted "In general, the accuracy of steel measuring tapes that we receive here at NIST for calibration is fairly good. Usually, we see typical accuracies of ¼ inch in 100 ft. In fact, it is seldom that we see one larger than that."

Twenty-four of the 33 tested tapes met the draft standards. Only one, Pete's Brazilian Stanley 30 m tape (PR3), did not fall within the "1/4 inch in 100 feet" limit which Mr. Fronczek considers as fairly good. The rest met this relaxed standard.

Age of the Standard Tape: The standard tape, HW1, was calibrated by NBS (now NIST) in 1954. Has it changed length since then? Pete has made inquiries of surveyors and manufacturers, and nobody has heard of a tape that ever changed its length. In addition, NIST provided the following data of a customer's 100 foot tape that was submitted at several time intervals:

1977	100.0028
1989	100.0027
1990	100.0028
1993	100.0029
1994	100.0028
1996	100.0029
1999	100.0030

Tension of Accuracy for Various Tapes - From NIST

US Customary Unit Tapes	Metric Unit Tapes
0 - 100 ft overall length - 10 lb	0 - 30 m overall length - 50N (5 kg)
Length greater than 100 ft - 20 lb	Length greater than 30 m - 100 N (10 kg)

NIST DRAFT TOLERANCES

Length		NIST Tolerance		Percent of Length
100	ft	0.108	in	0.0090
150	ft	0.156	in	0.0087
200	ft	0.204	in	0.0085

30	m	2.7	mm	0.0090
50	m	4.3	mm	0.0086
100	m	8.3	mm	0.0083

This specification gives a general tolerance of +/- 0.009 percent of nominal length, for the range of lengths tested.

Tapes that range from 99.991 to 100.009 percent of nominal length thus match the draft spec.

Fronczek says "As you can see, if treated properly, there is little discernible change in the length of the tape. Of course, if one were to exceed the elastic limit of the tape (~40,000 to 60,000 psi) by over stretching it all bets are off. This could happen if one were to attach a tape to the back end of a car and the tape was snagged on a fireplug or tree. We have had a customer do this."

Note: A pull of 50 N (11 lb) produced tensile stress of less than 7,200 psi in all tapes tested.

Temperature: Testing was conducted at 71F. Standard temperature is 68F, or 20C. Because all tapes were steel, expanding at the same rate, comparative results are unaffected by the difference.

COMPARISON OF 50 METRE TAPES

As no standard of comparison was available, these tapes were pulled "by hand," with tension estimated at 50N. As the JD1 tape was most accurate at 30 m, it is used here as a substitute standard.

Code	Owner	Tension by feel 50 metre pull Measured Distance metres	Tension by feel 50 metre pull Measured Distance feet	Difference from JD1 mm
JFD1	Jean-Francois Delasalle	48.376	158.714	-3.0
LL1	Laurent Lacroix	48.378	158.720	-1.0
JD1	John Disley	48.379	158.724	0.0
WN2	Wayne Nicoll	48.381	158.730	1.9
MW2	Mike Wickiser	48.384	158.740	4.8
PO1	Paul Oerth	48.385	158.743	6.0
RT1	Bob Thurston	48.387	158.750	8.0

Longer Tapes: Because we did not possess a calibrated tape longer than 100 feet, we did not test the longer tapes in a rigorous manner. Instead we put down a new set of marks and, using tension "by feel" to approximate the proper pull, measured the distance with each of the long tapes. The table at left shows the comparative readings. Because JD1 showed the least error in the 30 m pulls, we use it here as a quasi-standard for the others.

"Surveyor" Tapes vs "Hardware" Tapes: Three "surveyor" type tapes were submitted (WN1, PR2, PxR1). They have open reels and unpainted ribbon. Results of testing these three tapes did not show any marked difference in accuracy between these tapes and the others.

