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NIST Instrumented Charpy Analysis Software (NICAS) – User's Manual

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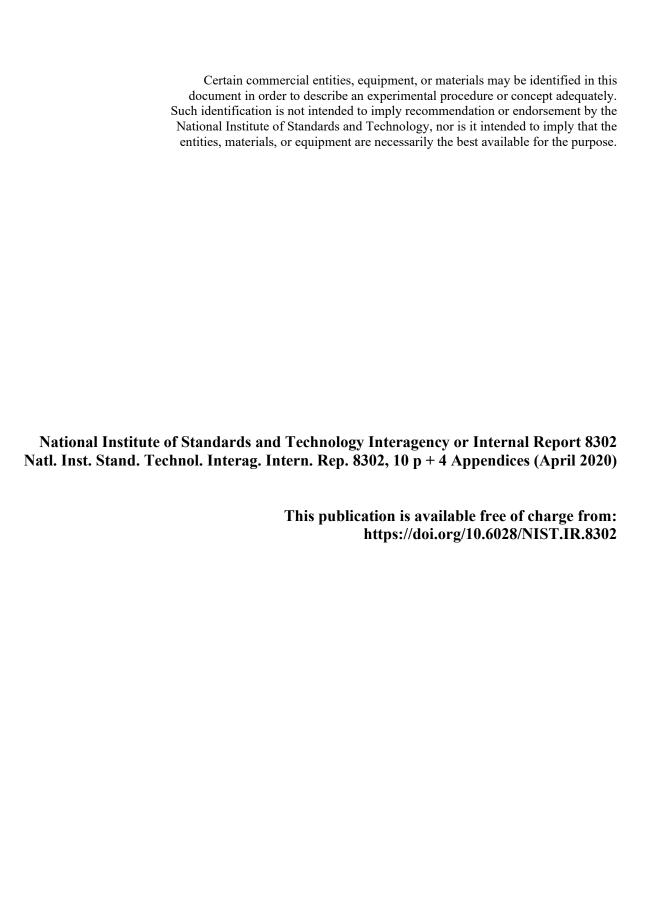
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U.S. Department of Commerce Wilbur L. Ross, Jr., Secretary



Abstract

The NIST Instrumented Charpy Analysis Software (NICAS) is a standalone LabVIEW¹ program that can be used to analyze instrumented impact tests in accordance with the following international test standards: ASTM E2298-18 [1] and ISO 14556:2015 [2]. It is also possible to perform some operations manually, *i.e.*, not in strict accordance with the above cited standards. The software is provided free of charge in both raw LabVIEW code and executable (*.EXE) formats with an installer for PC platforms running Windows 7 or later.

Key words

Analysis software; ASTM E2298; instrumented Charpy test; ISO 14556; LabVIEW code; user's manual.

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Glossary

- A Striker calibration coefficient for the linear term (kN/V)
- B Striker calibration coefficient for the quadratic term (kN/V^2)
- C_{el} Experimental elastic compliance (mm/kN)
- CF Correction Factor
- DFA Dynamic Force Adjustment
- $F_{\rm a}$ Crack arrest force (kN)
- $F_{\rm gy}$ Force at general yield (kN)
- F_{iu} Force at unstable crack propagation (kN) [NOTE: this is called F_{bf} in ASTM E2298]
- $F_{\rm m}$ Maximum force (kN)
- $F_{\rm t}$ Force at test end (kN)
- KV Dial energy (J)
- s_a Displacement at crack arrest (mm)
- SFA Shear Fracture Appearance (%)
- $s_{\rm gy}$ Displacement at general yield (mm)
- s_{iu} Force at unstable crack propagation (mm) [NOTE: this is called s_{bf} in ASTM E2298]
- $s_{\rm m}$ Displacement at maximum force (mm)
- s_t Displacement at test end (mm)
- W_a Energy at crack arrest (J)
- $W_{\rm gy}$ Energy at general yield (J)
- W_{iu} Energy at unstable crack propagation (J) [NOTE: this is called W_{bf} in ASTM E2298]
- $W_{\rm m}$ Energy at maximum force (J)
- $W_{\rm t}$ Total instrumented energy (J)

1. Introduction

The Charpy impact test has been used worldwide since the late 1800s/early 1900s [3,4] for characterizing the notch toughness of metals, and thereby their suitability for applications ranging from ship hulls and railroad tracks to nuclear reactor pressure vessels. A standard Charpy test consists of a swinging mass (pendulum) dropping from a known height and striking a notched specimen located in its path. As the specimen fractures, the difference between the height to which the pendulum rises and its original height provides a measurement of the energy absorbed in breaking the specimen. The Charpy verification program at the National Institute of Standards and Technology (NIST) supplies thousands of customers worldwide with verification steel specimens that have been certified on the three NIST reference Charpy machines. This program achieves the tightest consistency of any population of Charpy machines in the world [5]. A schematic drawing of a Charpy machine, which identifies its different parts and shows a specimen being impacted, is provided in Fig 1.

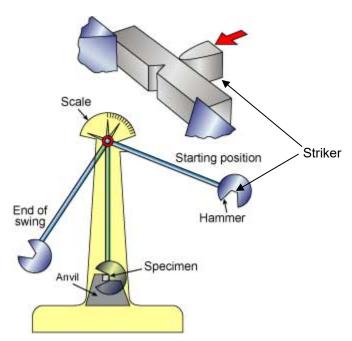


Figure 1 - Schematic drawing of a Charpy machine and a Charpy specimen being tested (image reproduced and modified from https://www.twi-global.com/technical-knowledge/faqs/faq-what-is-charpy-testing).

In the instrumented version of the Charpy test, strain gauges attached to the striker⁴ transform it into a force transducer that provides a measurement of the force applied to the specimen during impact (Fig. 2). The force-time record derived from an instrumented Charpy striker provides additional information about the tested material's properties in comparison to a standard (*i.e.*, non-instrumented) impact test, such as dynamic tensile properties [6], estimated shear fracture appearance [7], and alternative definitions of the material's ductile-to-brittle transition temperature [8].

⁴ In a Charpy machine, the striker is the part of the swinging hammer that impacts the specimen and, in the instrumented version of the test, is equipped with strain gauges to measure the deformation during the impact.

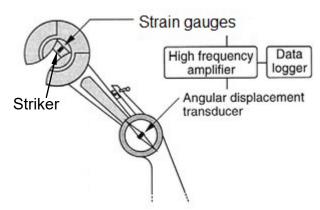


Figure 2 - Schematic of an instrumented Charpy test (image reproduced and modified from https://images.app.goo.gl/z57xgdHtNsZWSgfq6).

This document provides the user's manual for a software package (NICAS) that can be used to analyze instrumented Charpy tests on metallic materials in accordance with the most commonly used international standards [1,2].

2. Installation

The NICAS software package is provided as a compressed .zip file and must be extracted before installation. Inside the extracted file folder, there are several sub-folders, which contain software components, code and executables. If the computer running the software already has LabVIEW 2016 or a later version installed, or has a run-time engine for LabVIEW 2016 installed, then the executables should run and the remainder of this installation section can be skipped. If the computer does not have LabVIEW 2016 or its associated run-time engine, then the "Setup.exe" program found in the "Installer" folder should be run. Please note that this installation process may prompt you to restart your computer.

Once the installer for the LabVIEW run-time engine has completed, the executable file (CHARPY DATA ANALYZER 3.2.exe) should be usable. An explanation of its operation is provided in subsequent sections of this manual. In addition to the executable files, project files that contain fully commented LabVIEW source code and EXE build specifications for this software package can be found in the "Source Code" folder.

