

September 26, 1991

Dear Dr. Thornton,

Please find enclosed copies of all the paper work I completed in conjunction with the KC-135 flight test of your Isotonic Device. I am very concerned that you feel that I have not done justice to your device based on the verbal report Mike gave to you on the phone. Please remember that I said that there are two reports; one from me on the first flight and another report generated by another KRUG employee. As discussed with you on the phone, I don't pretend to know all there is to know about microgravity and exercise nor training. The report was generated by me with the format developed by Judy Hayes. I strongly believe that the device would be a good countermeasure, easy to use on the orbiter, using brown line fittings to support both the device and the subjects. After speaking with you on the phone I wrote down some notes and looked at them again at home. As discussed, I was the only one over at KRUG who thought the device had any future. I don't believe in re-inventing the wheel if one can suffice until a better one comes along. The only immediate changes would be in the selection knobs of the weight device, as they would stick in a position and wouldn't allow the weight to be changed. The actual lifting motions were smooth and felt like weight lifting. When reviewing the enclosed video tape, in some exercise situations, spotting and assistance was given to a subject when necessary as the subject could not lift the lowest weight. Assistance was necessary during the attempt of two exercises, arm curl and bar dips.

I will be at NASA, #37 with Steve Siconolfi on Fridays starting on September 27, at 483-7110. I would be happy to meet with you at this time or any other Friday that meets with your schedule. I would like to learn where you personally disagree with my assessments of your device. I would invite an accept any opportunity to learn from your views. One of my major reasons for leaving KRUG was because I could no longer function under the professional codes of ethics and professionalism that I was taught to aspire to by my mentor, Edward L. Fox. I saw that one could easily loose their independence and objectivity in that system.

I look forward to your reply.

Sincerely,

A handwritten signature in blue ink, appearing to read "Kevin".

Kevin T. Kear, Ph.D.

KC-135 POST-FLIGHT REPORT

by Kevin T. Kear, Ph.D.

TITLE: PRELIMINARY CHECKOUT REPORT OF THE (Thornton)
ISOTONIC DEVICE

FLIGHT DATES: April 19th and 20th

TEST OPERATOR: Kevin Kear

TEST SUBJECTS: April 19 Kevin Kear, John McBrine
Glenn Klute, Rick Smith

April 20- John McBrine, Judy Hayes
John Kiowski, Mark Bowman

OBJECTIVES: The objectives of the KC-135 flight were to check-out the functional design of the equipment and the subject usability of the Thornton Isotonic Device in a microgravity environment.

PROCEDURES: Four subjects per flight were tested on; squat, bar dip, arm curl, pull downs, and pull ups exercises. Subjects in some cases choose to try additional exercises not planned such as the tricep pull down and the dead lift.

METHODS

Preflight: The (Thornton) Isotonic Training Device (ITD), one version of the Musculoskeletal Over Trainer (MOT) design concept, was manufactured by the Whitmore Company. It's design was for specific use in the shuttle to provide a stimulus to the musculoskeletal system to combat deconditioning. A load cell was attached to the end of the rope of the ITD while forces were recorded on a computer as subjects performed weight lifting types of exercises. The load cell was calibrated before flight. Additionally, isotonic curves were produced during ground based testing, by placing a ten pound load at the end of the load cell during arm curls and reported in grams of work (chart A). Since force is equal to mass times distance, $F = M \times D$, the load of ten pounds could easily be exceeded with the end product of force production dependant upon the distance or velocity of the lift. Chart A shows the force produced during a slow lift, whereas chart B shows a load curve during a rapid lift. The resultant plateau and arched curve are a direct result of the velocity of the lift. This produces a curved response to the loads produced by the subjects. A load setting of 100 lbs. could be easily exceeded by 30-50

pounds, or 50% as in the bar dips, that had an average reported load cell work production of 143 pounds.

Inflight: During testing in the KC-135, a ramped protocol was designed to test both the operation of the equipment and subject variability, using different sized and gender individuals. Loads of 100, 150, 200 and 250 pounds were attempted during exercise using large and small muscle groups and subjective individual consent. Only four load settings were possible based on the interaction of two bottoms, A and B. The chart below explains the in and out positions and setting of the desired loads.

Thornton Isotonic Device(ISD)- Load Settings

Bottom A		B	
LBS.	50 LB.	100 LB.	
SETTING		SETTING	
100	- OUT	OUT	
150	- IN	OUT	
200	- OUT	IN	
250	- IN	IN	

Five activities were performed by using a variety of attachments that were connected to a tension rope that provided an inward pull towards the Isotonic Device. One of the attachments included the treadmill harness. The harness was strapped around the hips of the subjects while the load cell end was connected to a buckle on the treadmill harness, providing tension during exercise, such as squats. Pull ups were also done with the treadmill harness providing the downward force attached to the Isotonic rope that went through a floor pulley from the subject to the resistive machine. Subjects held onto a horizontal bar that was attached to a metal, horse shoe shaped arch over head. Bar dips were accomplished by attaching ropes to the arch, almost shoulder width apart, with grip handles at either end. This activity was similar to dip exercises done on parallel bars. Dead lifts and arm curls were done using the horizontal bar in front of the individual, attached to the rope and load cell end after passing through the pulley to the machine.

RESULTS: In some cases subject performance had to be facilitate due to the person's inability to perform the desired lift at the lightest level, 100 lbs. In no cases were subjects able to accomplish the arm curl to its full range of motion. An isometric contraction was possible after some isotonic work, to about 50%, but this was the best subject's effort. Neither did the mechanism respond well to adjustments in load level settings. In about 70% of the cases the machine did not make the desired

response to the adjustments but rather stayed at the 100 lb. load setting or other load settings. Attempts were made to pull the rope in and out of the exit port of the ITD to assist in setting the device for the next desired level. The selection buttons, A and B, were very difficult to adjust and had a tendency to stick and sometime disengage at the desired resistance selection. Overall, the device acted very smoothly and felt like lifting free weights, but had an initial dead rope response, until some of the rope had been pulled out. In order to recommend the device, modifications to the load settings is essential. The device did act well enough to produce the following subject load out puts, chart C.

Average peak pounds and standard deviations of load production responses of eight subjects were as follows:

	SQUATS	BAR DIPS	PULL UPS	ARM CURLS	DEAD LIFTS
AVERAGE PEAK LBS.PRODUCED	157	143	175	129	171
STANDARD DEVIATION LBS.	12	20	28	59	0 *
RANGES- LBS.	125 - 176 LBS.	80 - 172 LBS.	124 - 271 LBS.	80-167 LBS.	171

(* only 2 data points, both identical in response)

Recommendations/Conclusions:

1. The device must be able to adjust to a desired load settings, even if the selection is limited to four choices. Based on the work responses, subject production loads ranging from 129-175 pounds, the stimulus for training appears viable and workable.
2. The increments for selection should be more varied, with a low setting of 25 pounds, as in such cases as arm curls, so that weaker/smaller subjects can accomplish the desired lift.
3. The desired settings should be shown as a response to the setting of the load, 50 lbs selected should show that it has engaged as 50 and not some other level.
4. The weight and size of the device should be reduced to conform with current Orbiter load and safety limits.
5. The set up time for the KC flight was exorbitant due to the necessity to have the Anthropometry and Biomechanics Lab arch and the number of attachments as the treadmill harness for the squats and dead-lifts.

6. The tricep pull down was attempted but not completed successfully as the load was too heavy and the foot restraints not satisfactory.

7. Although there are arm curl forces reported, the actions were only at 50% of the range of motion at best (see video tape). Subjects were forced to stop the action of flexion of the elbow due to the weight being too heavy to lift. Some subjects were only able to perform slight motion with mostly an isometric contraction to follow.

Below are the individual summaries, parabola by parabola, of the eight subjects who flew on the KC-135. The load setting, the max load produced during the attempt and the numbers of repetitions per parabola. A key is provided to assist in the interpretation showing that the next setting did not engage (*), that the setting worked as planned (**), that the device did not work isotonicly (#) and that a spotter was used to facilitate the performance and the outcome of the success in both range of motion and pounds of work produced.

K.K.	Load Setting pounds	Max Load	# of reps
Squat	100 *	125	10
	250 *	133	16
Bar Dips	50 *	80	1
	150 *	123	18
	250 *	172	13
Pull ups	100 **	125	4
	150 **	184	4
Pull ups	100 *	132	8
	150 *		
Tricep pulls	100	235 #	1
	100 **	118##	5
Arm Curls	100 **	107	4
	100	80##	4

* -other higher settings did not engage

** -worked as planned at higher settings when initiated

-exercise did not work isotonicly, instead was isometric

-worked with a spotter to facilitate work

G.K.	Load Setting pounds	Max Load	# of reps
Arm Curls	100 *	118	5
	100 **	119	6
Toe Raises	150 *	94	12
Squats	150 **	154	11
	250 *		0
	150 **	153	13
	250 *	169	14
Pull ups	150 **	187	8
-behind head	150 **	178	4
-front	150 **	178	3
Bar Dips	100 **	145	8
	100 **	146	6

- * -other higher settings did not engage
 ** -worked as planned at higher settings when initiated
 # -exercise did not work isotonically, instead was isometric
 # # -worked with a spotter to facilitate work

J.K.	Load Setting pounds	Max Load	# of reps
Squat	100 **	167	7
	150 **	154	3
	200 *	160	4
	250 *	160	3
	250 *	160	3
	250 *	171	10
Pull Ups	100 *	178	6
	150 **	177	7
Bar Dips	100 **	148	7
Arm Curls	100 **	165	5
	100 **	147 # # spotted	9
	100 *	167 # #	4
Dead Lift	100 *	171	7
	200 *	171	6

- * -other higher settings did not engage
- ** -worked as planned at higher settings when initiated
- # -exercise did not work isotonicly, instead was isometric
- # # -worked with a spotter to facilitate work

