Containerboard Consulting Ltd.
100 Morgan Dr.
Jesup, GA 31545
912-427-4977

Final Technical Report for DOE Grant # DE-FG36-99G010408.
Linear Corrugating
May 23, 2000

Linear Corrugating is a process for the manufacture of corrugated containers in which the flutes of the corrugated medium are oriented in the Machine Direction (MD) of the several layers of paper used. Conversely, in the conventional corrugating process the flutes are oriented at right angles to the MD or in the Cross Machine Direction (CD).

Paper is stronger in MD than in CD. Therefore, boxes made using the Linear Corrugating process are significantly stronger in the prime strength criteria, Box Compression Test (BCT) than boxes made conventionally. This means that using Linear Corrugating boxes can be manufactured to BCT equaling conventional boxes but containing 30% less fiber.

The corrugated container industry is a large part of the U. S. economy, producing over 40 million tons annually. For such a large industry, the potential savings of Linear Corrugating are enormous.

The grant for this project covered three phases in the development of the Linear Corrugating process:

I. Production and evaluation of corrugated boxes on commercial equipment to verify that boxes so manufactured would have enhanced BCT as proposed in the application.
II. Production and evaluation of corrugated boxes made on laboratory equipment using combined board from I above but having dual manufactures joints (glue joints). This box manufacturing method (Dual Joint) is proposed to overcome box perimeter limitations of the Linear Corrugating process.
III. Design, Construction, Operation and Evaluation of an engineering prototype machine to form flutes in corrugating medium in the MD of the paper. This operation is the central requirement of the Linear Corrugating process.

Items I and II were successfully completed, showing predicted BCT increases from the Linear Corrugated boxes and significant strength improvement in the Dual Joint boxes. The Former was constructed and operated successfully using kraft linerboard as the forming medium. It was found that tensile strength and stretch characteristics of the corrugating medium were not sufficient to allow fluting this paper in the former. Possible causes and corrective actions to overcome this problem are addressed in the body of the report below.

Procedures

I. Linear Corrugated Boxes

Boxes were made from combined containerboard manufactured on a commercial conventional corrugator. The board was made using rolls of specially prepared paper (linerboard and corrugating medium). Paper Paper Cutters, Inc. of Greenville, S. C, prepared the rolls of paper.

The rolls were prepared by using a roll of 42# linerboard from Interstate Paper, Riceboro, GA and a roll of 26# corrugating medium from Mead Containerboard, Stevenson, AL. First, sufficient sample (approximately 3000 ft) of each was placed on the core of the prepared roll. Following this, sufficient linerboard and medium was sheeted, (800 & 400 sheets respectively). These sheets were rotated 90° and spliced into a continuous sheet, which was then added to the roll of conventional sample. This procedure produced two rolls of linerboard and one roll of corrugating medium, each containing paper oriented conventionally and paper rotated 90° all from the same parent paper rolls.

These rolls were used on a conventional commercial corrugator Mead Containers, Atlanta, GA to produce combined containerboard sheets. In some of the sheets the paper was oriented conventionally with the flutes at 90° to the MD of the paper and those sheets made from the rotated and spliced material the flutes were oriented in the MD of the three papers. This is as would be the case in Linear Corrugating, and all from the same parent paper.

The making of these rolls with over 1200 double taped splices using a special polyester tape was an extremely tedious and expensive project.

Copious amounts of waste were generated in the corrugating process due to the mismatching of splices and the short duration of the run on the corrugator. However, enough good conventional and linearly oriented sheets were produced to provide boxes for comparison of BCT and for the Dual Joint phase of the project. There were also enough for sample boxes and unconverted sheets for use as samples in promoting Linear Corrugating.

Boxes were manufactured by running the sample sheets through a commercial flexo-folder-gluer machine, which produced finished, printed boxes. The boxes were evaluated by the Institute of Paper Science and Technology in Atlanta, GA (IPST). Results of BCT evaluation are as follows:

	Conventional Corrugation	Linear Corrugation
BCT	451#	687#
Std. Dev.	35.6	40.1

% Increase = 49.0

Similar sized boxes were made from sample sheets of the combined board in the IPST laboratory by hand. They were also evaluated with the following results:

	Conventional Corrugated	Linear Corrugated
BCT	595#	821#
Std. Dev.	57.7	101.7

% Increase = 38.0

Variation of the testing was significantly higher in the hand made boxes.

II. Dual Joint Boxes

In Linear Corrugating one of the limiting factors is that the width of the corrugating machine is the perimeter limit of the finished box. If this limit cannot be surmounted the process would be limited in its application to only the smaller boxes, estimated at some 20% of all boxes. The Dual Joint phase of the project was done to evaluate the possibility of manufacturing boxes from two panels of Linearly Corrugated material using two manufacturers joints (glue joints). It was the intent of this study to show multiple glue joints has no adverse effect on the BCT of the box and is therefore, a way around the size limitation of the Linear Corrugating process.

Boxes were made with dual glue joints in the IPST laboratory from conventional combined board obtained as above. This phase of the project compares the Dual Joint effect only on conventional board. The boxes were tested for BCT with results as follows:

	Single Joint	Dual Joint
BCT	619#	782#

% Increase = 27.9

III. The primary issue addressed in this grant project is whether combined containerboard paper can be fluted in the Machine Direction on a scale approaching commercial. It having already been shown possible at bench scale (4" wide).

To answer this question a former of finished size of 24" and capable of speeds approaching commercial (250 fpm) was constructed (see photo page). The most significant difference between this machine and the bench model, other than size, is that the forming "V" shaped dies are machined from steel rather than being made of glazed ceramic material. This change proved to be significant but was necessary to complete the project within the budget limitations.

In operation it was found that corrugation medium, the paper traditionally used in combined containerboard, would not perform in the former. It is believed that the tensile and stretch characteristics of this material are not sufficient to allow it's being drawn through the former dies. In an effort to reduce the tension required the dies were coated with a low coefficient of friction metallic coating. This showed some improvement, but not enough. The medium still broke under the tension forces when being drawn through the dies. A steam shower box was secured to heat and lubricate the paper. This too did not help. It appeared than any lubrication effect of the heat and moisture of the steam was negated by the paper loosing strength because of the additional moisture. Several different medium papers were tried without satisfactory results.