3. Operation of the NICAS software

The NICAS program (version 3.2) uses raw data files from instrumented Charpy tests in ASCII format. The input data files must contain only values of strain-gage output (in V or mV) in non-converted form, *i.e.*, before any transformation into force values. Time values should not be included, as they are automatically calculated based on the sampling rate. A set of sample data files, which can be used to test the functionality of the NICAS software, can be found in the "Sample Data Files" folder.

The following sub-sections will describe the steps required to analyze a test data set and obtain output in different forms.

3.1. Identification of the input and output folders

Upon launching the software, the user first needs to identify the folders where input and output files are located (can be the same folder). This is accomplished by either clicking the folder icons on the right side of the controls called "Data File Folder path" (input files) and "Analysis Folder path" (output files), or typing the folder address(es) directly inside the controls (red arrows in Fig. 3).

Note that the default value of "Specimen ID" in the leftmost window (green arrow in Fig. 3) is the file name (without extension), but it can be freely edited by the user if required.

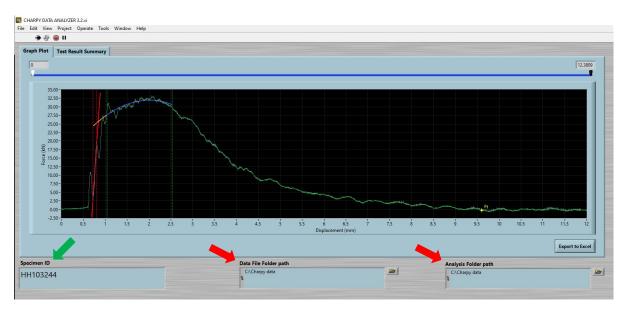


Figure 3 - Identification of input and output data folders, and specimen ID (if required).

3.2. Test file selection and definition of desired test range and test parameters

An input data file can be uploaded by clicking the button "Load New Test" in the lower right part of the screen and selecting the appropriate file.

As soon as the file is loaded, the window for the definition of the test range and test parameters opens (Fig. 4).

3.2.1. Test range selection

The portion of the test that will be visualized in the following steps of the analysis can be established in two ways:

- a) In the upper force vs. time plot, by dragging the red (start) and blue (end) vertical lines (red arrows in Fig. 4);
- b) In the lower right portion of the "Cursors" control (yellow arrow in Fig. 4), by clicking the green arrows to move (one data point at a time) the cursors corresponding to the beginning and end of the test. Specific values of time and force can also be manually entered under the column heading "X".

NOTE: It is recommended to select the desired test range in two steps. First, drag the vertical lines as close as possible to the desired locations (step a above). Then, fine tune the cursors by means of the arrows (step b). This procedure is particularly suitable for defining the start point of the test range.

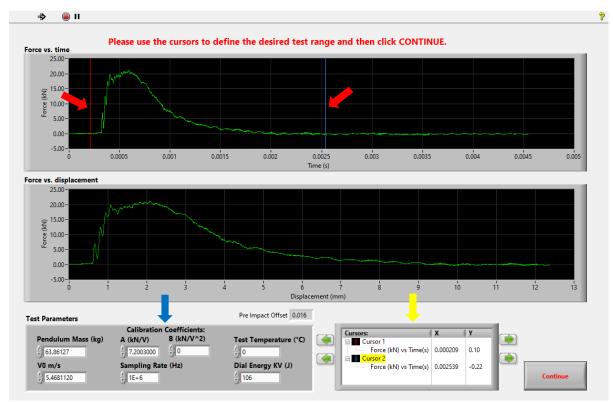


Figure 4 - Definition of desired test range and test parameters.

3.2.2. Test parameters

Test parameters are manually entered in the lower left region (blue arrow in Fig. 4). For every parameter, the required units (e.g. kg, °C, J, etc.) are indicated.

The coefficients required to convert strain-gage output into force are generally obtained from a static calibration of the striker [1,2]. The calibration (conversion) curve must have the following general form:

$$Y = AX + BX^2 (1)$$

where X is strain gage output in V, Y is force in kN, and A, B are calibration (conversion) coefficients. Note that if the calibration curve is just a straight line, B = 0.

The default values in the fields are the values used in the previous analysis. This avoids the need to re-type parameters that generally don't change from one test to the next, such as pendulum mass, calibration coefficients, initial velocity, or sampling rate⁵.

To proceed, click "Continue". Throughout the analysis, the test parameters will be shown in the lower left corner of the screen.

⁵ The sampling rate, in Hz, corresponding to the inverse of the time interval, in seconds, between two consecutive data points in the input file

3.3. Selection of the type of force/displacement curve

Before any analysis can be performed, the user must select the type of force/displacement curve, which corresponds to the mechanical behavior of the specimen (brittle, transitional, ductile). This is accomplished by first clicking the "Please click here to choose the type of force/displacement curve" box below the curve (red arrow in Fig. 5), and then clicking on the desired type of curve (green arrow in Fig. 5). The current type selected is highlighted with a blue rectangle.



Figure 5 - Selection of the type of force-displacement curve.

In NICAS, we adopted the ISO 14556 classification, which distinguishes six types of curves (A through F). By contrast, ASTM E2298 only specifies three types of curves: A (corresponding to ISO type A), B (ISO type E), and C (ISO type F).

Selecting one of the curves A to F automatically identifies the corresponding characteristic force, displacement, and energy values, dependent on the type of curve:

- Type A (fully brittle): F_m , s_m , and W_m ; F_t .
- Type B: F_m , s_m , and W_m ; F_a , s_a , and W_a ; F_t .
- Type C: F_{gy} , s_{gy} , and W_{gy} ; F_{m} , s_{m} , and W_{m} ; F_{t} . By definition, $F_{iu}^{6} = F_{m}$ and $F_{a} = 0$.
- Type D: F_{gy} , s_{gy} , and W_{gy} ; F_{m} , s_{m} , and W_{m} ; F_{a} , s_{a} , and W_{a} ; F_{t} . By definition, $F_{iu} = F_{m}$.
- Type E: F_{gy} , s_{gy} , and W_{gy} ; F_{m} , s_{m} , and W_{m} ; F_{iu} , s_{iu} , and W_{iu} ; F_{a} , s_{a} , and W_{a} ; F_{t} .

⁶ F_{Iu} is the ISO 14556 denomination of the force at the initiation of unstable fracture. The same parameter is identified as F_{bf} in ASTM E2298.

• Type F (fully ductile): F_{gy} , s_{gy} , and W_{gy} ; F_{m} , s_{m} , and W_{m} ; F_{t} .

A fully manual analysis option (not strictly compliant with either ASTM E2298 or ISO 14556) is also available by clicking on the last available option in the curve selection box (circled in green in Fig. 5). When this option is selected, the user can select the characteristic values by simply dragging the points along the curve. As points are moved, their characteristic values (force, displacement, energy) are updated in the results panel at the bottom of the screen.

With any curve type except A, the user can change the automatic analysis results in different ways (Fig. 6):

- the location of the general yield force can be changed by dragging/moving the two red dotted vertical lines that define the limits of the linear fit of the initial portion of the curve (red arrows in Fig. 6);
- the regression range for maximum force can be changed by dragging/moving the two green dotted vertical lines that define the limits of the parabolic fit (green arrows in Fig. 6);
- the locations of F_{iu} and F_a can be changed by simply dragging the corresponding points along the curve.

Before performing any analysis, the user can zoom on a part of the curve by dragging the sliders above the curve or entering numerical values for the limits of the X-axis just above the sliders, see the blue circles in Fig. 6.