R.S..	Load Setting pounds	Max Load	# of reps
Squat	200 **	160	10
	250 *	160	0
	250 *	162	10
Pull ups	150 **	271 very fast	9
	150 **	197	8
Bar Dips	100 *	160	11

Day 2 April 20th

J.J.	Load Setting pounds	Max Load	# of reps
Squat	100 *	167	7
	150 *	167	7
	?	154	6
	?	170	8
Pull Ups	100 **	171	7
	150 *	177	6
	200 *	175	4
	250 *	170	5
	?	176	4
	150 **	184	4
Bar Dips	100 ?**	137	5
	?150 **	153	8
	100 ?	154	8
Dead Lift	?100 **	171 # #	5

- * -other higher settings did not engage
- ** -worked as planned at higher settings when initiated
- # -exercise did not work isotonicly, instead was isometric
- # # -worked with a spotter to facilitate work

J.H.	Load Setting pounds	Max Load	# of reps
Squat	? 100 * *	154	5
	? 100 **	150	7
Pull Ups	100 **	150 #	6 / 8
	100 **	124 #	4 / 7
	100 **	175 # #	5 / 9
Bar Dips	100 ?	141 # #	4
	100 ?	137 # #	4
	100 ?	136 # #	4

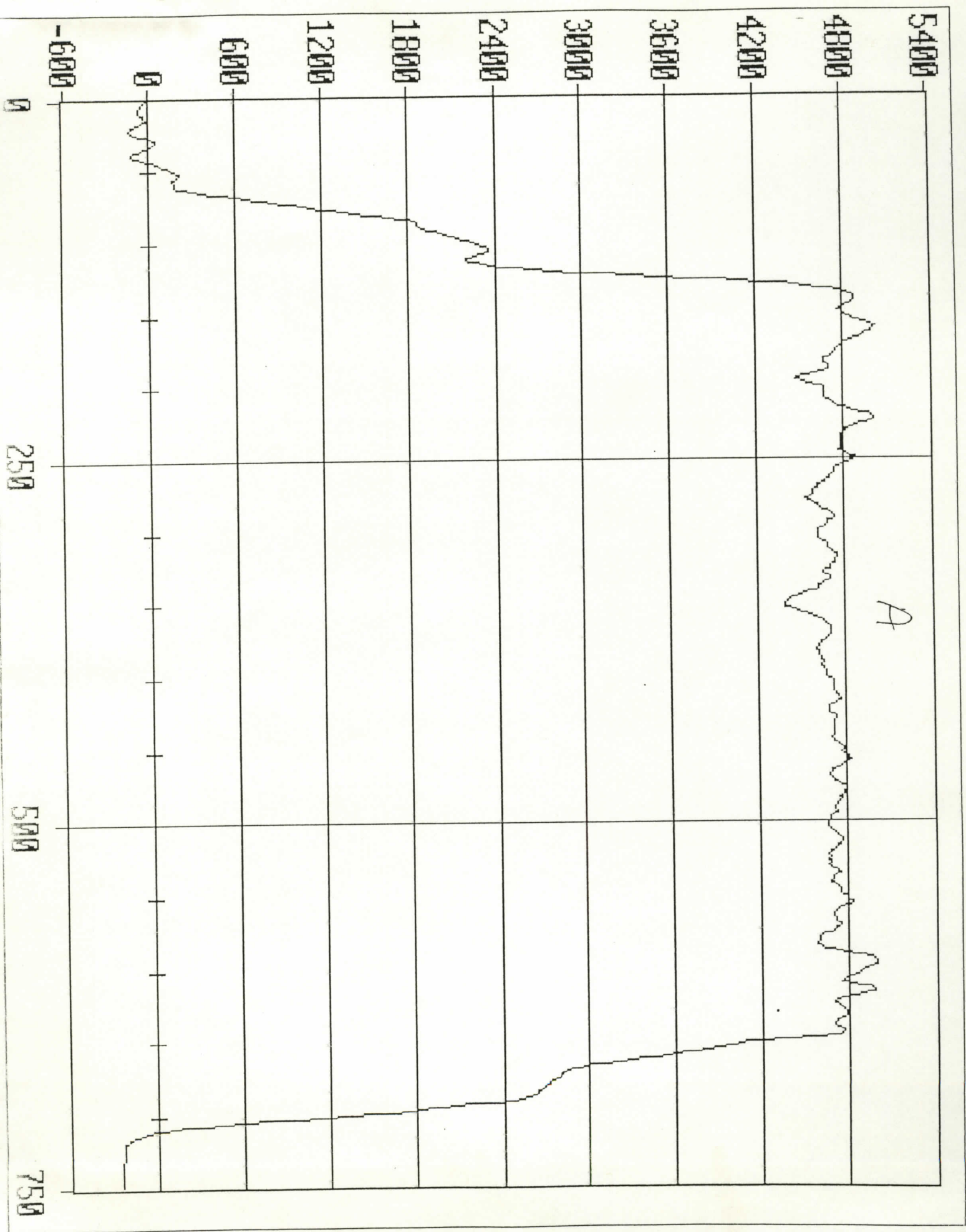
- * -other higher settings did not engage
- ** -worked as planned at higher settings when initiated
- # -exercise did not work isotonicly, instead was isometric
- # # -worked with a spotter to facilitate work

J.K.	Load Setting pounds	Max Load	# of reps
Squat	100 **	150	8
	? 150 *		0
	250 *	174	6
	?	176	11
Pull Ups	? 100 * *	174	3
	250 *	175	7
	? 250 *	176	10

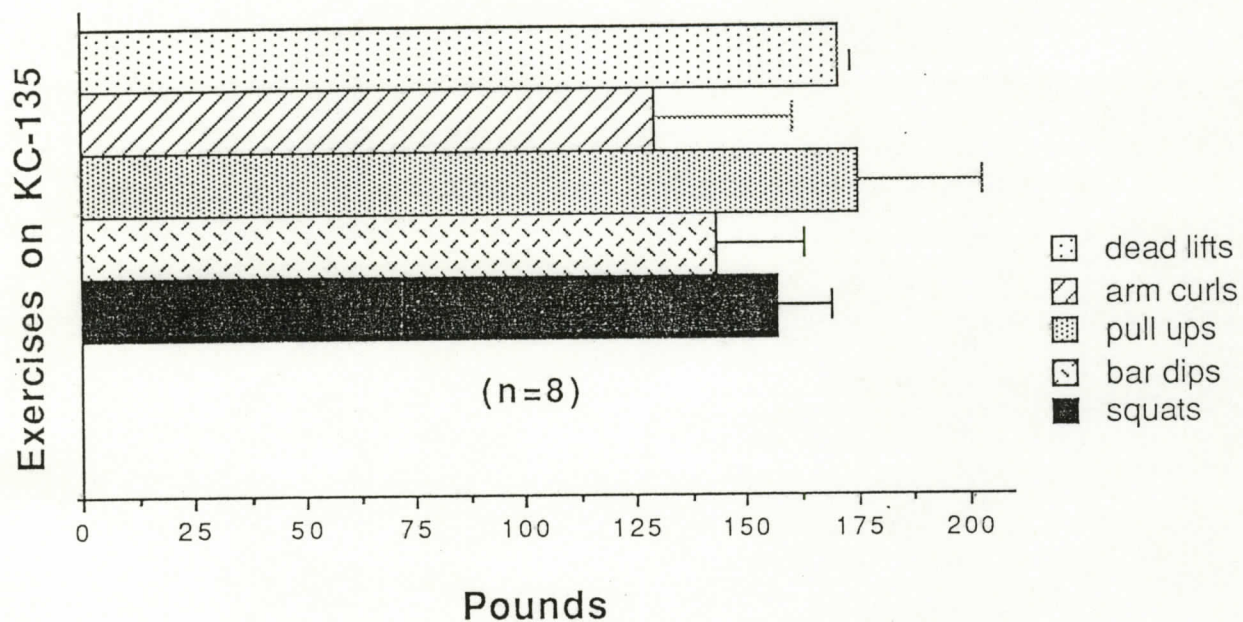
- * -other higher settings did not engage
- ** -worked as planned at higher settings when initiated
- # -exercise did not work isotonicly, instead was isometric
- # # -worked with a spotter to facilitate work

M.B..	Load Setting pounds	Max Load	# of reps
Pull Ups	? 100	178	7
	? 150 - 100 *	179	7
Squats	250 *	153	15
	? 250 *	147	16
	? 250 *	144	15
Bar Dips	250 *	154	11
	250 ?	154	12
	250 ?	153	11

A



Thornton's Isotonic Device
Load Productions in Microgravity
(KC-135)