Kraft linerboard, the paper traditionally used for the two outer layers of the combined board, of the same basis weight as the medium was used. Linerboard generally has greater tensile and stretch properties than medium and is somewhat water resistant, retaining these properties under moderate addition of moisture.

This material performed satisfactorily in the former. It was successfully fluted in the Machine Direction at a finished width of 23"and at speeds of up to 250 fpm. It appeared that using the low friction coated dies and the steam shower linerboard had more than adequate tensile and stretch properties and that the 250 fpm speed was not near the limit of the speed at which it could be fluted.

Conclusions

The stated purpose of the grant projects were as follows:

1. Verify that corrugated containers manufactured with the flutes oriented in the Machine Direction of the paper would have significantly higher BCT.
2. Show that the width limitation of the Linear Corrugating process could be surmounted by manufacturing boxes from more than one sheet of combined board and utilizing Dual Joints.
3. Show that paper used in containerboard could be fluted in the Machine Direction at widths and speeds approaching those of commercial scale by the Linear Corrugating process.

1. Linear Corrugated Boxes

The results from this phase of the project were better than anticipated. From the analysis reported above, BCT improvement in excess of 40% can be expected with boxes made by Linear Corrugating.

As anticipated in the grant application, this can translate into more than 30% reduction in the fiber content of the papers used to make boxes of equal strength using Linear Corrugating. This reduction would more than meet the stated goal of a 4,000,000 barrels of oil reduction annually if the process were applied to the estimated 20% of all boxes in the U. S, which could utilize this process.

2. Dual Joint Boxes

Results from this phase of the project show an increase in BCT when boxes were made from two separate panels of combined board, using two glue joints. Intuitively projecting these results, it is believed that multiple panels could be utilized to make the Linear Corrugating process applicable to 80% or more of all boxes. Though the necessary equipment would have to be designed and the added expense of another manufacturing step incorporated in the box making process the savings would much more than justify the cost. This concept greatly expands the utility and economic benefits of using the Linear Corrugating process in corrugated container manufacturing.

3. Former Construction and Operation

Mechanically the former met its design criteria. It is capable of drawing paper up to 34" wide through the fixed dies and producing fluted in the machine direction of the paper at speeds of up to 250 fpm. This results is a fluted sheet of up to 24" wide. This was accomplished using kraft linerboard as the paper rather than corrugated medium as was anticipated. It was determined through extensive trials that the medium paper did not have the tensile and stretch characteristics necessary to allow it to be drawn through the dies without rupturing. The linerboard paper of the same basis weight did so easily.

In the 4" bench scale model the medium paper fluted well. It is believed that the difference in that model and the larger pilot scale former is the surface smoothness and friction coefficient of the surface of the forming dies. The 4" dies were made of glazed ceramic material with the extremely low coefficient of friction of that material. The 24" dies of the former were machined from steel and although they were hand polished and given a low friction metallic coating their friction on the paper was much higher. The difference can be seen and felt. The expense of having 24" dies made of ceramic material precluded its use in this project.

Several things were learned in the operation of the former that will be used in the scaling it up for commercial demonstration.

Linerboard will be used as the fluting medium. There appears to be no reason why this cannot be done from a manufacturing or box integrity standpoint. Linerboard generally costs slightly more than medium but this can be offset by being able to use a lighter basis weight sheet because of it's greater strength.

Dies should be made of low friction ceramic material. If this is done it may be found that medium paper can again be used for the fluting. However, it may be found that linerboard remains the paper of choice for this application.

Optimum die geometry has not yet been determined. The budget for this project did not allow for a study of the die geometry. An angle for the dies was picked from limited experience on the bench model and one set of 24" steel dies was made. In addition to the angle of the dies, the shape of each flute, especially the leading edge, should be examined.

In a commercial demonstration it is anticipated that finite element analysis should be performed on these parameters in order to get optimum die design.

Better controls must be incorporated into the commercial scale design. This is particularly needed in the areas of tension control and in control of die raising and lowering. Also easier and quicker thread-up of the process is needed.

Overall the project is considered to be a success. The experience and results obtained will be useful and important in taking the process up to commercial scale. They also provide impressive experiences in securing industry support for further commercialization of Linear Corrugating.

Further Commercialization

The goal of Linear Corrugating has been to get the process into the corrugated containerboard industry. To that end, it is anticipated that an entity with the resources of a major paper/box manufacturer or an equipment manufacturer will be needed. The results from this project will be used to further present the process to those potential candidates in these groups. In addition to and parallel to this ongoing effort, it is anticipated that a grant application for a Commercial Demonstration project will be successfully pursued.

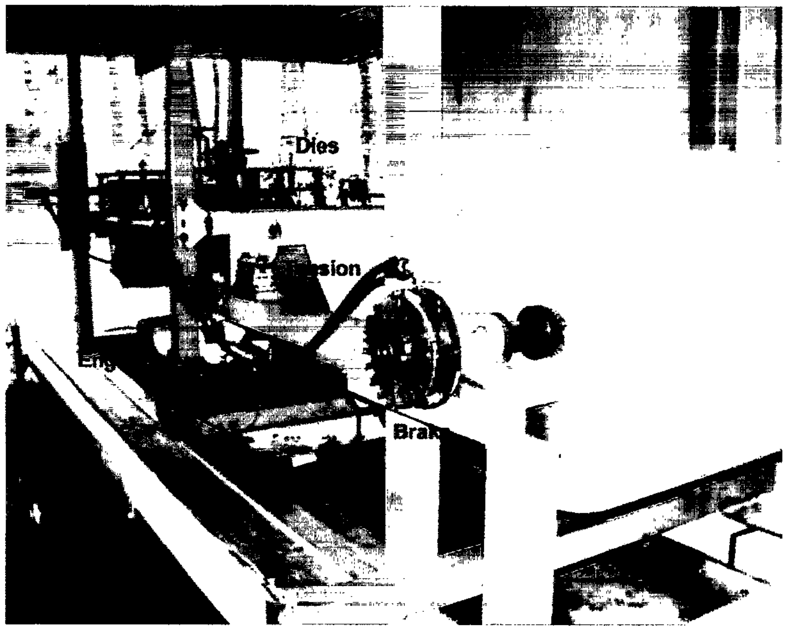
Results of this Commercial Demonstration will be a lightweight linear corrugator which will produce limited quantities of commercial combined containerboard. This combined board will be used to make boxes. Following adequate performance evaluation the boxes will be introduced into the market.