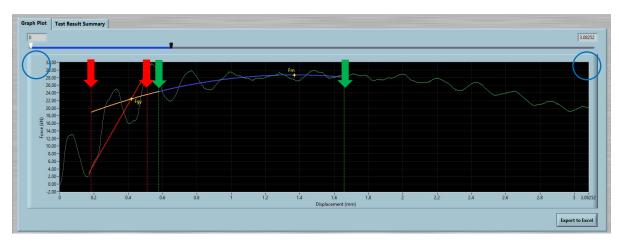


Figure 6 - Selection of fitting limits for $F_{\rm gy}$ and $F_{\rm m}$, and options for zooming in.

3.3.1. Definition of F_t (test end)

ASTM E2298 and ISO 14556 provide different definitions of the point corresponding to F_t , s_t , and W_t .

The F_t definition to be used can be selected using the "Ft definition" control (red rectangle in Fig.7). There are four options provided:

- "ASTM E2298" s_t is defined as "the displacement at which the force has decreased to the pre-test baseline value," *i.e.*, $F_t = 0$.
- "ISO 14566" s_t is defined as "the abscissa value of the fitted curve through the oscillations corresponding to $F = 0.02 F_m$," i.e., $F_t = 0.02 F_m$.

- "Manual" The position of F_t can be adjusted by dragging the point along the curve.
- "Max energy" When this option is selected, F_t corresponds to the largest value of absorbed energy, calculated by integrating force and displacement data.

Each of these four options yields a slightly different value of instrumented impact energy, W_t .



Figure 7 - Results panel.

3.3.2. Other parameters and calculations

3.3.2.1. Elastic compliance

The slope of the linear fit of the initial portion of the curve (solid red line in Fig. 6) corresponds to the experimental elastic compliance $C_{\rm el}^{7}$, in mm/kN. See green rectangle in Fig. 7.

3.3.2.2. Estimate of Shear Fracture Appearance

Characteristic forces from an instrumented impact test can be used to obtain an estimate of Shear Fracture Appearance, SFA est (%) [7]. Both ASTM E2298 and ISO 14456 include the same four empirical correlations between SFA and characteristic instrumented forces. Based on our experience, we used the third correlation for NICAS (Eq. (6) in ASTM E2298 and Eq. (C.3) in ISO 14556):

SFA est (%) =
$$1 - \frac{F_{iu} - F_a}{F_m + 0.5(F_m - F_{av})} \times 100 \%$$
 (2)

The estimated value of SFA, "SFA est", is reported in the top row of the results panel (blue rectangle in Fig. 7).

Note that, by definition, SFA = 0 % if the curve is of Type A, and SFA = 100 % if the curve is of Type F.

⁷ The inverse of compliance is the experimental stiffness, in kN/mm.

3.3.2.3. Dynamic Force Adjustment

The comparison between dial energy, KV, and total instrumented energy, W_t , is a good indicator of the quality of the instrumentation, and the calibration of the instrumented striker in particular.

ISO 14556 states that if differences between KV and W_t exceed ± 5 J, the user should investigate machine friction, calibration of the measuring system, and software used. ASTM E2298, on the other hand, is more prescriptive:

- a) If the difference is less than the larger of 15 % or 1 J, no adjustment is needed.
- b) If the difference is between 15 % and 25 % or 1 J and 2 J, whichever is larger, force values shall be adjusted until $W_t = KV$.
- c) If the difference exceeds the larger of 25 % or 2 J, the test shall be discarded and the instrumented striker re-calibrated.

The NICAS software allows the user to perform step b) above, which has been labelled "Dynamic Force Adjustment" (DFA) [9], by clicking the button "Adjust Force" on the top row of the results panel (yellow rectangle in Fig. 7). The value of the resulting correction factor (CF) for the forces is provided next to the button. Note that the user can click "Adjust Force" multiple times, thus performing successive iterations, until the values of KV and W_t effectively coincide.

3.3.2.4. Optional comments

The user can add comments inside the "Comments" control to the right of the results panel (purple rectangle in Fig. 7).

3.4. Software output

The NICAS software provides multiple types of output, as detailed below.

3.4.1. Test Results Summary

After analyzing a test in accordance with section 3.3, results can be added to the "**Test Results Summary**" tab (Fig. 8) by clicking "**Add Results to Summary**" on the lower right side of the screen. Test results are added in the rightmost column of the window. The window can be visualized by clicking the tab "**Test Results Summary**" at the top of the screen.

The last added column of results can be removed by clicking "Remove last results" below the window on the right (red arrow in Fig. 8).

An existing summary file created during a previous analysis can be loaded by clicking "Load Summary Report" below the window on the left (green arrow in Fig. 8). Any additional analysis can be added on as the rightmost column.

Once analyses are completed for a series of tests, the Summary Report can be saved as an ASCII (text) file by clicking "Save Summary Report" on the lower right side of the screen.

⁸ Note that, when adjusting force values, displacement values are also recalculated.

The default filename is "MM_DD_YYYY_Summary.txt". An example of Summary Report is provided in Appendix 1.

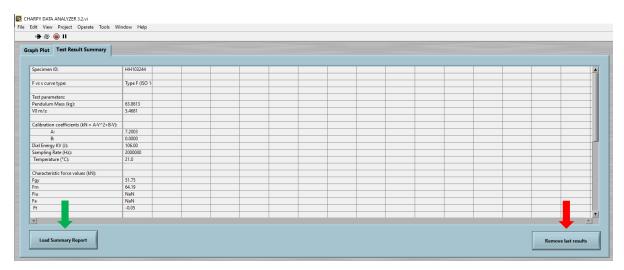


Figure 8 - "Test Results Summary" tab.

3.4.2. Individual test results

The results for an individual test can be saved in an ASCII file by clicking "Save Single Test Results" on the lower right side of the screen. The default filename is "Specimen ID Out.txt". An example of individual test result file is provided in Appendix 2.

3.4.3. Individual test data for plotting

Complete data for an individual test can be saved in an ASCII file by clicking "Save Single Test Plots" on the lower right side of the screen. The file contains, as headers, the specimen ID and the test parameters (Sec. 3.2.2), followed by values of force, velocity, energy, displacement, and time organized in columns. These data can easily be imported for plotting with a spreadsheet-based program, such as Microsoft Excel. The default filename is "Specimen ID Plots.txt". An example of a single test data file is provided in Appendix 3.

3.4.4. Exporting data to Excel

By clicking "**Export to Excel**" just below the force-displacement plot in the "Graph Plot" main tab (red arrow in Fig. 9), the NICAS software will automatically create a temporary Microsoft Excel file containing complete displacement and force data, organized in columns, for the different curves and regressions: raw curve, quadratic fit, extended quadratic fit, and linear fit of the initial part of the curve. These data points allow the user to reproduce in Excel the test diagram exactly as visualized in the "Graph Plot" window, including the regression curves (Fig. 9). If the user has zoomed on a part of the curve (as described at the end of section 3.3.2.2), only the currently visible data is exported.

As mentioned above, the file is temporary (*.tmp), and must be saved as *.xls or *.xlsx if the user wants to keep it.

⁹ With reference to Fig. 6: the raw curve is in green, the quadratic fit is in blue, the extended quadratic fit corresponds to the orange + blue curves, and the linear fit is the red solid line.

An example of a temporary Excel file is provided in Appendix 4.



Figure 9 – "Graph Plot" window.

3.5. Exiting the program

Clicking "Exit" in the lower right corner closes the program.

4. Dissemination

The NICAS software package will be made available free of charge through a link on the NIST Charpy Machine Verification Program web page (https://www.nist.gov/programs-projects/charpy-machine-verification-program).

The LabVIEW code will also be made available through the development platform GitHub (https://github.com/), which is a collaborative hosting repository for software development control providing bug tracking, feature requests, task management, and wikis for every project. It is currently the largest host of source code in the world [10].