QUALITY OF THE TAPES WE USE

We have seen, in the sample tested, that about ¾ of the tested tapes met the NIST standard. All but one met the expectations of NIST for tapes they are given for test – an accuracy of about ¼ inch in 100 feet, or 2 metres in 10 km. What does this mean for us?

Can we obtain more accurate tapes? Do we need to? In the early days of US course certification, use of a "calibrated" steel tape was recommended. This recommendation, while well-meaning, did not take into account the time (weeks to months) and expense (several hundreds of dollars) of getting a tape calibrated. Few people actually obeyed this recommendation. Instead, people would use the tapes they had, or could obtain, trusting that they were good enough.

The longest tape we tested was Pete's Brazilian Stanley tape, which is 30.01 m in length. This disparity is quite small, and was only discovered by accident when Pete used the Brazilian tape to measure a 300 m calibration course, and a second tape to check it, and found a 10 cm difference which he could not attribute to operator error. Further checking by Pete and the Stanley factory confirmed the length of the tape.

There are certainly a few tapes out there that are beyond what we would like, but without some form of good luck they are unlikely to be discovered.

Unless we can find a practical alternative, we must continue as we are doing. The only mechanism we have to evaluate our method is the validation measurement, and it shows that in the majority of cases the method works. If our small sample is truly representative of the tapes available to us, things are satisfactory.

One thing that can be done is for people to check their tapes against each other when possible. Generally, reasonably good agreement will be found. When disagreement is found, a need for further checking is indicated.

Thanks to all who submitted tapes. We hope that the individual results obtained will be of help to you.

* * * *

Original data on which this study was based appeared in *Measurement News*, Issue #110, November 2001. These data, and the calculations supporting this report, are available as a Microsoft Excel or Lotus 1-2-3 file. Contact the authors for an electronic copy.

FROM MN #110

TAPE CHARACTERISTICS

This is a quick presentation of the data obtained. There may be some errors in the calculations, but the data are believed to be correct.

These data and calculations exist in an Excel file. Contact Pete Riegel if you want a copy.

Date of these calculations 7 November 2001

FURTHER ANALYSIS IS INVITED AND WILL BE DEALT WITH IN NEXT ISSUE OF MN.