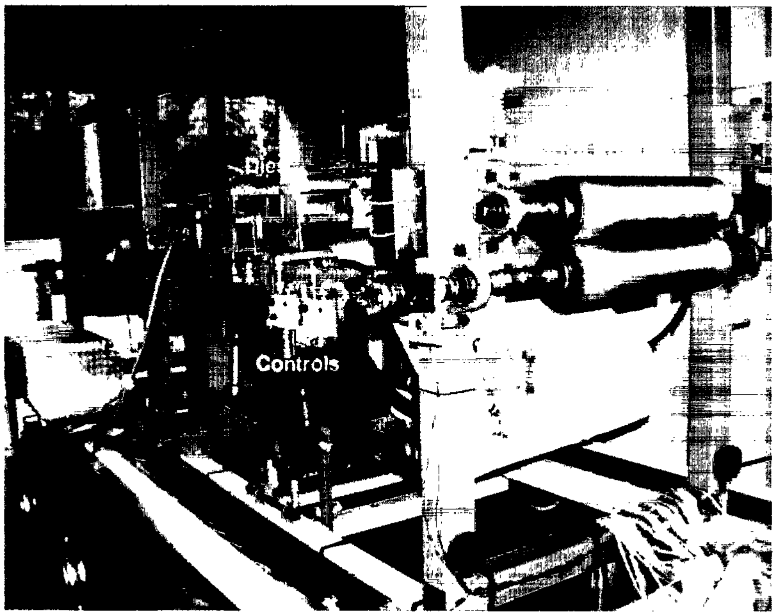
It is believed that once these boxes, with their 30% fiber savings, are in the market, Linear Corrugating will quickly be adopted by the industry.

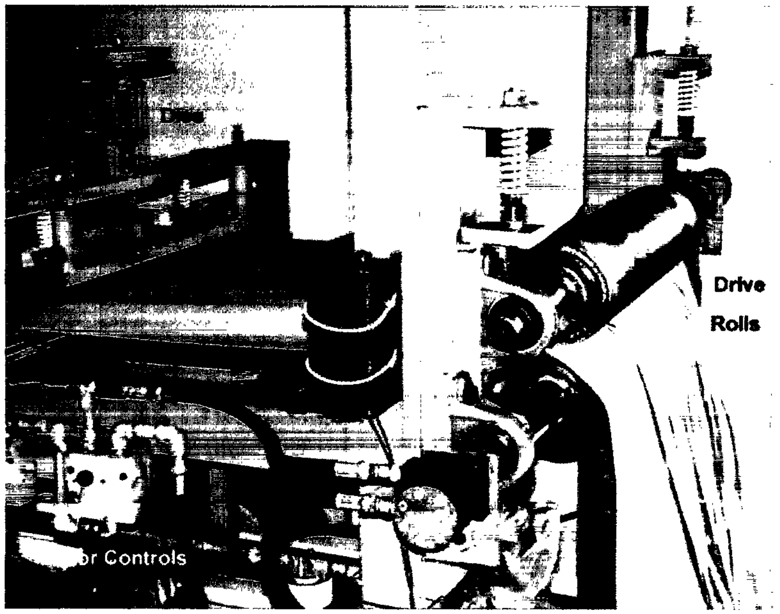
It is hereby gratefully acknowledged that without funding though the Department of Energy this project could not have been accomplished.