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Appendix 1 Example of Summary Report

Specimen ID:	30-1	35-1	64-1
F vs s curve type:	Type F	Type F	Type E
Test parameters: Pendulum Mass (kg):	63.8613	63.8613	63.8613
V0 m/s:	5.4681	5.4681	5.4681
Calibration coefficie	ents (kN = $A^{\dagger}V^2+B^{\dagger}V$):		
A:	31.1159	31.1159	31.1159
B:	0	0	0
Dial Energy KV (J):	230	311	224
Sampling Rate (Hz):	2000000	2000000	2000000
Temperature (-C):	21	21	21
Characteristic force			
Fgy	18.86	16.07	18.75
Fm	22.46	21.45	22.48
Fiu	NaN	NaN	15.77
Fa	NaN	NaN	14.05
Ft	-0.01	-0.03	-0.04
Characteristic displa	cement values (mm):		
sgy	0.65	0.28	0.32
sm	3.54	4.38	3.30
siu	NaN	NaN	7.53
sa	NaN	NaN	7.57
st	37.96	32.20	61.89
Characteristic energy			
Mah	4.17	2.03	2.57
Wm	65.48	82.70	64.00
Wiu	NaN	NaN	149.72
Wa	NaN	NaN	150.28
Wt	227.42	306.31	221.70
Elastic compliance (m			
Cel	0.01270	0.00661	0.00790

Appendix 2 Example of Individual Test Result File

```
Specimen ID:
                                          30 - 4
  F vs s curve type:
                                       Type E
    Test parameters:
                                      63.8613
 Pendulum Mass (kg):
             V0 m/s:
                                       5.4681
Calibration coefficients (kN = A \cdot V^2+B \cdot V):
                                      31.1159
                   A:
                   B:
                                             0
 Dial Energy KV (J):
                                           228
 Sampling Rate (Hz):
                                      2000000
   Temperature (°C):
                                           -40
Characteristic force values (kN):
                  Fgy
                                        18.74
                                        23.33
                   Fm
                  Fiu
                                        19.81
                   Fa
                                        17.00
                   Ft
                                        -0.01
Characteristic displacement values (mm):
                  sgy
                                          0.29
                                          3.38
                   sm
                                          6.30
                  siu
                                          6.36
                   sa
                                        37.97
                   st
Characteristic energy values (J):
                  Wgy
                                         2.16
                   Wm
                                        69.53
                  Wiu
                                       133.65
                                       134.61
                   Wa
                   Wt
                                       227.54
Elastic compliance (mm/kN):
                  Cel
                                      0.00625
```

Appendix 3

Example of Individual Test Data File (first part)

Specimen ID: HH103244 Pendulum Mass (kg): 63.8613 V0 m/s: 5.4681 Calibration coefficients (kN = $A \cdot V^2 + B \cdot V$): A = 7.2003 B= 0.0000

Dial Energy KV (J): 106.0000 Sampling Rate (Hz); 2000000.0000 Temperature (°C): 21.0000 Comments:

Comme	ent	S	
	F	(k)	ľ

F(KN)					
0.62577 5.46811 0.00000 0.00000 0.00000 3.41021 5.46807 0.00458 0.00547 0.00000 6.37190 5.46804 0.01296 0.00820 0.00000 10.95111 5.46797 0.02634 0.01094 0.00000 13.26287 5.46787 0.05002 0.01367 0.00000 16.03254 5.46776 0.08312 0.01640 0.00000 20.95887 5.46762 0.12316 0.01914 0.00000 21.35771 5.46730 0.22436 0.02461 0.00000 21.43896 5.46714 0.28220 0.02734 0.00000 21.79347 5.46680 0.39978 0.03281 0.00001 19.82884 5.46680 0.39978 0.03281 0.00001 16.52000 5.46636 0.56458 0.04101 0.00001 13.18162 5.46661 0.65256 0.04647 0.00001 15.78105 5.46596 0.73365 0.05467 0.00001	F(kN)	V(m/s)	W(J)	s(mm)	T(s)
2.72332 5.46810 0.00000 0.00273 0.00000 3.41021 5.46804 0.01296 0.00820 0.00000 10.95111 5.46797 0.02634 0.01094 0.00000 13.26287 5.46776 0.08312 0.01640 0.00000 16.03254 5.46762 0.12316 0.01914 0.00000 18.52155 5.46762 0.12316 0.01914 0.00000 20.95887 5.46747 0.17039 0.02187 0.00000 21.35771 5.46730 0.22436 0.02461 0.00000 21.43896 5.46714 0.28220 0.02734 0.00000 21.79347 5.46697 0.34069 0.03007 0.00001 20.48617 5.46697 0.34069 0.03007 0.00001 21.98284 5.46664 0.45757 0.03827 0.00001 18.15966 5.46639 0.51267 0.03827 0.00001 18.25200 5.46659 0.55266 0.0447 0.00001			0.00000	0.00000	0.00000
3.41021 5.46807 0.00458 0.00547 0.00000 6.37190 5.46804 0.01296 0.00820 0.00000 10.95111 5.46797 0.02634 0.01094 0.00000 13.26287 5.46776 0.08312 0.01640 0.00000 18.52155 5.46762 0.12316 0.01914 0.00000 20.95887 5.46747 0.17039 0.02187 0.00000 21.35771 5.46730 0.22436 0.02461 0.00000 21.43896 5.46714 0.28220 0.02734 0.00000 21.79347 5.46697 0.34069 0.03007 0.00001 19.82884 5.46664 0.45757 0.03281 0.00001 19.82884 5.46664 0.45757 0.03827 0.00001 13.18162 5.46636 0.56458 0.04101 0.0001 13.18162 5.466615 0.65256 0.04647 0.00001 7.1048 5.46661 0.71158 0.05467 0.0001 <t< td=""><td></td><td></td><td></td><td></td><td></td></t<>					
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30.84108 5.46089 2.43755 0.12297 0.00002 30.93710 5.46064 2.52184 0.12570 0.00002 29.97696 5.46041 2.60618 0.12843 0.00002 30.67120 5.46017 2.68934 0.13116 0.00002 32.25178 5.45992 2.77212 0.13389 0.00002 34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003	32.89434	5.46138	2.25954	0.11751	0.00002
30.937105.460642.521840.125700.0000229.976965.460412.606180.128430.0000230.671205.460172.689340.131160.0000232.251785.459922.772120.133890.0000234.068695.459662.858020.136620.0000236.328745.459392.948540.139350.0000338.839945.459093.044620.142080.0000341.993675.458783.147210.144810.00003	30.90018	5.46113	2.35045	0.12024	0.00002
29.97696 5.46041 2.60618 0.12843 0.00002 30.67120 5.46017 2.68934 0.13116 0.00002 32.25178 5.45992 2.77212 0.13389 0.00002 34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003	30.84108	5.46089	2.43755	0.12297	0.00002
29.97696 5.46041 2.60618 0.12843 0.00002 30.67120 5.46017 2.68934 0.13116 0.00002 32.25178 5.45992 2.77212 0.13389 0.00002 34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003	30.93710	5.46064	2.52184	0.12570	0.00002
30.67120 5.46017 2.68934 0.13116 0.00002 32.25178 5.45992 2.77212 0.13389 0.00002 34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003					
32.25178 5.45992 2.77212 0.13389 0.00002 34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003					
34.06869 5.45966 2.85802 0.13662 0.00002 36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003					
36.32874 5.45939 2.94854 0.13935 0.00003 38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003					
38.83994 5.45909 3.04462 0.14208 0.00003 41.99367 5.45878 3.14721 0.14481 0.00003					
41.99367 5.45878 3.14721 0.14481 0.00003					
43.72190					
	43./2195	3.43844	3.43/33	0.14/54	0.00003