Isotonic loads

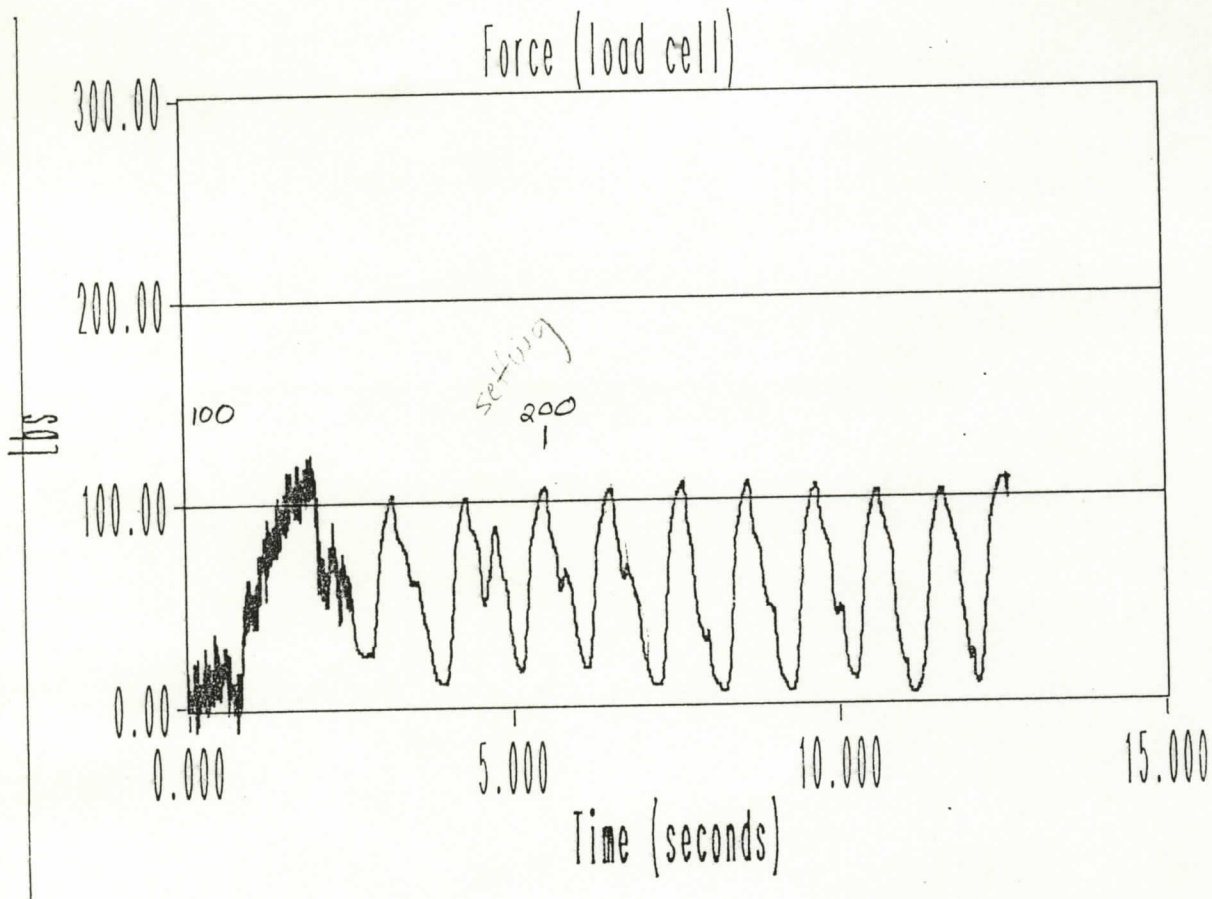
	A	B	C	D	E	F
1		Squats	Bar Dips	Pull ups	Tricep Pulls	Arm curls
2		125	80	125	235	107
3		133	123	184	118	80
4		154	172	132		118
5		153	145	187		119
6		169	146	178		165
7		167	148	178		147
8		154	160	178	177	167
9		160	137	271		
10		160	153	197		
11		160	154	171		
12		171	141	177		
13		160	137	175		
14		162	136	170		
15		160	154	176		
16		167	154	184		
17		167	153	150		
18		154		124		
19		170		175		
20		154		174		
21		150		175		
22		150		176		
23		174		178		
24		176		179		
25		153				
26		147				
27		144				
28						
29	average	157.461538	143.3125	174.521739	176.666667	129
30	standard Dev.	11.9305684	20.368992	28.3450646	58.5007122	32.0676369

Isotonic loads

	G
1	Dead Lifts
2	171
3	171
4	171
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	171
30	0

4-19-91

KC-135 Isotonic Data Display



PARABOLA $\frac{1}{2}$

~~PULL UPS~~
squats

MAX FORCE = 125

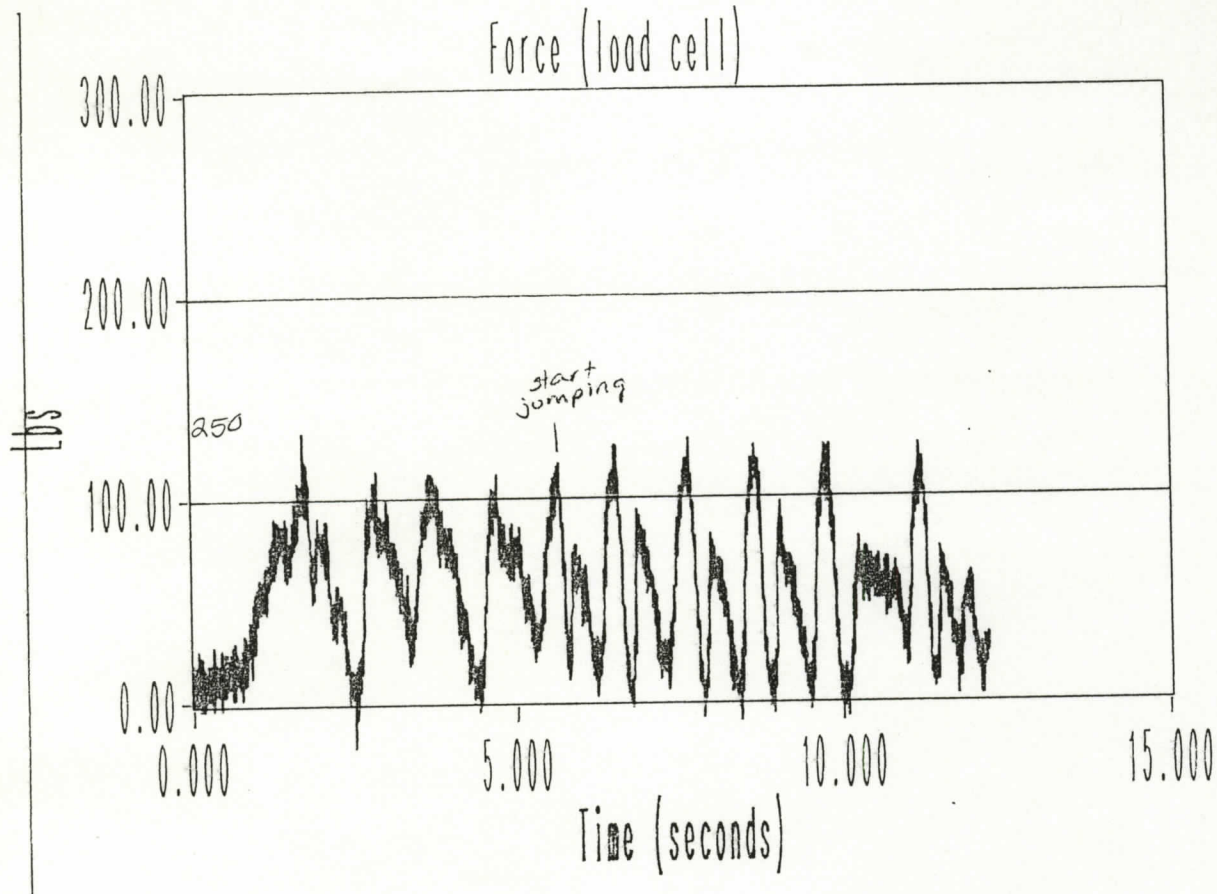
SUBJECT 1

Kevin
Kear

not getting full extension
~50% (?)