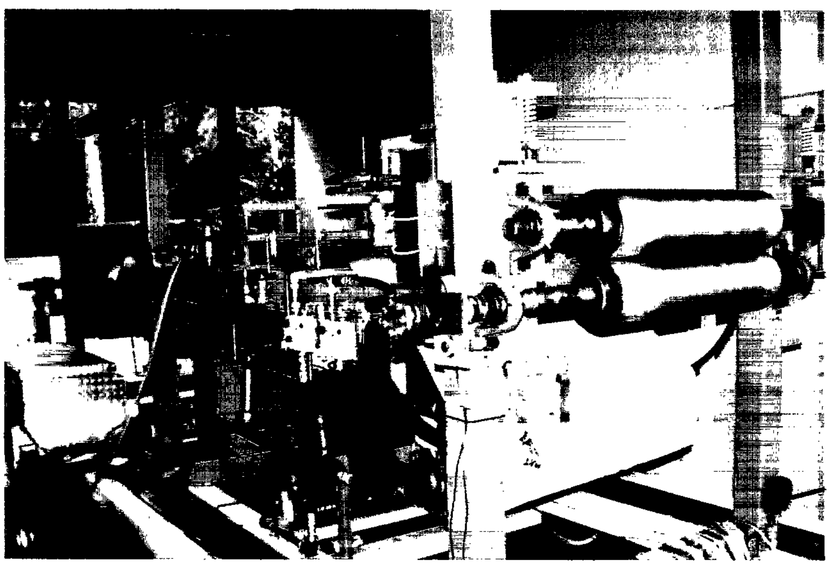
Lloyd Chapman

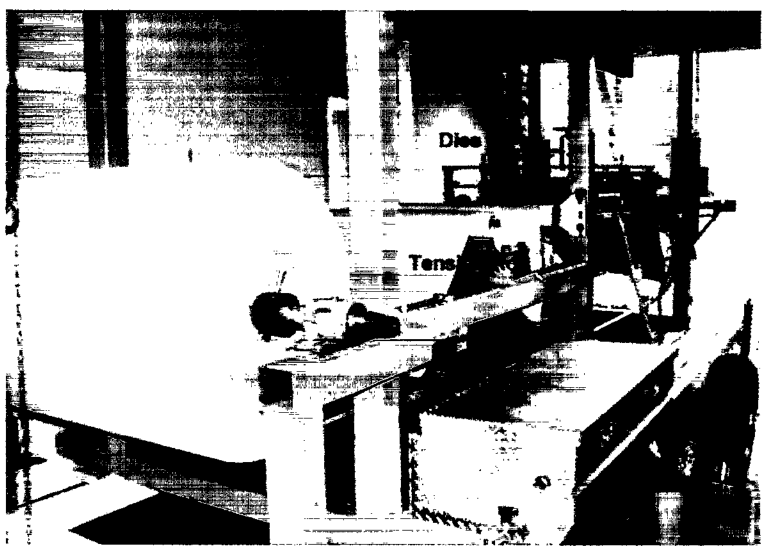
Former Photographs
DOE Grant # DE-FG36-99GO10408











October 27, 1999

Lloyd Chapman
Linear Corrugating
100 Morgan Drive
Jesup, GA 31545

Dear Lloyd:

Here are copies of the latest and final testing completed at IPST. These are the results of the top-to-bottom box compression tests for the blanks converted on the Flexo at Mead. Twenty repeats were tested in each of the linear and conventional cases. Earlier, I sent an e-mail addressing how these results compared to previous testing.

Hope all is going well. Please let me know how work on the pilot linear corrugator is proceeding.

Sincerely,

Michael

Michael Schaepe
Assoc. Scientist

pop =	20
$\bar{x}$:	451.05
min:	392.00
max:	506.00
r:	114.00
s:	35.58
-3s:	344.30
+3s:	557.80
-Tol:	0.00
+Tol:	2000.00
Cp:	9.37
Cpk:	4.23
cell size:	16.29

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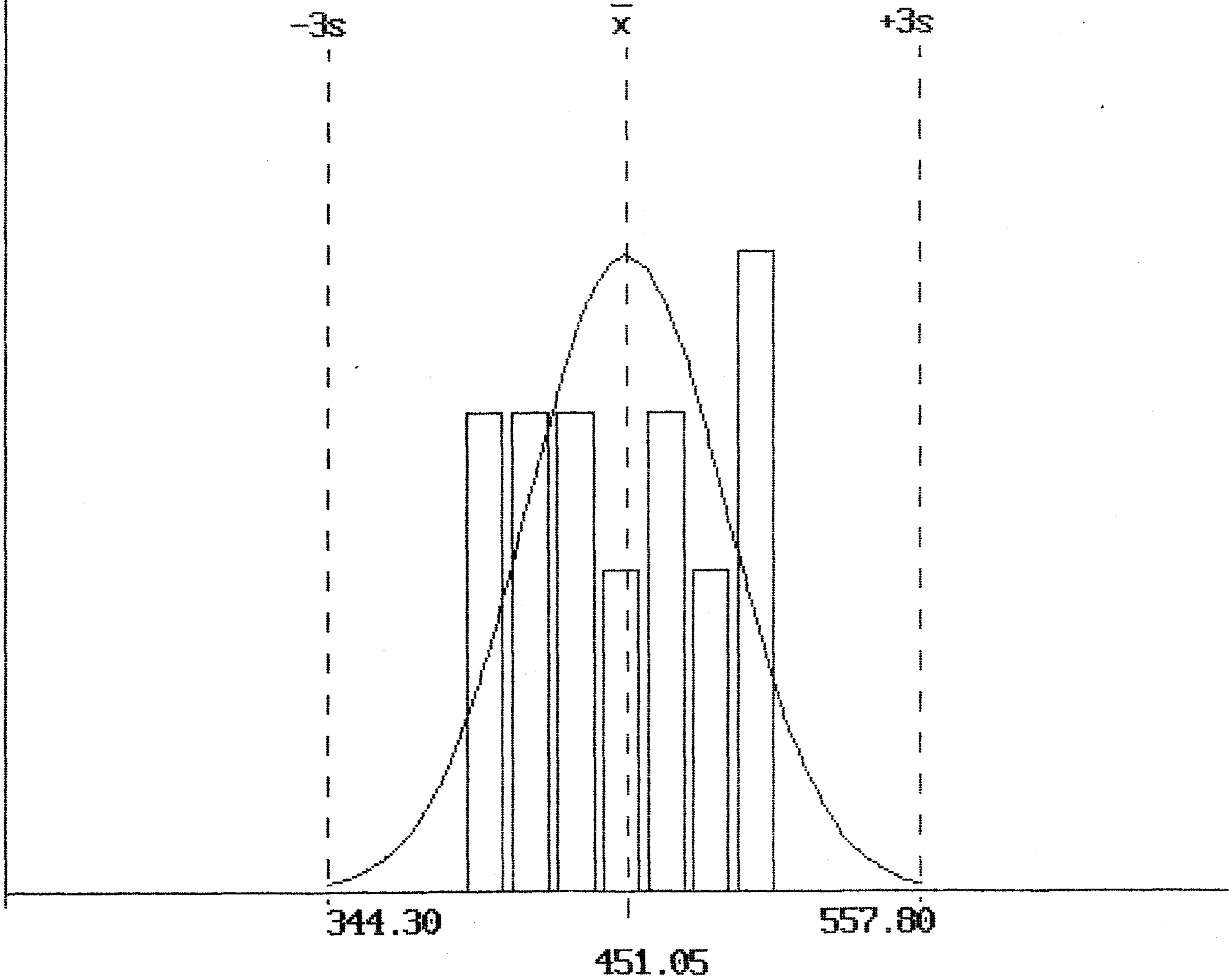

BOX COMPRESSION: CONTROLS

FILE NO.	LOAD (lbs)	DEFLECTION (in)	% FALLBACK
1991022.013	506	0.31	80.00
1991022.014	466	0.27	80.00
1991022.015	454	0.26	80.00
1991022.016	407	0.27	80.00
1991022.017	466	0.26	80.00
1991022.018	491	0.29	80.00
1991022.019	506	0.28	80.00
1991022.020	392	0.26	80.00
1991022.021	464	0.27	80.00
1991022.022	421	0.36	80.00
1991022.023	500	0.26	80.00
1991022.024	414	0.26	80.00
1991022.025	440	0.23	80.00
1991022.026	438	0.25	80.00
1991022.027	480	0.28	80.00
1991022.028	476	0.24	80.00
1991022.029	427	0.23	80.00
1991022.030	451	0.25	80.00
1991022.031	420	0.22	80.00
1991022.032	402	0.24	80.00

CUMU...