Appendix 4

Example of Temporary Excel File (first part)

Force (7	۷	80	U	_			,	
0.00546 0.05 1.04091 27.7 0.777204 0.436 9.436 0.00596 0.05 1.05406 1.05401 27.79 0.72720 0.72720 24.43 0.010996 0.07 1.05401 27.79 0.7385 0.7485 24.43 0.010996 0.02 1.0561 27.79 0.7385 0.7485 24.43 0.010747 0.12 1.0764 27.29 0.7485 24.53 24.53 0.022747 0.12 1.0764 27.29 0.7485 24.53 24.53 0.022747 0.12 1.0764 27.29 0.7485 24.53 24.53 0.022747 0.12 1.0764 27.29 0.7485 24.53 24.53 0.02374 0.12 1.0764 27.24 0.7485 24.43 24.43 0.024501 0.12 1.0764 27.24 0.7485 24.43 24.43 0.024502 0.12 1.0764 27.24 0.7485 24.43 24.43	1 Displacem	ent (mm) - Raw Data	Force (kN) - Raw Data	Displacement (mm) - Quadratic Fit	Force (kN) - Quadratic Fi	t Displacement (mm) - Extended Quadratic Fit	Force (kN) - Extended Quadratic Fit	: Displacement (mm) - Linear Fit Fi	rce (kN) - Linear Fit
0.0010956 0.004 1.005464 27.77 0.77274 24.42 0.0010956 0.01 1.00651 72.79 0.73815 24.53 0.021872 0.01 1.00551 27.99 0.73815 24.53 0.021872 0.1 1.00754 27.99 0.74815 24.53 0.021872 0.1 1.00754 27.29 0.74825 24.53 0.021872 0.1 1.00754 27.29 0.74825 24.53 0.021872 0.1 1.00754 27.29 0.74825 24.53 0.021872 0.1 1.00754 22.21 0.75695 24.53 0.021872 0.1 1.00774 22.21 0.75695 24.53 0.022872 0.1 1.10827 28.21 0.75695 24.53 0.022872 0.1 1.10827 28.21 0.77839 24.53 0.022872 0.1 1.10827 28.21 0.77839 24.53 0.022872 0.1 1.1144 2	2)		1.04921			24.3		-2.2
0.010-056 0.07 1,000-01 27.79 0,738-18 24-48 0.015-64 0.12 1,005-01 1,000-01 0.73 24-55 24-55 0.0275-47 0.12 1,007-00 27-39 0.74-66 24-75 0.0275-41 0.13 1,004-00 27-39 0.74-66 24-75 0.0275-41 0.14 1,007-10 27-39 0.74-66 24-75 0.0475-12 0.12 1,007-10 28-75 0.78-65 24-75 0.045-12 0.12 1,007-10 28-10 0.77-69-10 24-75 0.045-12 0.12 1,007-10 28-10 0.77-69-10 24-75 0.045-12 0.12 1,107-10 28-21 0.77-69-10 24-75 0.045-12 0.14 1,107-10 28-21 0.77-69-10 24-75 0.045-12 0.14 1,114-11 28-21 0.77-69-10 24-75 0.045-12 0.14 1,144-11 28-47 0.77-69-10 24-75 0.047-14	8	0.005468		1.05466			24.4		-1.16
0.018604 0.12 1,075 7,284 0.73813 34.55 0.020387 0.03 1,107 7.29 0.7480 24.67 0.027741 0.13 1,10683 2.29 0.73803 24.67 0.02777 0.12 1,10682 2.81 0.73893 24.73 0.02827 0.12 1,10827 2.81 0.75859 24.73 0.02821 0.12 1,10827 2.81 0.77824 2.45 0.02821 0.12 1,10827 2.81 0.77824 2.45 0.02841 0.12 1,10827 2.81 0.77824 2.48 0.02841 0.13 1,11936 2.82 0.77824 2.48 0.02841 0.13 1,11936 2.83 0.77824 2.54 0.03874 0.13 1,1184 2.84 0.77824 2.54 0.04274 0.13 1,1447 2.84 0.77824 2.54 0.07884 0.13 1,1447 2.84 0.78824<	4	0.010936		1.06011			24.4		-0.13
0.007347 0.10 107044 27.58 0.0456 3467 0.007348 0.13 1.07644 27.58 0.7545 24.67 0.007349 0.14 1.0818 27.58 0.7545 24.67 0.049349 0.14 1.0872 28.20 0.7545 24.67 0.049349 0.12 1.07277 28.07 0.7545 24.82 0.049349 0.12 1.07827 28.12 0.7545 24.82 0.049481 0.14 1.10482 28.21 0.7545 24.82 0.045481 0.14 1.11444 28.22 0.75836 25.44 0.045481 0.14 1.1144 28.24 0.75836 25.44 0.045481 0.14 1.1444 28.24 0.75834 25.14 0.045481 0.14 1.1444 28.24 0.75834 25.44 0.045482 0.14 1.1448 28.24 0.75834 25.44 0.045482 0.14 1.1448 28.44	5	0.016404		1.06555			24.5		0.0
6.002209 0.18 1,078 7,29 0,74653 24.75 6.002204 0.14 1,08734 27.93 0,74553 24.73 6.002204 0.13 1,08734 28.07 0,75565 24.28 6.002204 0.12 1,09277 28.12 0,75566 24.58 6.002204 0.12 1,10267 28.12 0,77569 24.58 6.002204 0.13 1,1056 28.25 0,77571 24.58 6.002204 0.13 1,1184 28.25 0,77571 24.58 6.007005 0.13 1,1184 28.25 0,77571 24.58 6.007005 0.13 1,1184 28.24 0,77571 24.58 6.007006 0.13 1,1184 28.24 0,77571 25.24 6.007007 0.13 1,1147 28.24 0,77571 25.24 6.007007 0.14 1,1474 28.24 0,77571 25.24 6.018 0.15 1,1474 28.24 <td>9</td> <td>0.021872</td> <td></td> <td>1.071</td> <td></td> <td></td> <td>24.6</td> <td></td> <td>1.94</td>	9	0.021872		1.071			24.6		1.94
0.082500 0.1 1,000 125 7,58 0,7553 24.5 0.0 0.08270 0.12 1,000 125 28.0 0,75550 24.8 0.0 0.084314 0.12 1,000 12 28.1 0,77550 2.4 2.4 0.054921 0.07 1,100 1 28.1 0,77550 2.4 0.0 0.054921 0.07 1,100 1 28.1 0,77550 2.4 0.0 0.054921 0.12 1,11056 28.2 0,77520 2.5 0 0.056920 0.13 1,11056 28.3 0,78771 2.5 0 0.056920 0.13 1,11056 28.3 0,78771 2.5 0 0.056920 0.14 1,11056 28.3 0,88771 2.5 0 0.056920 0.14 1,11056 28.3 0,88772 2.5 0 0.14270 0.15 1,11056 28.4 0,88772 2.5 0 0.14270 0.15	7	0.027341		1.07644			24.6		2.97
0.048377 0.14 1.09773 28.03 0.75895 24.8 0 0.048218 0.12 1.09773 28.07 0.778915 24.8 0.48 0.045461 0.12 1.09822 28.12 0.778915 24.9 24.9 0.045461 0.14 1.10041 28.12 0.778915 25.04 24.9 0.054661 0.14 1.11041 28.12 0.77831 25.04 25.04 0.054661 0.13 1.11096 28.25 0.77831 25.15 0 0.054661 0.13 1.11596 28.25 0.77831 25.16 0 0.05461 0.13 1.11596 28.24 0.77831 25.16 0 0.05476 0.14 1.11596 28.24 0.77831 25.24 0 0.05476 0.15 1.11586 28.47 0.27824 25.24 0 0.05874 0.15 1.11478 28.47 0.283479 25.24 0 0.15472 <td>00</td> <td>0.032805</td> <td></td> <td>1.08189</td> <td></td> <td></td> <td>24.7.</td> <td></td> <td>4</td>	00	0.032805		1.08189			24.7.		4