Code		Owner	Reading at Mike's End	Tension 50 N Reading at Pete's End	Tension 50N Calculated Length Metres	Tension 50N Calculated Length Feet	Tension by feel 50 metre pull metres	Tension by feel 50 metre pull feet	Tension 100 N Reading at Pete's End	Tension 100 N Calculated Length Metres	Tension 100 N Calculated Length Feet
PR3	Pete	Riegel	30	0.7435	29.257	95.986			0.748	29.252	95.971
PR1	Pete	Riegel	97	0.995	29.262	96.005			1.008	29.258	95.992
WN1	Wayne	Nicoll	146	0.53	29.264	96.010			0.55	29.260	95.997
JFD1	Jean-Francois	Delasalle	30	0.736	29.264	96.010	48.376	158.7139	0.739	29.261	96.001
PR2	Pete	Riegel	30	0.735	29.265	96.014			0.7375	29.263	96.006
PR6	Pete	Riegel	97	0.985	29.265	96.015			0.99	29.264	96.010
HW1	Harley	Watts	96	0.015	29.265	96.015			0.012	29.264	96.012
PH2	Paul	Hronjak	97	11.8125	29.266	96.016			11.975	29.261	96.002
BL1	Bob	Lang	97	11.8125	29.266	96.016			11.9375	29.262	96.005
JD1	John	Disley	30	0.734	29.266	96.017	48.379	158.7238	0.739	29.261	96.001
ETM1	Tom	McBrayer	97	11.7875	29.266	96.018			12	29.261	96.000
BC1	Bernie	Conway	30	0.7335	29.267	96.019			0.7395	29.261	95.999
PR5	Pete	Riegel	30	0.7335	29.267	96.019			0.738	29.262	96.004
PH1	Paul	Hronjak	97	11.7625	29.267	96.020			12	29.261	96.000
WN2	Wayne	Nicoll	97	0.98	29.267	96.020	48.3809	158.73	1	29.261	96.000
PxR1	Patrick	Riddell	30	0.733	29.267	96.020			0.738	29.262	96.004
HD1		Hudson	97	11.75	29.267	96.021			11.9375	29.262	96.005
HD2		Hudson	97	11.75	29.267	96.021			11.9375	29.262	96.005
KU1	Karl	Ungurean	97	11.75	29.267	96.021			11.875	29.264	96.010
MW3	Mike	Wickiser	97	11.75	29.267	96.021			11.875	29.264	96.010
MW4	Mike	Wickiser	97	11.75	29.267	96.021			11.875	29.264	96.010
MW5	Mike	Wickiser	97	11.75	29.267	96.021			11.875	29.264	96.010
MW2	Mike	Wickiser	97	11.7375	29.267	96.022	48.38383	158.7396	12	29.261	96.000
ETM2	Tom	McBrayer	30	0.7325	29.268	96.022			0.7365	29.264	96.009
RE1	Rodolfo	Eichler	30	0.732	29.268	96.024			0.738	29.262	96.004
LL1	Laurent	Lacroix	30	0.732	29.268	96.024	48.378	158.7205	0.737	29.263	96.007
PO1	Paul	Oerth	30	0.732	29.268	96.024	48.385	158.7434	0.737	29.263	96.007
MW1	Alan	Jones	97	11.6875	29.269	96.026			11.75	29.267	96.021
RT1	Bob	Thurston	30	0.731	29.269	96.027	48.387	158.75	0.735	29.265	96.014
SH1	Scott	Hubbard	97	11.6625	29.269	96.028			11.9375	29.262	96.005
RS1	Ron	Scardera	97	0.97	29.270	96.030			0.983	29.266	96.017
PR4	Pete	Riegel	30	0.73	29.270	96.030			0.734	29.266	96.017
DC1	Don	Connolly	97	11.625	29.270	96.031			11.8125	29.266	96.016
DS1	Don	Shepan	97	11.625	29.270	96.031			11.875	29.264	96.010

For WN1: 1 link = 7.92 inches
100 links = 66 feet

Notes:
1) Testing was done in a vehicle maintenance building, on a concrete floor.
2) Tension was maintained by two weighted sandbags, 11 pounds each. Mike would pull the tape until the sandbag rose from the floor, establish his mark, and Pete would then read the tape
3) The order of testing was random, as tapes were removed from the storage box. The 50 meter tapes were checked last.
4) Temperature during testing was stable at 71F
5) Date of testing was November 3, 2001, from 11:00 to 14:00

Pr3 was calibrated by Stanley (1996). 30 meters indicated = 30.00987 meters.
HW1 was calibrated by the US Bureau of Standards (1954). 100 indicated feet = 100.001 feet.

Corrected length by PR3, by Stanley calibration = 96.0175 feet
Corrected length by HW1, by USBS calibration, at 10 lbf at 68F = 96.0160 feet
PR1 is a very thin ribbon of steel, coated in a lot of plastic. It is marked "50N" but the manufacturer says to use 4.5 pounds
RT1 has 50 N on the tape itself, but Bob Thurston reports that the literature recommended 70 N.