10-22-1999 16:08:26
PEAK LOAD = 506 LBS
DEFLECTION AT PEAK LOAD = 0.31 IN
% FALLBACK = 80.00 %

10-22-1999 16:13:49
PEAK LOAD = 466 LBS
DEFLECTION AT PEAK LOAD = 0.27 IN
% FALLBACK = 80.00 %

10-22-1999 16:17:50
PEAK LOAD = 454 LBS
DEFLECTION AT PEAK LOAD = 0.26 IN
% FALLBACK = 80.00 %

10-22-1999 16:21:41
PEAK LOAD = 407 LBS
DEFLECTION AT PEAK LOAD = 0.27 IN
% FALLBACK = 80.00 %

10-22-1999 16:25:22
PEAK LOAD = 466 LBS
DEFLECTION AT PEAK LOAD = 0.26 IN
% FALLBACK = 80.00 %

10-22-1999 16:29:13
PEAK LOAD = 491 LBS
DEFLECTION AT PEAK LOAD = 0.29 IN
% FALLBACK = 80.00 %

10-22-1999 16:32:43
PEAK LOAD = 506 LBS
DEFLECTION AT PEAK LOAD = 0.28 IN
% FALLBACK = 80.00 %

10-22-1999 16:36:44
PEAK LOAD = 392 LBS
DEFLECTION AT PEAK LOAD = 0.26 IN
% FALLBACK = 80.00 %

10-22-1999 16:40:36
PEAK LOAD = 464 LBS
DEFLECTION AT PEAK LOAD = 0.27 IN
% FALLBACK = 80.00 %

10-22-1999 16:44:51
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DEFLECTION AT PEAK LOAD = 0.38 IN
% FALLBACK = 80.00 %

10-22-1999 16:48:38
PEAK LOAD = 500 LBS
DEFLECTION AT PEAK LOAD = 0.26 IN
% FALLBACK = 80.00 %

10-22-1999 16:52:57
PEAK LOAD = 414 LBS
DEFLECTION AT PEAK LOAD = 0.26 IN

DEFLECTION AT PEAK LOAD = 0.23 IN
% FALLBACK = 80.00 %

10-22-1999 17:00:03
PEAK LOAD = 438 LBS
DEFLECTION AT PEAK LOAD = 0.25 IN
% FALLBACK = 80.00 %

10-22-1999 17:03:21
PEAK LOAD = 480 LBS
DEFLECTION AT PEAK LOAD = 0.28 IN
% FALLBACK = 80.00 %

10-22-1999 17:06:57
PEAK LOAD = 476 LBS
DEFLECTION AT PEAK LOAD = 0.24 IN
% FALLBACK = 80.00 %

10-22-1999 17:11:04
PEAK LOAD = 427 LBS
DEFLECTION AT PEAK LOAD = 0.23 IN
% FALLBACK = 80.00 %

10-22-1999 17:14:49
PEAK LOAD = 451 LBS
DEFLECTION AT PEAK LOAD = 0.25 IN
% FALLBACK = 80.00 %

10-22-1999 17:18:20
PEAK LOAD = 420 LBS
DEFLECTION AT PEAK LOAD = 0.22 IN
% FALLBACK = 80.00 %

10-22-1999 17:21:41
PEAK LOAD = 402 LBS
DEFLECTION AT PEAK LOAD = 0.24 IN
% FALLBACK = 80.00 %

pop = 20

$\bar{x}$:	687.60
min:	610.00
max:	768.00
r:	158.00
s:	40.10
-3s:	567.31
+3s:	807.89
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Cpk:	5.72
cell size:	22.57

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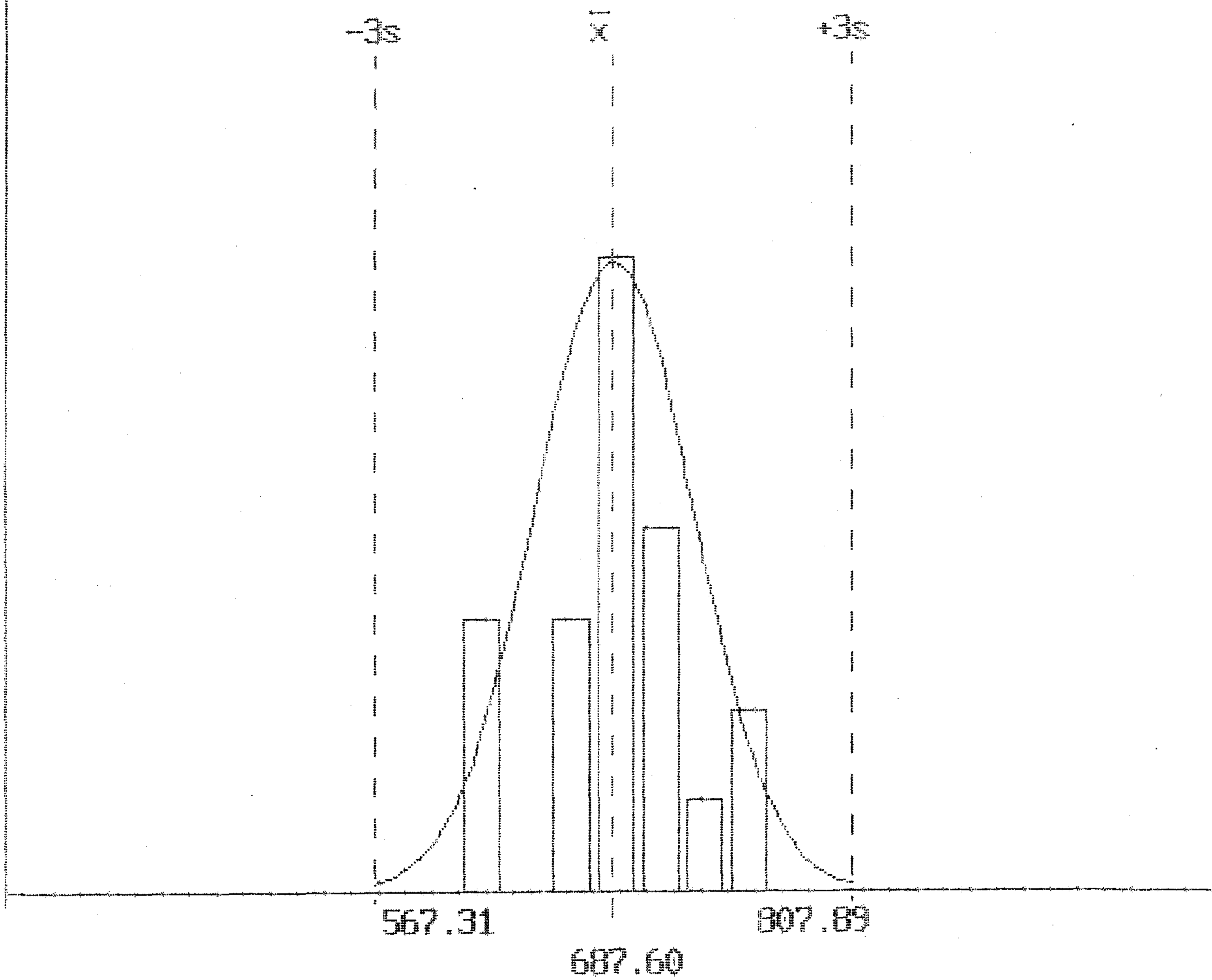