0.04545 0.12 109277 28.17 0.70546 24.86 0.05464 0.046213 0.046213 0.046213 0.07 1.0054 28.17 0.70549 24.98 0.04 0.046213 0.04 1.1094 28.18 0.77639 25.48 0.05 0.04 </td <td>6</td> <td>0.03827,</td> <td></td> <td>1.08733</td> <td></td> <td></td> <td>24.</td> <td></td> <td>5.04</td>	6	0.03827,		1.08733			24.		5.04
0.0564681 0.12 1.106922 28.12 0.7779515 24.92 0.42 0.0564681 0.07 1.1064 28.21 0.778359 24.92 0.04 0.056149 0.14 1.1064 28.21 0.778317 25.44 0.0 0.056179 0.12 1.11454 28.24 0.778317 25.16 0.0 0.056279 0.13 1.11542 28.34 0.778241 25.24 0.0 0.057201 0.13 1.11542 28.34 0.797241 25.24 0.0 0.058201 0.13 1.11542 28.34 0.797241 25.24 0.0 0.058320 0.14 1.14174 28.31 0.797241 25.54 0.0 0.058320 0.15 1.14174 28.51 0.52056 25.44 0.0 0.15 1.14174 28.54 0.52056 25.54 0.0 25.44 0.0 0.14583 0.15 1.14174 28.54 0.52056 25.54 0.0	10	0.043745		1.09277			24.8		6.07
0.054681 0.07 1,10066 28.1 0,776381 24.48 0.005619 0.14 1,1094 28.2 0,781381 24.58 0.005617 0.12 1,1149 28.2 0,797281 25.14 0.007653 0.13 1,1149 28.3 0,792381 25.24 0.007653 0.13 1,1149 28.3 0,792381 25.23 0.007653 0.13 1,1149 28.3 0,792381 25.23 0.007653 0.14 1,11478 28.3 0,792381 25.24 0.007654 0.15 1,14718 28.4 0,792381 25.24 0.10894 0.15 1,14718 28.5 0,82004 25.23 0.10894 0.15 1,14718 28.5 0,82004 25.24 0.10894 0.15 1,14718 28.5 0,82004 25.23 0.10894 0.15 1,14718 28.6 0,82104 25.2 0.10894 0.15 1,14718 28.6	11	0.049213		1.09822			24.9.		7.1
0,000149 0,14 1,11091 28.21 0,781833 25,04 0,000657 0,12 1,11092 28.23 0,787317 25,12 0,000653 0,13 1,11396 28.24 0,787341 25,23 0,000653 0,13 1,11368 28.24 0,787241 25,21 0,000654 0,13 1,11369 28.24 0,89047 25,23 0,000675 0,13 1,11369 28.24 0,89047 25,24 0,000676 0,14 1,1366 28.24 0,89047 25,24 0,000677 0,15 1,1478 28.24 0,89047 25,24 0,103824 0,15 1,1478 28.25 0,89048 25,24 0,103824 0,15 1,1478 28.24 0,89049 25,24 0,103824 0,15 1,1478 28.26 0,89049 25,24 0,103824 0,15 1,1743 28.24 0,89049 25,24 0,14177 0,15 1,1743 <t< td=""><td>12</td><td>0.054681</td><td></td><td>1.10366</td><td></td><td></td><td>24.9</td><td></td><td>8.14</td></t<>	12	0.054681		1.10366			24.9		8.14
0.0056617 0.12 1.11494 28.24 0.797311 25.1 0.0076038 0.13 1.115946 28.34 0.797314 25.28 0.0076039 0.13 1.12442 28.34 0.797314 25.28 0.007639 0.13 1.13466 28.34 0.809177 25.28 0.007639 0.14 1.1366 28.47 0.80917 25.28 0.007639 0.14 1.1456 28.47 0.80917 25.24 0.007639 0.15 1.1456 28.47 0.80917 25.24 0.10844 0.15 1.1456 28.47 0.80917 25.4 0.10859 0.15 1.1456 28.47 0.8146 25.2 0.10841 0.15 1.1586 28.64 0.83459 25.2 0.10842 0.15 1.1487 28.47 0.84491 25.2 0.10842 0.15 1.1489 28.46 0.84491 25.4 0.1417 0.14 1.1489 28.47 <td>13</td> <td>0.060145</td> <td></td> <td>1.1091</td> <td></td> <td></td> <td>25.0</td> <td></td> <td>9.17</td>	13	0.060145		1.1091			25.0		9.17
0,077,0165 0,11 1119542 28,29 0,792,781 25,16 0,080,021 0,13 1,13424 28,34 0,792,781 25,23 0,080,021 0,13 1,1343 28,43 0,789,244 25,24 0,080,021 0,13 1,1343 28,43 0,893,77 25,34 0,095,056 0,14 1,147,18 28,47 0,84452 25,44 0,095,056 0,15 1,147,18 28,54 0,833,77 25,44 0,010884 0,15 1,147,18 28,54 0,835,556 25,52 0,010886 0,15 1,1458 28,64 25,54 25,64 0,014277 0,15 1,1487 28,64 25,54 25,64 0,13276 0,15 1,1487 28,8 0,834791 25,54 0,14277 0,16 1,1447 28,8 0,834791 25,64 0,14377 0,15 1,1447 28,8 0,834791 25,8 0,14377 0,15 1,1447	14	0.065617		1.11454			25		10.2
0.07653 0.11 11254 28.34 0.798244 55.2 0.082021 0.15 11286 28.38 0.79824 52.3 0.082024 0.15 1.1366 28.43 0.80917 52.4 0.09258 0.14 1.1417 28.47 0.80917 52.4 0.09258 0.15 1.1417 28.47 0.80917 5.24 0.10384 0.15 1.1471 28.51 0.80947 5.54 0.10384 0.15 1.1472 28.51 0.82556 5.54 0.10384 0.15 1.1580 2.8 0.82439 5.54 0.10384 0.15 1.1580 2.8 0.8144 5.5 0.12576 0.15 1.1784 2.8 0.8144 5.5 0.12576 0.15 1.1784 2.8 0.81444 5.5 0.12570 0.15 1.1784 2.8 0.84440 5.5 0.14271 0.15 1.1472 2.8 0.84440 2	15	0.071085		1.11998			25.1		11.24
0.082024 0.13 0.833 0.680707 5.28 0.0020265 0.13 1.11374 2.84.3 0.6814622 5.24 0.0020266 0.14 1.11374 2.84.7 0.6814622 5.24 0.0020268 0.14 1.11374 2.84.7 0.681662 5.24 0.103802 0.15 1.14718 2.84.5 0.623064 5.24 0.103802 0.15 1.1576 2.84.5 0.830479 5.54 0.103802 0.15 1.1473 2.84.6 0.834479 5.54 0.143702 0.15 1.1474 2.87.6 0.834479 5.54 0.143702 0.15 1.1474 2.87.6 0.84149 5.54 0.143702 0.15 1.1474 2.87.6 0.83449 5.54 0.14371 0.14 1.1474 2.87.6 0.84149 5.54 0.14371 0.14 1.1474 2.87.6 0.84149 5.54 0.14371 0.14 1.1474 2.87.6	16	0.076553		1.12542			25.2.		12.27