outline indicates original data readings

Code	Length	Marked Tension	Reel	Type	Zero at	Smallest Division	Thickness, in includes coating	Width, in
PR3	30 m		Cased	Painted Steel	Inset 10 cm	1 mm	0.006	0.375
PR1	103 ft	50N	Open	Plastic coated steel	Inset 0.7 ft	0.01 ft	0.02	0.405
WN1	150 links		Open	Unpainted steel	end	1/10 link	0.0168	0.312
JFD1	50 m	50N 20C	Open	Painted Steel	end	1 mm	0.0075	0.5
PR2	30 m		Open	Unpainted steel	Inset 15 cm	1 mm	0.019	0.25
PR6	100 ft		Cased	Painted Steel	end	0.01 ft	0.01	0.375
HW1	100 ft		Open	Unpainted steel	Inset	0.01 ft	0.0223	0.305
PH2	100 ft		Cased	Painted Steel	end	1/8 in	0.0098	0.375
BL1	100 ft		Cased	Unpainted steel	end	1/8 in	0.0075	0.375
JD1	50 m		Open	Plastic coated steel	end	1 mm	0.021	0.53
ETM1	100 ft		Cased	Painted Steel	end	1/8 in	0.007	0.375
BC1	30m/100 ft	50N	Cased	Painted Steel	end	1mm, 1/8 in	0.0063	0.375
PR5	30m/100 ft		Cased	Painted Steel	Inset 10 cm	1 mm	0.01	0.375
PH1	100 Ft.		Cased	Painted Steel	end	1/8 in	0.0068	0.375
WN2	200 ft.	2kgf	Open	Plastic coated steel	loop	1/10 in	0.0218	0.41
PxR1	50m/164 ft	50N	Open	Unpainted steel	end	1mm, 1/8 in	0.0132	0.255
HD1	100 ft		Cased	Painted Steel	end	1/8 in	0.0064	0.375
HD2	100 ft		Cased	Painted Steel	end	1/8 in	0.0064	0.375
KU1	100 ft		Cased	Painted Steel	end	1/8 in	0.0192	0.375
MW3	100 Ft.		Cased	Painted Steel	end	1/8 in	0.0095	0.375
MW4	100Ft.		Cased	Unpainted steel	end	1/8 in	0.0083	0.375
MW5	100Ft.		Cased	Unpainted steel	end	1/8 in	0.0091	0.0375
MW2	165 foot	20C 5kgf	Open	Plastic coated steel	end	1/8 in	0.0205	0.409
ETM2	30m/100 ft		Cased	Painted Steel	end	1/8 in	0.01	0.375
RE1	30 m	50N	Cased	Painted Steel	Inset	1 mm	0.0076	0.375
LL1	50m/164 ft	50N	Cased	Painted Steel	end	1mm, 1/8 in	0.0065	0.375
PO1	50m/164 ft	50N	Cased	Painted Steel	end	1mm, 1/8 in	0.0097	0.375
MW1	30m	50N	Cased	Painted Steel	end	1mm, 1/8 in	0.0089	0.375
RT1	60 m	50N	Open	Plastic coated steel	inset 30 cm	1 mm	0.0178	0.25
SH1	100 ft		Cased	Painted Steel	end	1/8 in	0.0072	0.375
RS1	100 ft	15 lbf	Open	Plastic coated steel	inset 30 cm	0.01 ft	0.0185	0.26
PR4	30m/100 ft	50N 20C	Cased	Painted Steel	end	5mm, 1/8 in	0.0055	0.375
DC1	100 ft	50N	Open	Plastic coated steel	end	1/8 in	0.018	0.4
DS1	100 ft		Cased	Painted Steel	end	1/8 in	0.0066	0.375