FILE NO.	LOAD	DEFLECTION	% FALLBACK
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19991025.002	689.0	0.32	80.0
19991025.003	680.0	0.30	80.0
19991025.004	700.0	0.27	80.0
19991025.005	685.0	0.31	80.0
19991025.006	723.0	0.31	80.0
19991025.007	676.0	0.29	80.0
19991025.008	690.0	0.28	80.0
19991025.009	610.0	0.32	80.0
19991025.010	624.0	0.29	80.0
19991025.011	768.0	0.30	80.0
19991025.012	671.0	0.33	80.0
19991025.013	759.0	0.29	80.0
19991025.014	701.0	0.28	80.0
19991025.015	708.0	0.29	80.0
19991025.016	616.0	0.27	80.0
19991025.017	702.0	0.26	80.0
19991025.018	682.0	0.29	80.0
19991025.019	688.0	0.27	80.0
19991025.020	667.0	0.30	80.0

10-25-1999 09:24:59
PEAK LOAD = 713 LBS
DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

10-25-1999 09:29:32
PEAK LOAD = 689 LBS
DEFLECTION AT PEAK LOAD = 0.32 IN
% FALLBACK = 80.00 %

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DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

10-25-1999 09:36:46
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DEFLECTION AT PEAK LOAD = 0.27 IN
% FALLBACK = 80.00 %

10-25-1999 09:41:45
PEAK LOAD = 685 LBS
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% FALLBACK = 80.00 %

10-25-1999 09:53:03
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DEFLECTION AT PEAK LOAD = 0.31 IN
% FALLBACK = 80.00 %

10-25-1999 10:08:50
PEAK LOAD = 676 LBS
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% FALLBACK = 80.00 %

10-25-1999 10:12:45
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DEFLECTION AT PEAK LOAD = 0.28 IN
% FALLBACK = 80.00 %

10-25-1999 10:17:11
PEAK LOAD = 610 LBS
DEFLECTION AT PEAK LOAD = 0.32 IN
% FALLBACK = 80.00 %

10-25-1999 10:41:33
PEAK LOAD = 624 LBS
DEFLECTION AT PEAK LOAD = 0.29 IN
% FALLBACK = 80.00 %

10-25-1999 10:46:00
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% FALLBACK = 80.00 %

10-25-1999 10:50:12
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10-25-1999 10:54:00
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PEAK LOAD = 701 LBS
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% FALLBACK = 80.00 %

10-25-1999 11:02:37
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10-25-1999 11:06:38
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% FALLBACK = 80.00 %

10-25-1999 11:11:19
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% FALLBACK = 80.00 %

10-25-1999 11:16:13
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% FALLBACK = 80.00 %

10-25-1999 11:20:51
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DEFLECTION AT PEAK LOAD = 0.27 IN
% FALLBACK = 80.00 %

10-25-1999 11:24:52
PEAK LOAD = 667 LBS
DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

IPST Data on Hand Made Boxes in Laboratory

Conventional = Boxes with conventional flute orientation

Linear = Boxes with linear flute orientation

Dual Joint = Boxes with conventional flute orientation and dual glue joints

11-28-1999 23:04:17
PEAK LOAD = 656 LBS
DEFLECTION AT PEAK LOAD = 0.47 IN
% FALLBACK = 80.00 %

11-28-1999 23:08:23
PEAK LOAD = 595 LBS
DEFLECTION AT PEAK LOAD = 0.41 IN
% FALLBACK = 80.00 %

11-28-1999 23:11:30
PEAK LOAD = 631 LBS
DEFLECTION AT PEAK LOAD = 0.40 IN
% FALLBACK = 80.00 %

11-28-1999 23:14:35
PEAK LOAD = 640 LBS
DEFLECTION AT PEAK LOAD = 0.43 IN
% FALLBACK = 80.00 %

11-28-1999 23:18:27
PEAK LOAD = 645 LBS
DEFLECTION AT PEAK LOAD = 0.41 IN
% FALLBACK = 80.00 %

11-28-1999 23:23:20
PEAK LOAD = 472 LBS
DEFLECTION AT PEAK LOAD = 0.56 IN
% FALLBACK = 80.00 %

11-28-1999 23:31:53
PEAK LOAD = 527 LBS
DEFLECTION AT PEAK LOAD = 0.86 IN
% FALLBACK = 80.00 %

11-28-1999 23:36:22
PEAK LOAD = 604 LBS
DEFLECTION AT PEAK LOAD = 0.38 IN
% FALLBACK = 80.00 %

11-28-1999 23:39:04
PEAK LOAD = 609 LBS
DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