0.08749 0.13 28.43 0.60917 25.34 0.08256 0.14 1.14174 28.47 0.820094 25.54 0.098476 0.15 1.14174 28.51 0.820094 25.52 0.10884 0.15 1.14572 28.51 0.820094 25.52 0.10885 0.15 1.1586 28.6 0.82556 25.52 0.10887 0.15 1.1586 28.6 0.836479 25.52 0.10887 0.15 1.1689 28.6 0.836479 25.53 0.10897 0.15 1.1689 28.6 0.836479 25.53 0.1576 0.15 1.1747 28.4 0.84194 25.7 0.1576 0.15 1.18524 28.8 0.88231 25.7 0.1427 0.15 1.1908 28.8 0.88231 25.9 0.1557 0.15 1.1561 28.8 0.88231 25.9 0.1557 0.15 1.2068 2.25 0.874701 25	17	0.082023		1.13086			25.2		13.3
0.092936 0.14 114174 28.47 0.614632 25.4 0.00842 0.16 1.14718 28.51 0.820094 25.46 0.00842 0.16 1.15262 28.55 0.825566 25.56 0.10984 0.16 1.1580 28.5 0.831018 25.54 0.10483 0.15 1.1583 28.6 0.831018 25.64 0.10484 0.16 1.1437 28.7 0.834740 25.64 0.12706 0.16 1.17437 28.7 0.834740 25.7 0.12707 0.12708 0.16 1.17437 28.7 0.834740 25.7 0.12706 0.1270 0.12 1.17437 28.8 0.852861 25.8 0.12706 0.12 1.17437 28.8 0.852861 25.8 0.12707 0.12 1.19062 28.8 0.88341 25.8 0.12708 0.13 1.12043 28.9 0.88041 25.9 0.14701 0.16	18	0.08745		1.1363			25.3		14.34
0.058426 0.16 114738 28.51 0.820094 25.46 0.103862 0.15 1.15262 28.64 0.831018 25.52 0.103862 0.15 1.15806 28.64 0.831018 25.54 0.11483 2.86 0.83474 25.64 25.64 0.11483 2.86 0.835479 25.64 0.12029 0.15 1.1789 28.68 0.83471 25.64 0.12029 0.15 1.1784 28.76 0.85381 25.71 0.13024 0.16 1.1798 28.76 0.85381 25.81 0.14703 0.18 28.8 0.85321 25.81 25.81 0.14703 0.15 1.15641 28.8 0.865241 25.81 25.81 0.14703 0.15 1.15611 28.8 28.8 0.865241 25.64 25.94 0.14573 0.18 1.21781 2.94 0.891078 25.14 25.14 0.144703 0.14 0.14	19	0.092958		1.14174			25.4		15.37
0.103894 0.15 115262 28.5 0.82555 25.52 0.103862 0.16 1.15806 28.6 0.831018 25.58 0.10362 0.15 1.15806 28.6 0.831018 25.58 0.10276 0.15 1.15833 28.68 0.84194 25.74 0.10276 0.15 1.1788 28.78 0.84194 25.73 0.13724 0.16 1.1784 28.75 28.68 0.84194 25.75 0.13524 0.15 1.1788 28.75 28.75 25.73 25.81 0.1427 0.15 1.13068 28.84 0.68531 25.81 25.81 0.1427 0.14 1.1461 28.8 0.68934 25.93 25.93 0.1427 0.14 1.1461 28.8 0.68934 25.93 25.93 0.1427 0.14 0.12 1.2124 28.8 0.68934 25.93 0.1452 0.14 0.12 1.2124 29.0 0.881	20	0.098426					25.4		16.4
0.109362 0.115806 28.6 0.831018 25.58 0.104383 0.15 1.1635 28.64 0.834479 25.64 0.10438 0.15 1.1635 28.64 0.834479 25.54 0.12768 0.15 1.17437 28.72 0.837401 25.54 0.12766 0.16 1.17437 28.72 0.837401 25.51 0.13770 0.16 1.13624 28.76 0.88731 25.81 0.14277 0.16 1.13624 28.84 0.885321 25.51 0.14370 0.16 1.13624 28.84 0.885321 25.53 0.155074 0.13 1.13641 28.84 0.885321 25.93 0.156074 0.13 1.13641 28.94 0.8854701 25.61 0.156074 0.13 1.12441 29.94 0.885619 26.12 0.156074 0.12 1.12441 29.14 0.981619 26.12 0.15604 0.15 1.12441 29.12	21	0.103894		1.15262			25.5;		17.43
0.11483 0.11633 28.64 0.836479 25.64 0.120298 0.15 1.16893 28.68 0.64134 25.7 0.120298 0.15 1.1789 28.68 0.64134 25.75 0.131234 0.16 1.1798 28.76 0.682340 25.87 0.131234 0.16 1.18524 28.76 0.682342 25.87 0.131234 0.16 1.18524 28.84 0.682342 25.87 0.136702 0.15 1.1961 28.84 0.863742 25.87 0.143703 0.15 1.1961 28.84 0.863742 25.87 0.15874 0.13 1.2015 28.84 0.88241 25.87 0.15874 0.13 1.2015 28.95 0.88041 26.12 0.1691 0.14 1.2241 29.14 29.14 25.14 0.180447 0.12 1.2241 29.12 0.90745 26.37 0.180447 0.18 1.22424 29.16 0.9	22	0.10936		1.15806			25.5		18.47
0.12028 0.15 25.7 0.12576 0.1 1.1683 28.6 0.84140 25.7 0.12576 0.1 1.1743 28.7 0.88740 25.75 0.13573 0.1 1.1798 28.7 28.7 25.81 0.13670 0.1 1.1906 28.8 0.853782 25.87 0.1471 0.1 1.1906 28.8 0.863782 25.87 0.1471 0.1 1.1906 28.8 0.863782 25.8 0.1471 0.1 1.1906 28.8 0.863782 25.8 0.1457 0.1 1.1061 28.8 0.863782 25.8 0.1587 0.1 1.1061 28.8 0.863782 25.8 0.1587 0.1 1.1061 28.9 0.8810 25.8 0.1587 0.1 1.1278 29.0 0.8810 25.1 0.1865 0.1 1.2 2.1 2.1 2.1 0.1 0.1 0.1	23	0.1148		1.1635			25.6		19.5
0.12576 0.16 1.17437 28.72 0.847401 25.75 0.131234 0.16 1.1798 28.76 0.852381 25.81 0.131234 0.16 1.19624 28.8 28.8 28.83 25.93 0.14217 0.15 1.19618 28.88 0.863241 25.93 25.93 0.14217 0.15 1.19618 28.88 0.843241 25.98 25.98 0.15874 0.18 1.20155 28.92 0.863241 25.98 25.98 0.15874 0.13 1.2068 28.96 0.874701 26.04 26.04 0.15874 0.13 1.21281 28.96 0.88261 26.15 26.15 0.14047 0.13 1.21281 29.08 0.895636 26.21 26.15 0.18947 0.18 1.2228 29.08 0.901995 26.25 26.21 0.18948 0.18 2.21 29.12 0.901995 26.23 26.21 0.18948 0.18 <td>24</td> <td>0.120298</td> <td></td> <td>1.16893</td> <td></td> <td></td> <td>25.</td> <td></td> <td>20.53</td>	24	0.120298		1.16893			25.		20.53
0.131234 0.16 1.1798 28.76 0.682361 25.81 0.136702 0.15 1.18524 28.8 0.688321 25.87 0.146702 0.15 1.19068 28.84 0.683782 25.87 0.146703 0.15 1.19068 28.96 0.88378 25.98 0.154704 0.18 1.2015 28.96 0.88016 26.13 0.164042 0.15 1.21241 29.04 0.88056 26.15 0.164042 0.15 1.21242 29.04 0.88056 26.15 0.164043 0.15 1.21243 29.04 0.891078 26.15 0.169514 0.14979 0.15 1.22328 29.04 0.891078 26.21 0.18691 0.18691 0.18 29.04 0.901995 26.24 26.24 0.18691 0.18 0.12 1.2344 29.14 29.14 29.14 26.14 0.18681 0.18 0.18 0.18 0.91836 26.48	25	0.12576t					25.7.		21.57