4-19

KC-135 Isotonic Data Display



PARABOLA #2

~~PULL UPS~~
squats

MAX FORCE = 133

SUBJECT 1

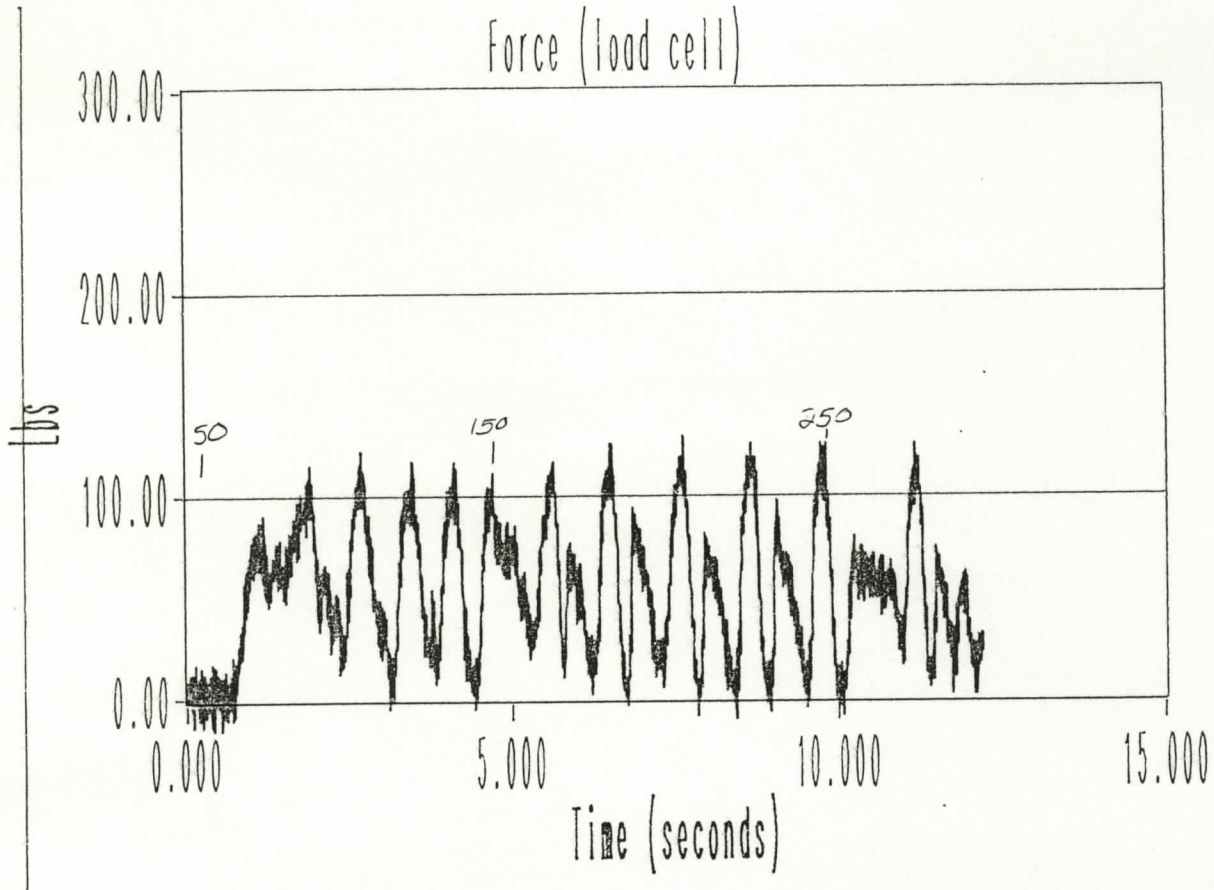
Kevin
Kear

jumping
cleared ground by a few inches

4-10-9

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA 1/3

~~PULL UPS~~

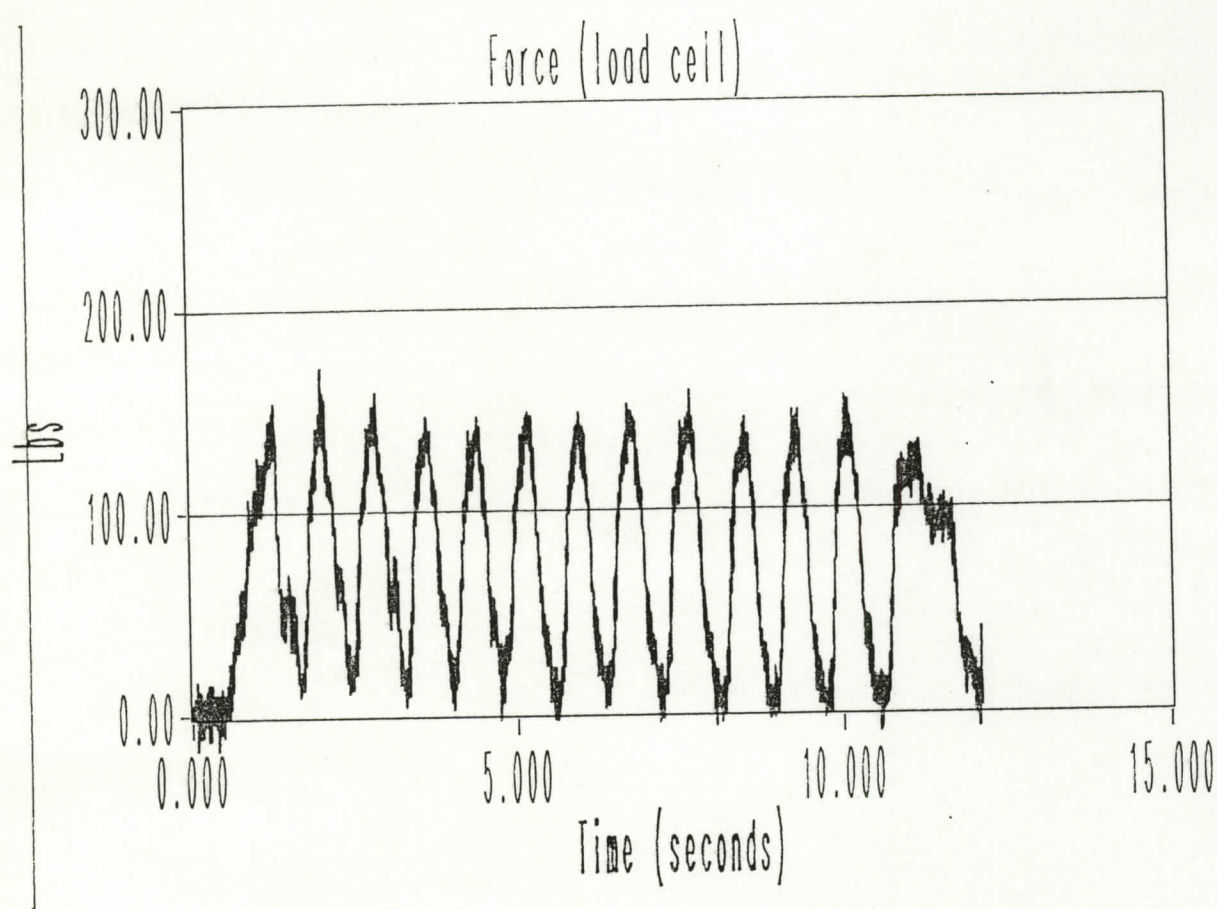
bar dips

MAX FORCE = 123

SUBJECT 1

Kevin
Kear

KC-135 Isotonic Data Display



PARABOLA ~~75~~
#4