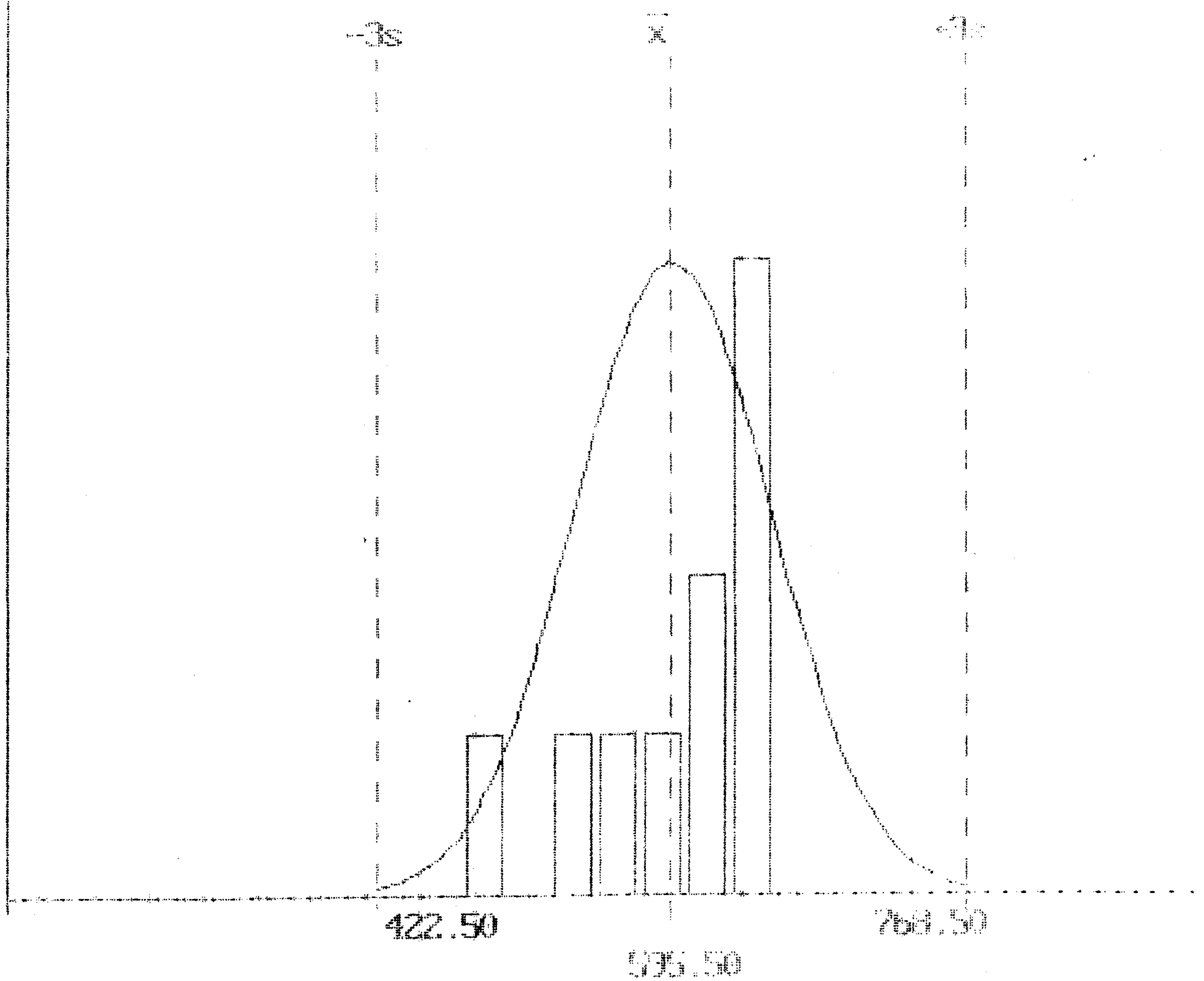
11-28-1999 23:41:55
PEAK LOAD = 576 LBS
DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

Conventional

[illegible] [illegible]

DATE: 11-26-1999 TIME: 23:44:22

[illegible]	595.50
min:	472.00
max:	656.00
r:	184.00
s:	57.67
-3s:	422.50
+3s:	768.50
-Tol:	0.00
+Tol:	2000.00
Cp:	5.78
Cpk:	3.44
cell size:	26.29



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% FALLBACK = 80.00 %

11-29-1999 00:05:14
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% FALLBACK = 80.00 %

11-29-1999 00:12:19
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DEFLECTION AT PEAK LOAD = 0.32 IN
% FALLBACK = 80.00 %

11-29-1999 00:18:02
PEAK LOAD = 816 LBS
DEFLECTION AT PEAK LOAD = 0.36 IN
% FALLBACK = 80.00 %

11-29-1999 00:21:30
PEAK LOAD = 941 LBS
DEFLECTION AT PEAK LOAD = 0.87 IN
% FALLBACK = 80.00 %

11-29-1999 00:24:59
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DEFLECTION AT PEAK LOAD = 0.36 IN
% FALLBACK = 80.00 %