Code	Made in	Markings on Blade	Markings on Reel
PR3	Brazil	Stanley - II - Made in Brazil	Stanley - 34390 - Ind Brasileira - Made in Brasil
PR1	Japan	100 FT - 50N - Leitz - Eslon	Leitz-Eslon Nylon Coated Steel Tape - 100 ft - 10ths - 8652-44 Japan
WN1	USA		Chicago
JFD1	France	50 m - C25 - Stanley - F87/05.311 - France - 50N 20C	50m/mm - Stanley - master acielak - 34-415 - Made in France
PR2	USA	Metre - The Lufkin Rule Co. - Made in USA - Patented	Lufkin - Made in USA - Hardened - 30M
PR6	USA	Tenth ft. - Made in USA	Lufkin 100' - White Tape - HW 226
HW1	USA	K&E Invincible NBS 1954 NBS No 10448	Champion Keuffel & Esser Co Made in USA
PH2	USA	Inch - Lufkin - Made in USA - P.R. App'd - 254 Tc	HYT 100 - 100' - Lufkin USA
BL1	USA		Universal Lufkin Rule Co. Steel Tape 100 Ft.
JD1	England	C - Rabone Chesterman - Made in England	Rabone Chesterman - 760/0-50m - Made in England
ETM1	USA	Eighths	Sears/Craftsman 9/39003 - 100 ft. Heavy Duty Long Tape
BC1	USA	30m Lufkin 20C 50N Made in USA Inch P.R. App'd 254 Tc	Benchmark 30m/100' 1049W788
PR5	USA	Lufkin - Made in USA - P.R. App'd - 254 Tc	Lufkin - 30m/100 ft - White Tape - W 226 ME
PH1	USA	Inch - Lufkin - Made in USA - P.R. App'd - 254 Tc	Lufkin USA 100'
WN2	Japan	20C 2kgf Keson Nylon Clad N845	200 Foot Nylon-Clad Keson Made in Japan
PxR1	USA	20C 50N Made 9n USA P.R.App'd for 254 Tc	Lufkin
HD1	USA	Lufkin P.R. App'd 254Tc	Lufkin USA 100'
HD2	USA	Lufkin P.R. App'd 254Tc	Lufkin USA 100'
KU1	USA	Feet/inch Stanley Life Guard Mylar Protected P.R. App'd No. 339 T.C 16 inch centers	100' Stanley Steelmaster Long Tape 34-400 Made in USA
MW3	USA	Lufkin Made in USA PR APPD 254Tc	Lufkin 100 foot
MW4	USA	Made in USA	Lufkin NI-Clad, steel tape, Lufkin Rule Co, Saginaw Mich, USA
MW5	USA	Made in USA	Lufkin NI-Clad, steel tape, Lufkin Rule Co, Saginaw Mich, USA
MW2	Japan	20C 5kgf Keson Nylon Clad 165 ft. PAT no. 603092N150	165 FOOT Perma Clad Nylon - Coated Steel KESON Japan
ETM2	USA	30m(inch) - Lufkin - Made in USA - P.R. App'd - 254 Tc	Lufkin 30m 100 ft Yellow Clad HW226ME
RE1	Brazil	Lufkin-Brasil 20C 50N	Lufkin 30m YSL30CM
LL1	USA	50m Inch Lufkin 20C 50N Made in USA	HYT50CME 164'/50m Lufkin USA
PO1	USA	Lufkin 20C. 50N. Made in USA	Lufkin 50m 164 ft Yellow Clad HW227CME
MW1	USA	Stanley Life Guard P.R. Appd. No 229TC 20C 50N	30m - 100 ft, Stanley, Steelmaster, 34-230, 62-230
RT1	England	Rabone Chesterman Made in England 50N 20C	Rabone Chesterman 60 m Made in England Leitz Rabone Chesterman Made in England
SH1	USA	Feet/Inch - Mylar protected - made in USA - P.R. App'd No. 339 T.C - 16 inch Centers	100' - Stanley - Hi-Visibility Long Tape - 34-096 - Made in USA
RS1	England	Decimal Foot 68F 15lbf Stanley Made in England'	Rabone Chesterman 100 ft Made in England
PR4	USA	in - cm - 30m - Stanley - P.R.App'd No.339TC - 20C 50N	30m/100 ft - Stanley - 34-393 - US Pats 3,908,277
DC1	Japan	100 ft - 50N - Sokkia - Eslon	Sokkia/Eslon Nylon Coated Steel Tape 100 ft-in 8651-44 Japan
DS1	USA	Inch - =16" Stud Centers - P. R. App'd 262 T.C. - Inch - Made in USA	Sears Craftsman9/39002 - 100 ft x 3/8 in - Made in USA