0.136702 0.15 1.18524 28.8 0.683321 25.87 0.147618 0.14 1.10068 28.84 0.683782 25.93 0.147618 0.14 1.10068 28.84 0.683742 25.93 0.147619 0.14 28.82 0.89541 25.93 0.15874 0.18 1.2018 28.95 0.88040 26.14 0.164042 0.15 1.21241 29 0.885619 26.15 0.164042 0.14 1.21241 29 0.885619 26.15 0.164042 0.14 1.21241 29 0.885619 26.15 0.164042 0.14 1.22328 29.04 0.885619 26.15 0.16951 0.15 1.22328 29.04 0.896536 26.21 0.18041 0.18 1.23414 29.16 0.91955 26.24 0.18041 0.18 1.2344 29.16 0.91945 26.34 0.18041 0.18 1.24 29.24 29.24 <td>26</td> <td>0.131234</td> <td></td> <td></td> <td></td> <td></td> <td>25.8</td> <td></td> <td>22.6</td>	26	0.131234					25.8		22.6
0.14717 0.16 1.1906a 28.84 0.863782 25.93 0.14763 0.13 1.19611 28.88 0.869241 25.98 0.153106 0.13 1.20153 28.92 0.874701 25.04 0.153104 0.13 1.21241 29 0.885619 26.15 0.164042 0.13 1.21241 29 0.885619 26.15 0.164042 0.13 1.21241 29 0.885619 26.15 0.164042 0.13 1.21241 29.08 0.885619 26.15 0.174979 0.15 1.22328 29.08 0.896336 26.20 0.185915 0.1 1.2341 29.16 0.91955 26.26 0.185915 0.1 1.2341 29.16 0.91955 26.36 0.18681 0.1 1.2344 29.16 0.91955 26.31 0.105831 0.1 1.2444 29.1 0.91955 26.34 0.106831 0.1 1.2444 29.1	27	0.13670		1.18524			25.8.		23.63
0.147638 0.15 28.88 0.869241 25.98 0.183106 0.13 1.20155 28.96 0.84701 25.98 0.153106 0.13 1.20158 28.96 0.881078 26.14 0.164042 0.15 1.21241 29 0.885519 26.15 0.16951 0.15 1.212785 29.08 0.881078 26.15 0.180447 0.12 1.22871 29.12 0.901995 26.26 0.180448 0.1 1.22841 29.16 0.901995 26.32 0.180491 0.1 1.22444 29.16 0.901995 26.32 0.180491 0.1 1.22444 29.16 0.901995 26.32 0.18041 0.1 1.2444 29.16 0.901995 26.32 0.1918 0.1 1.2444 29.16 0.91919 26.43 0.1091 0.1 1.2444 29.1 0.91937 26.43 0.1091 0.1 1.2444 29.2 0.91938 <td>28</td> <td>0.1421;</td> <td></td> <td></td> <td></td> <td></td> <td>25.9</td> <td></td> <td>24.66</td>	28	0.1421;					25.9		24.66
0.158106 0.18 1.20155 28.92 0.874701 26.04 0.158574 0.13 1.20698 28.96 0.88016 26.14 0.158574 0.13 1.21241 28.96 28.91 26.12 0.164042 0.13 1.21241 29.04 0.885619 26.12 0.165511 0.15 1.22871 29.04 0.891078 26.22 0.185915 0.12 1.22871 29.16 0.90195 26.32 0.185915 0.15 1.23414 29.16 0.90195 26.43 0.19681 0.15 1.2347 29.2 0.91291 26.43 0.07316 0.16 0.91241 29.16 0.91836 26.43 0.07316 0.16 0.16 0.91836 26.43 26.48	29	0.147638		1.19611			25.9		25.7
0.158574 0.13 1.20698 28.96 0.88016 26.1 0.164042 0.15 1.21241 29 0.885619 26.15 0.164042 0.13 1.21785 29.04 0.885619 26.15 0.16551 0.15 1.22328 29.08 0.896536 26.25 0.174979 0.12 1.22871 29.16 0.90452 26.32 0.185915 0.2 1.23414 29.16 0.91291 26.37 0.196821 0.18 1.245 29.23 0.918367 26.48 0.7031 0.16681 0.18 26.48 26.48 26.48	30	0.153100		1.20155			26.0		26.73
0.164042 0.15 1.21241 29 0.885619 26.15 0.169511 0.13 1.21785 29.04 0.891078 26.21 0.14979 0.12 1.22328 29.08 0.896536 26.21 0.185915 0.12 1.22871 29.16 0.907452 26.37 0.185918 0.15 1.23414 29.16 0.907452 26.37 0.19681 0.15 1.245 29.2 0.918367 26.48 0.7031 0.16 1.245 29.23 0.918367 26.48	31	0.158574		1.20698			. 56		27.76
0.169511 0.13 1.21785 29.04 0.891078 26.21 0.114979 0.12 1.22328 29.08 0.86536 26.22 0.186947 0.12 1.22871 29.12 0.90535 26.22 0.186913 0.18691 0.91595 26.37 26.37 0.18681 0.15 1.2344 29.2 0.91291 26.37 0.19681 0.18 1.245 29.2 0.918367 26.48 0.0731 0.18 1.245 29.2 0.918367 26.48	32	0.164042		1.21241			26.1.		28.79
0.174979 0.15 1.22328 29.08 0.896536 26.26 C 0.18047 0.12 1.22871 29.12 0.901995 26.37 C 0.185915 0.2 1.2344 29.16 0.907452 26.37 C 0.185915 0.15 1.2347 29.2 0.91291 26.43 C 0.196821 0.18 1.245 29.2 0.913867 26.48 C 0.70743 0.73 0.913867 26.48 C C C	33	0.16951		1.21785			26.2		29.83
0.180447 0.012 1.22871 29.12 0.901995 26.32 C 0.185915 0.2 1.23444 29.16 0.907452 26.37 C 0.19831 0.15 1.23957 29.2 0.91291 26.43 C 0.19831 0.18 1.245 29.23 0.91291 26.48 C 0.73749 0.18 1.56A3 79.77 79.74 78.74 78.74	34	0.17497		1.22328			26.2		30.86
0.185915 0.2 1.23414 29.16 0.907452 26.37 0.191383 0.15 1.23957 29.2 0.91291 26.43 0 0.196851 0.18 1.245 29.23 0.918367 26.48 0 0.707374 0.16 1.55A43 79.77 0.938367 76.48 76.48	35	0.18044;		1.22871			26.3.		31.89
0.191383 0.15 1.23357 29.2 0.91291 26.43 0.196851 0.18 29.23 0.918367 26.48 0.707319 0.16 1.35043 39.27 0.918367 26.48	36	0.18591		1.23414			26.3		32.92
0.196851 0.18 1.245 29.23 0.918367 0.707319 0.16 1.25043 29.77 0.93824	37	0.19138		1.23957			26.4		33.95
0 302319 0 15 15 10 10 10 10 10 10 10 10 10 10 10 10 10	38	0.196851		1.245			26.4	82	
	30	0 202316		1 25043			26.5	7	