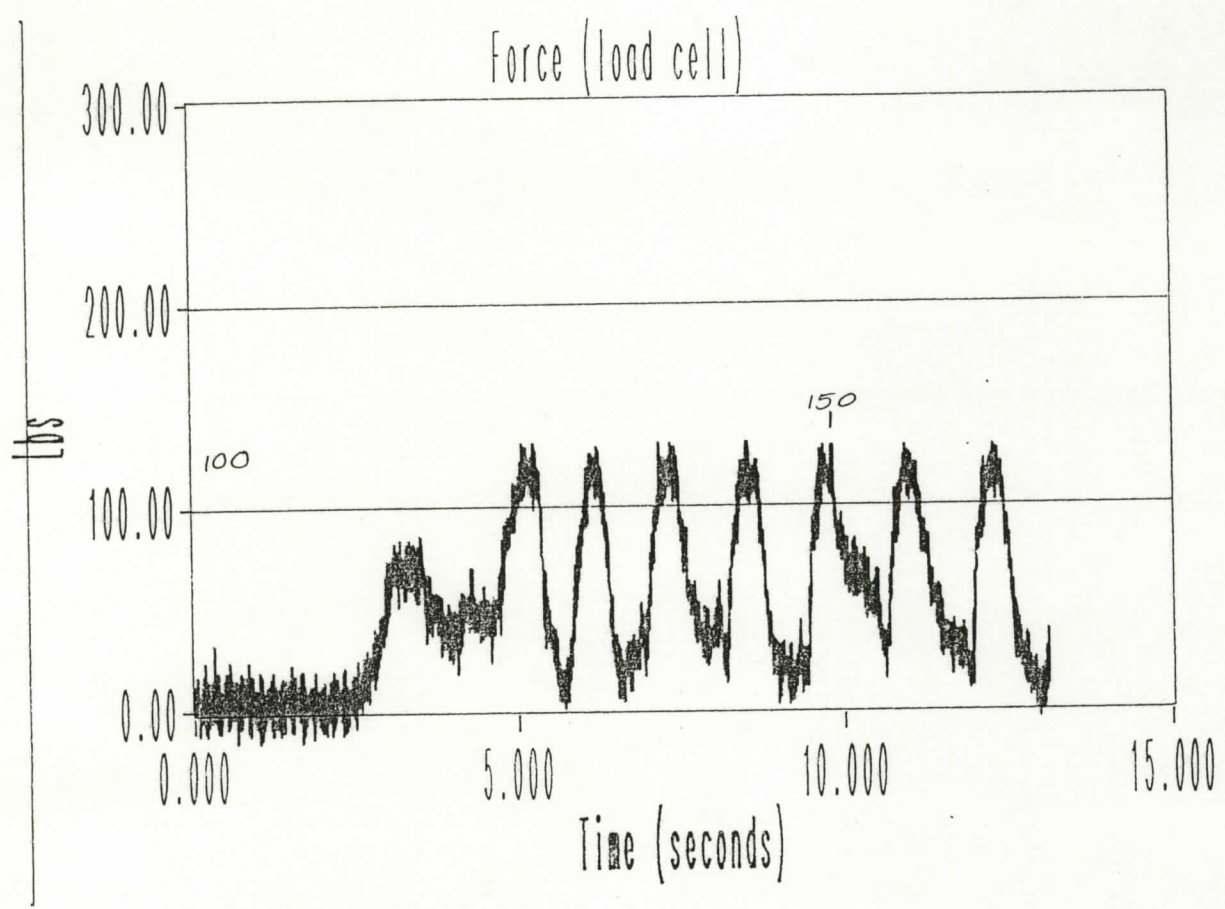
~~PULL UPS~~
bar dips

MAX FORCE = 172

SUBJECT 1
kevin

250 lbs setting

KC-135 Isotonic Data Display



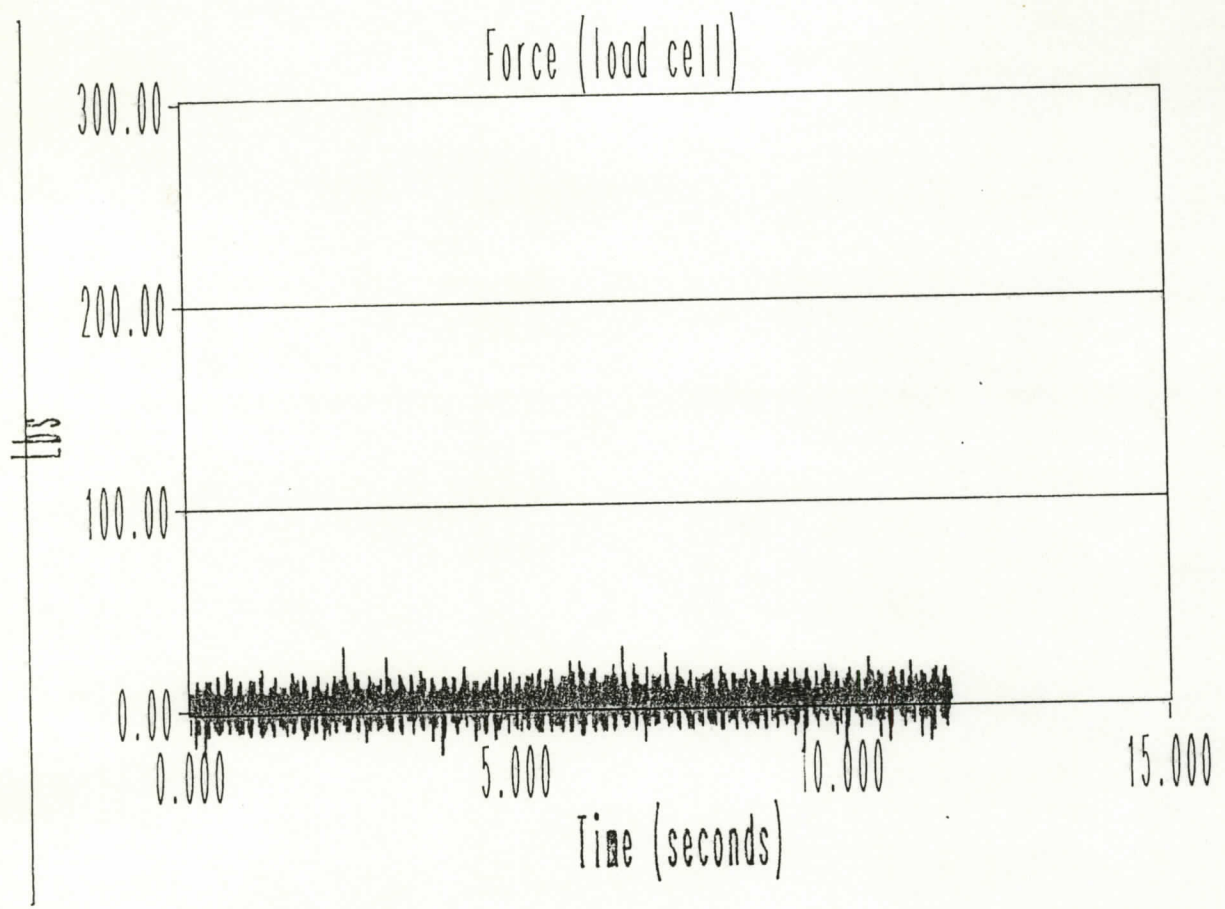
PARABOLA ~~7~~
#6

PULL UPS

MAX FORCE = 132

SUBJECT 1
Kevin
Kear

KC-135 Isotonic Data Display



PARABOLA ~~18~~
#7

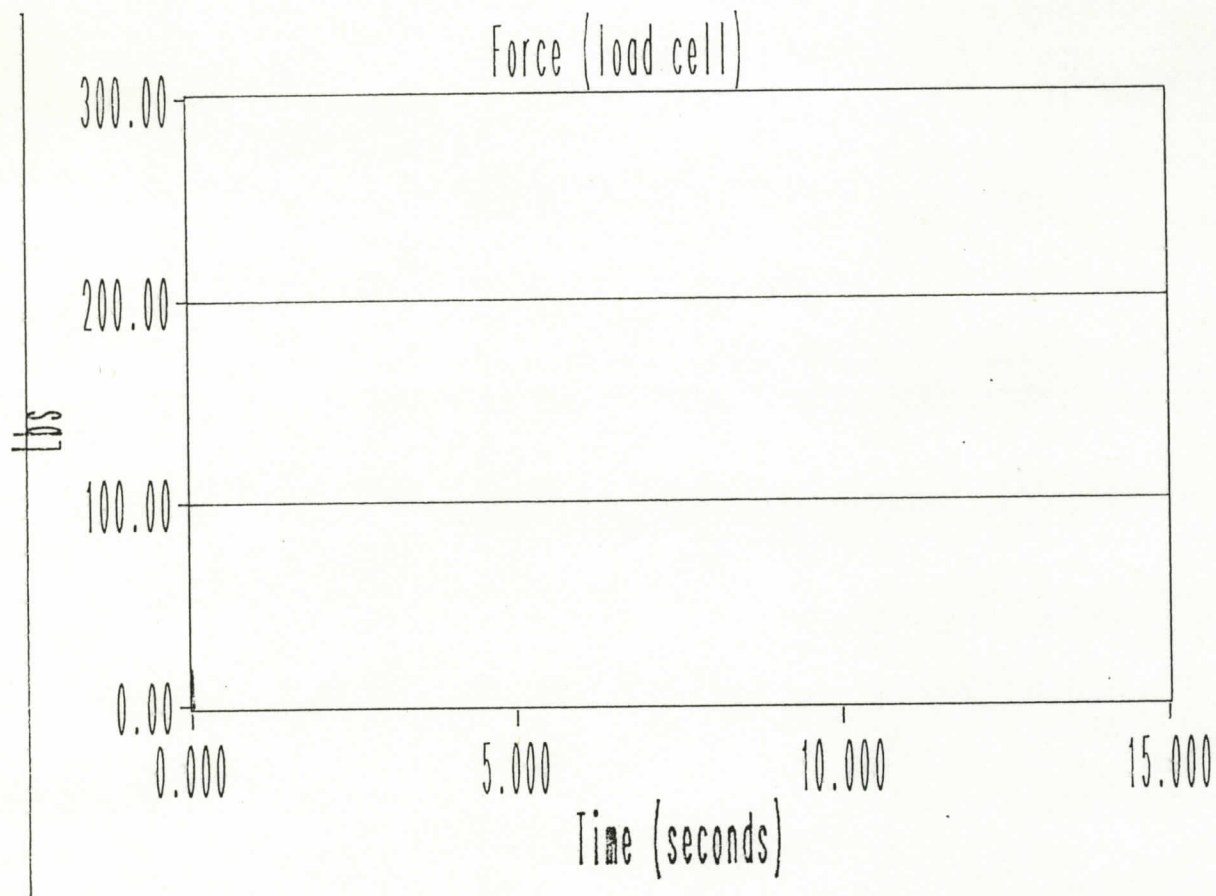
PULL UPS

MAX FORCE = 31

SUBJECT 1

manipulating equipment

KC-135 Isotonic Data Display



PARABOLA ~~79~~