11-29-1999 00:29:40
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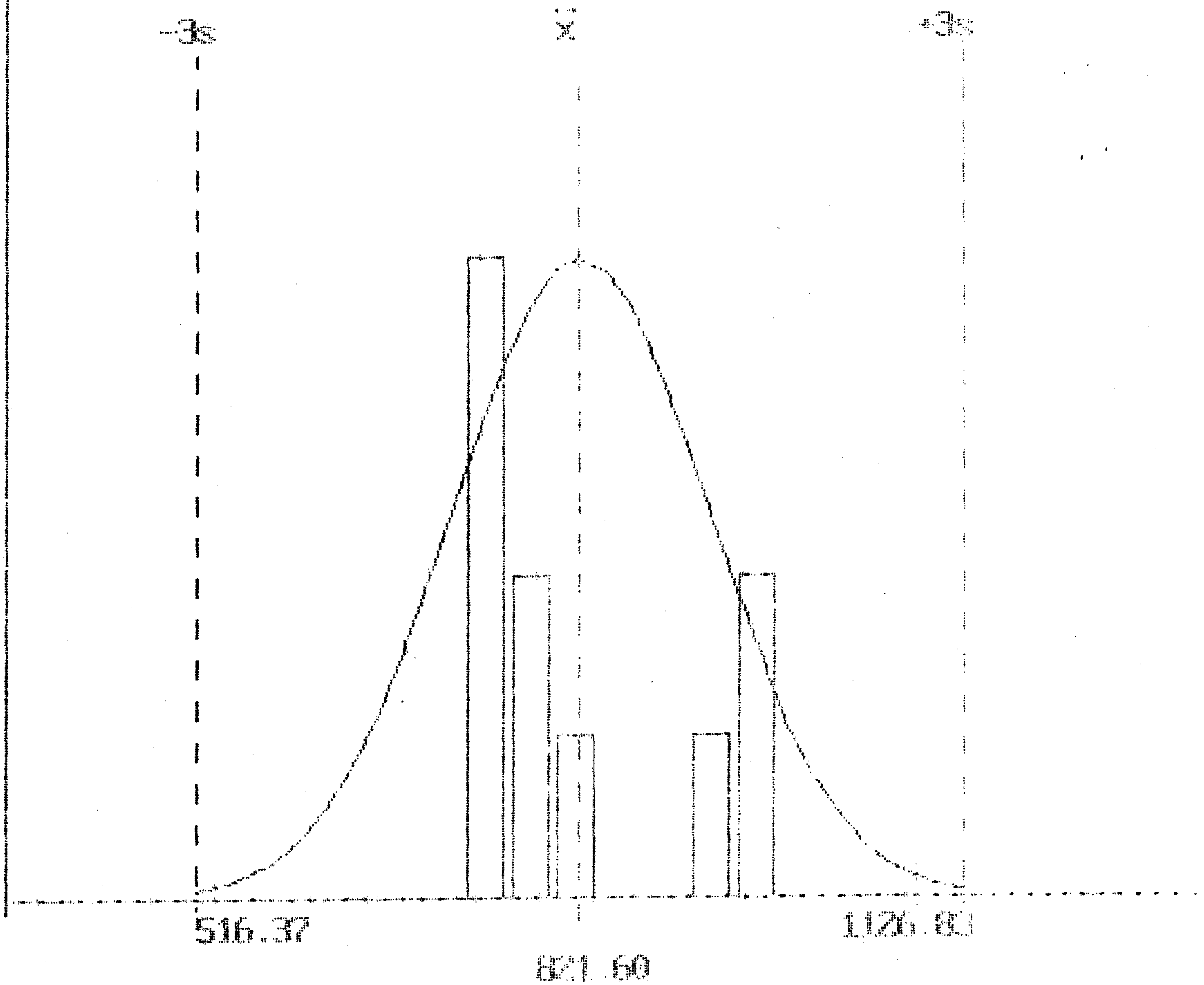
DEFLECTION AT PEAK LOAD = 0.34 IN
% FALLBACK = 80.00 %

11-29-1999 00:32:48
PEAK LOAD = 769 LBS
DEFLECTION AT PEAK LOAD = 0.31 IN
% FALLBACK = 80.00 %

11-29-1999 00:35:59
PEAK LOAD = 744 LBS
DEFLECTION AT PEAK LOAD = 0.36 IN
% FALLBACK = 80.00 %

DATE: 11-23-1999 TIME: 00:38:59

X̄:	821.60
Min:	729.00
Max:	980.00
R:	251.00
s:	101.74
-3s:	516.37
+3s:	1126.83
-Tol:	0.00
+Tol:	2000.00
Cp:	3.28
Cpk:	2.69
Cell Size:	35.86



PEAK LOAD = 802 LBS
DEFLECTION AT PEAK LOAD = 0.33 IN
% FALLBACK = 80.00 %

Dual Jont

11-29-1999 02:37:31
PEAK LOAD = 722 LBS
DEFLECTION AT PEAK LOAD = 0.25 IN
% FALLBACK = 80.00 %

11-29-1999 02:41:37
PEAK LOAD = 787 LBS
DEFLECTION AT PEAK LOAD = 0.37 IN
% FALLBACK = 80.00 %

11-29-1999 02:49:06
PEAK LOAD = 752 LBS
DEFLECTION AT PEAK LOAD = 0.36 IN
% FALLBACK = 80.00 %

11-29-1999 02:57:49
PEAK LOAD = 697 LBS
DEFLECTION AT PEAK LOAD = 0.30 IN
% FALLBACK = 80.00 %

11-29-1999 03:08:32
PEAK LOAD = 877 LBS
DEFLECTION AT PEAK LOAD = 0.75 IN
% FALLBACK = 80.00 %

11-29-1999 03:14:00
PEAK LOAD = 763 LBS
DEFLECTION AT PEAK LOAD = 0.36 IN
% FALLBACK = 80.00 %

11-29-1999 03:17:07
PEAK LOAD = 629 LBS
DEFLECTION AT PEAK LOAD = 0.23 IN
% FALLBACK = 80.00 %

11-29-1999 03:21:09
PEAK LOAD = 779 LBS
DEFLECTION AT PEAK LOAD = 0.70 IN
% FALLBACK = 80.00 %

11-29-1999 03:25:16
PEAK LOAD = 813 LBS
DEFLECTION AT PEAK LOAD = 0.33 IN
% FALLBACK = 80.00 %

DATE: 11-29-1999 TIME: 03:28:53

	10
	762.10
in:	629.00
ax:	877.00
	248.00
	68.28
3s:	557.27
3s:	966.93
Tol:	0.00
Tol:	2000.00
p:	4.88
pk:	3.72
ell	
ize:	35.43