#8

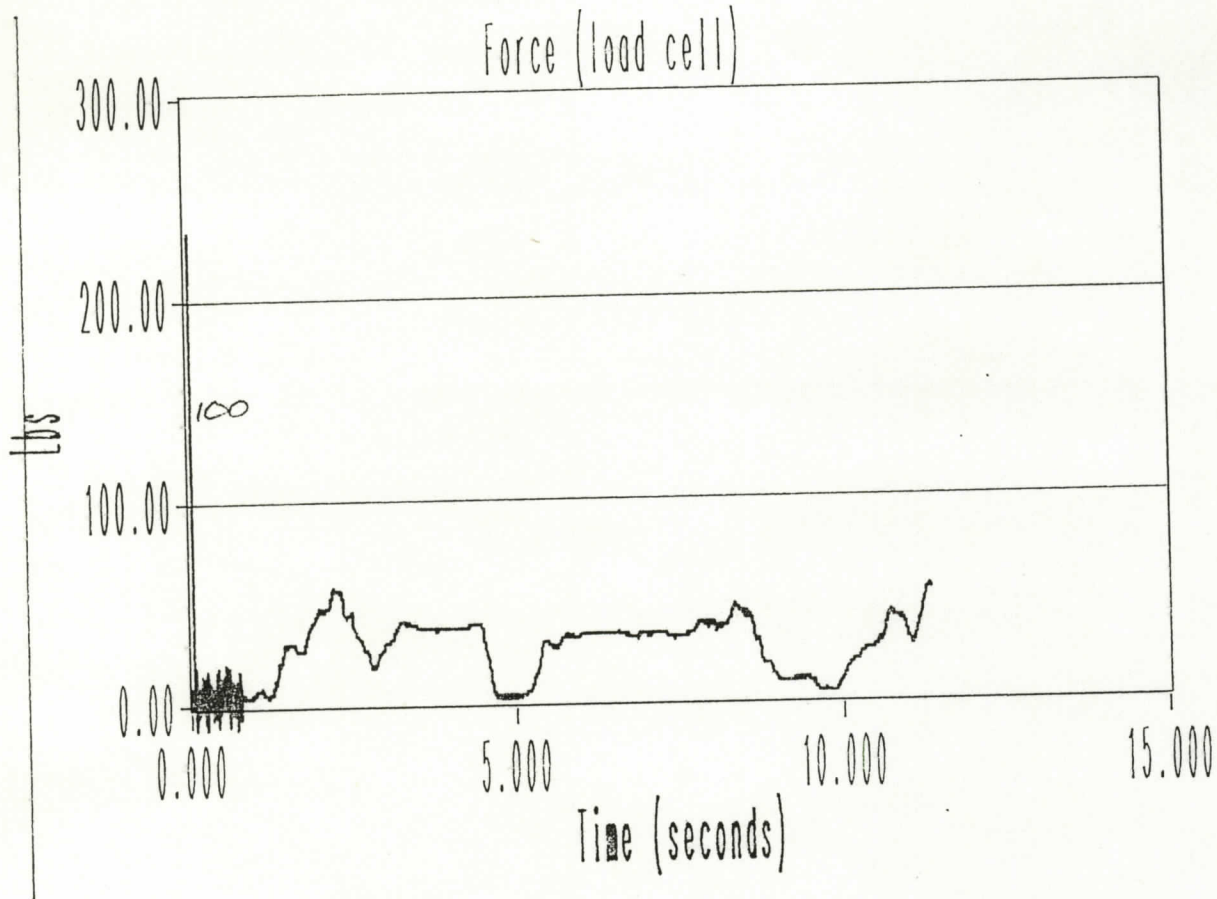
PULL UPS

MAX FORCE = 27

SUBJECT 1

manipulating equipment

KC-135 Isotonic Data Display



~~PARABOLA #11~~

#9

~~PULL UPS~~

tricept
pull downs

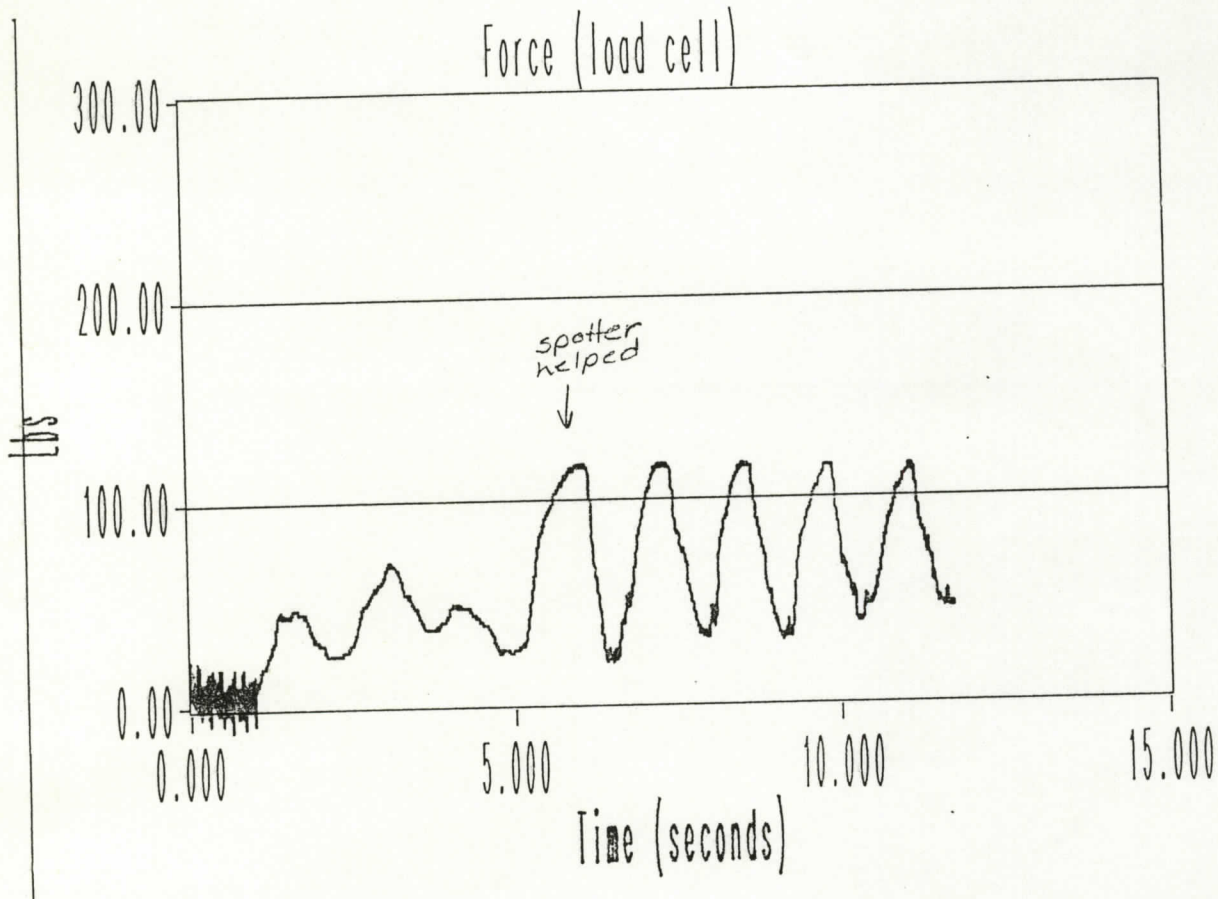
MAX FORCE = 235

SUBJECT 1

Kevin
Kear

exercise did not work

KC-135 Isotonic Data Display



PARABOLA ~~#12~~
#10

~~ELBOW CURLS~~
tricept
pull-downs

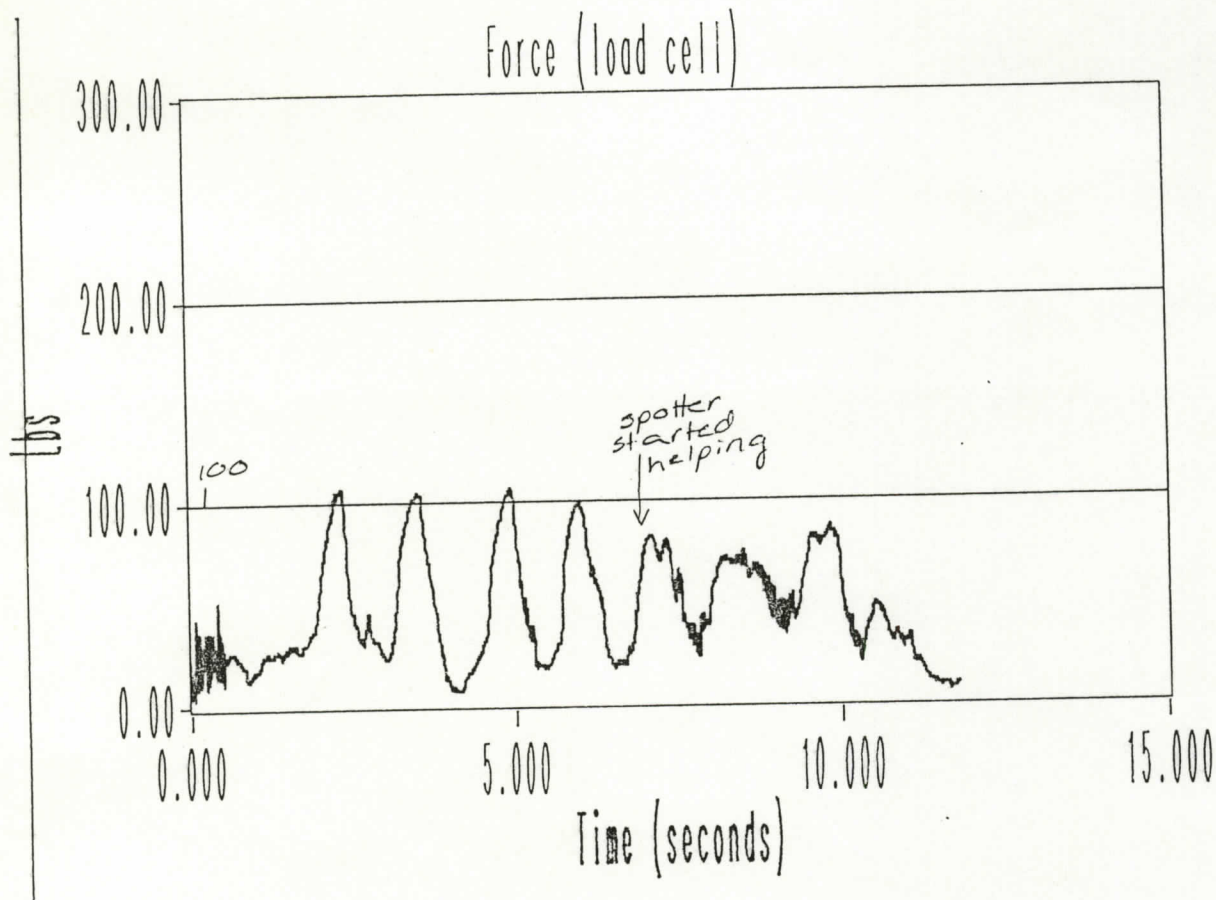
MAX FORCE = 118

SUBJECT 1

Kevin
Kear

* still cannot complete without assistance

KC-135 Isotonic Data Display



PARABOLA ~~13~~
#11

ELBOW CURLS

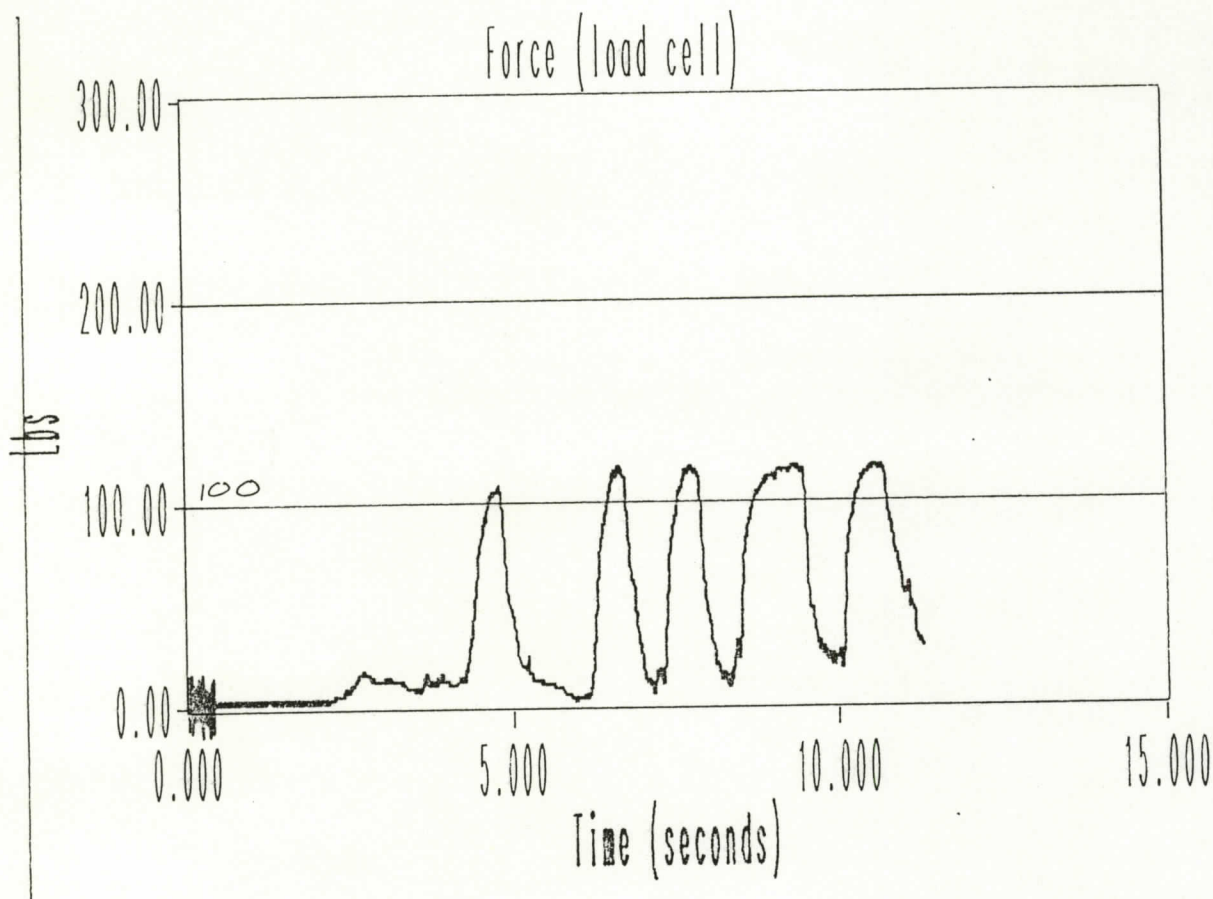
MAX FORCE = 107

SUBJECT 1

kevin
kear

4-19

KC-135 Isotonic Data Display



PARABOLA #1

#12

~~ELBOW CURLS~~

up rows

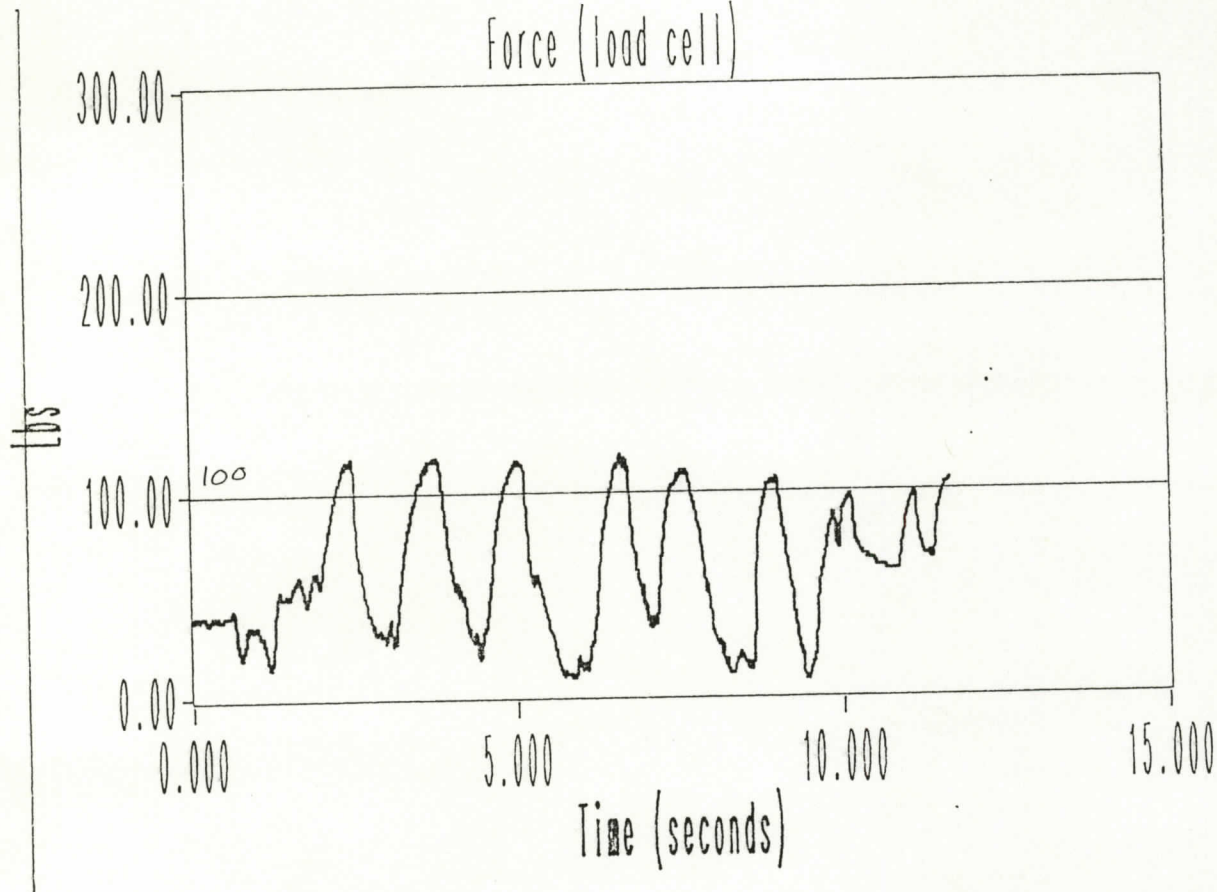
MAX FORCE = 118

SUBJECT 2

Glen
Klute

KC-135 Isotonic Data Display

Force (load cell)



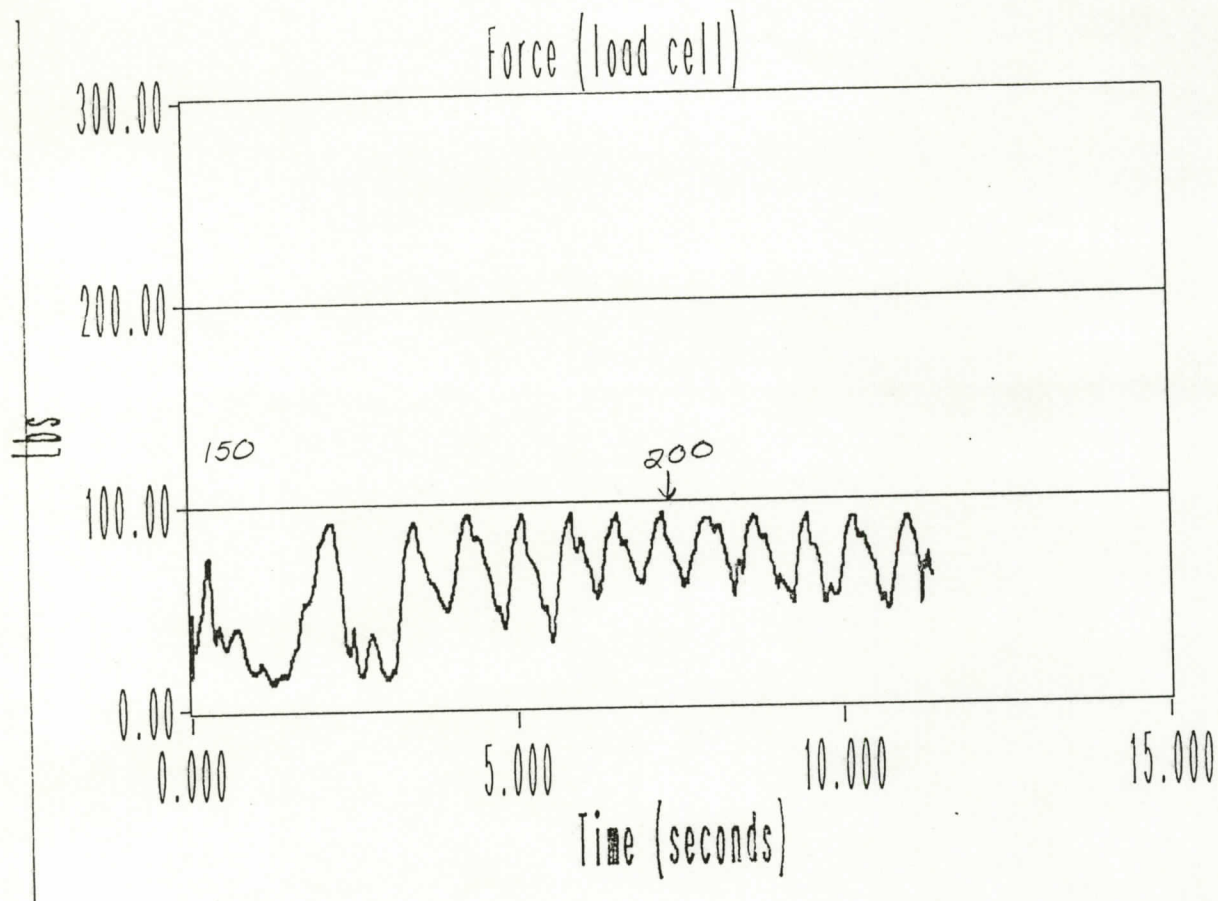
PARABOLA #2
13

~~ELBOW CURLS~~
up rows

MAX FORCE = 119

SUBJECT 2
Glen
klute

KC-135 Isotonic Data Display



PARABOLA #3
14

SQUATS

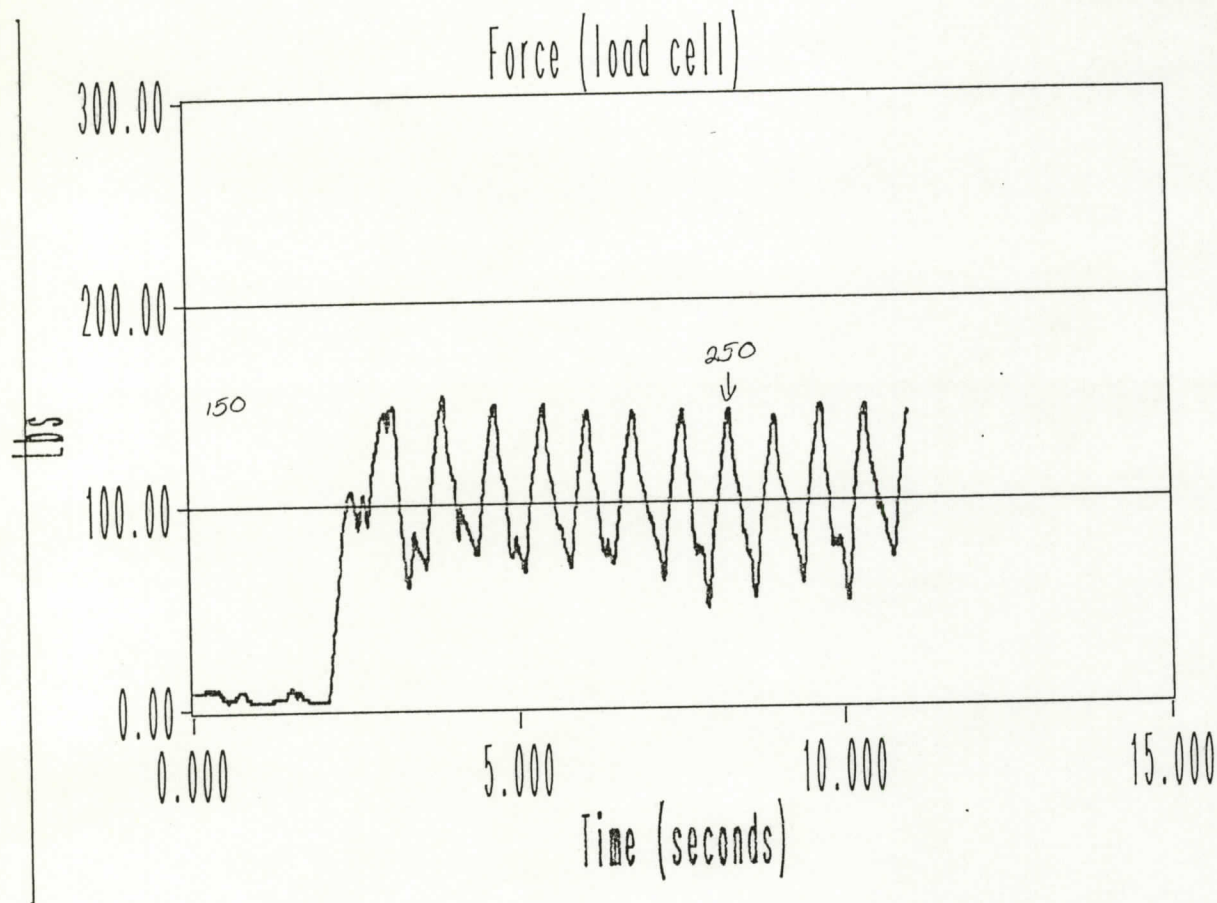
MAX FORCE = 94

SUBJECT 2

Glen
Klute

too much slack in rope
subject only able to do toe raises

KC-135 Isotonic Data Display



PARABOLA #4

15

SQUATS

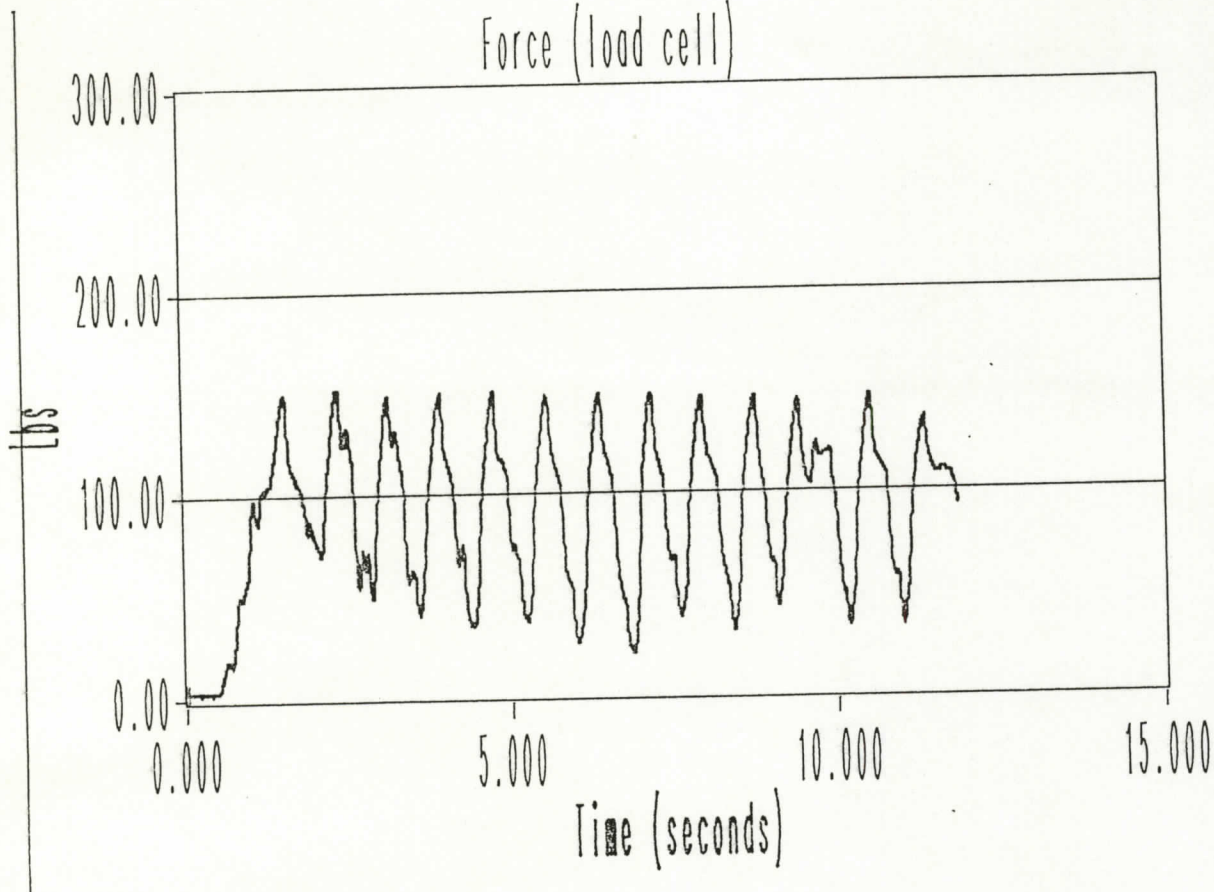
MAX FORCE = 154

SUBJECT 2

Glen
klute

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #5
16

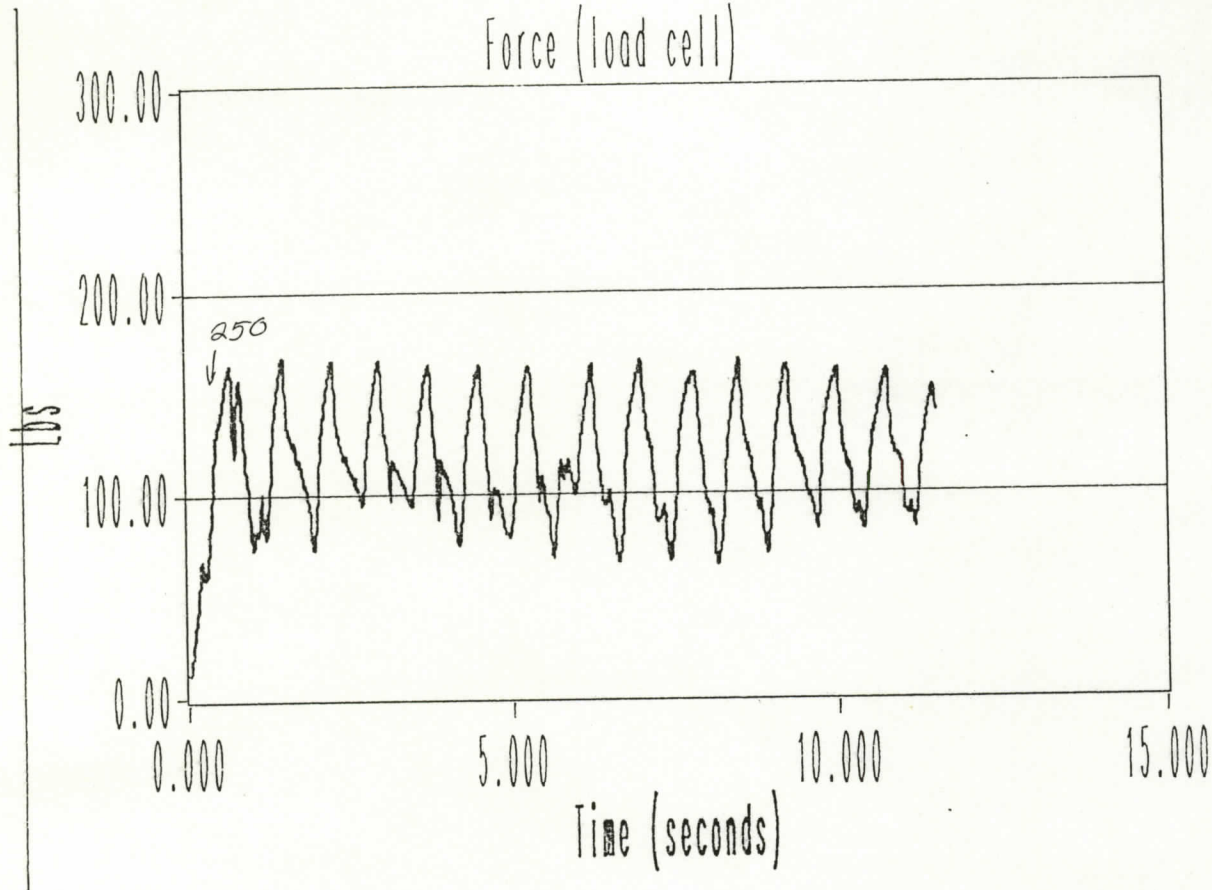
SQUATS

MAX FORCE = 153

SUBJECT 2
Glen
Klute

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #6
17

~~PULL UPS~~
squats

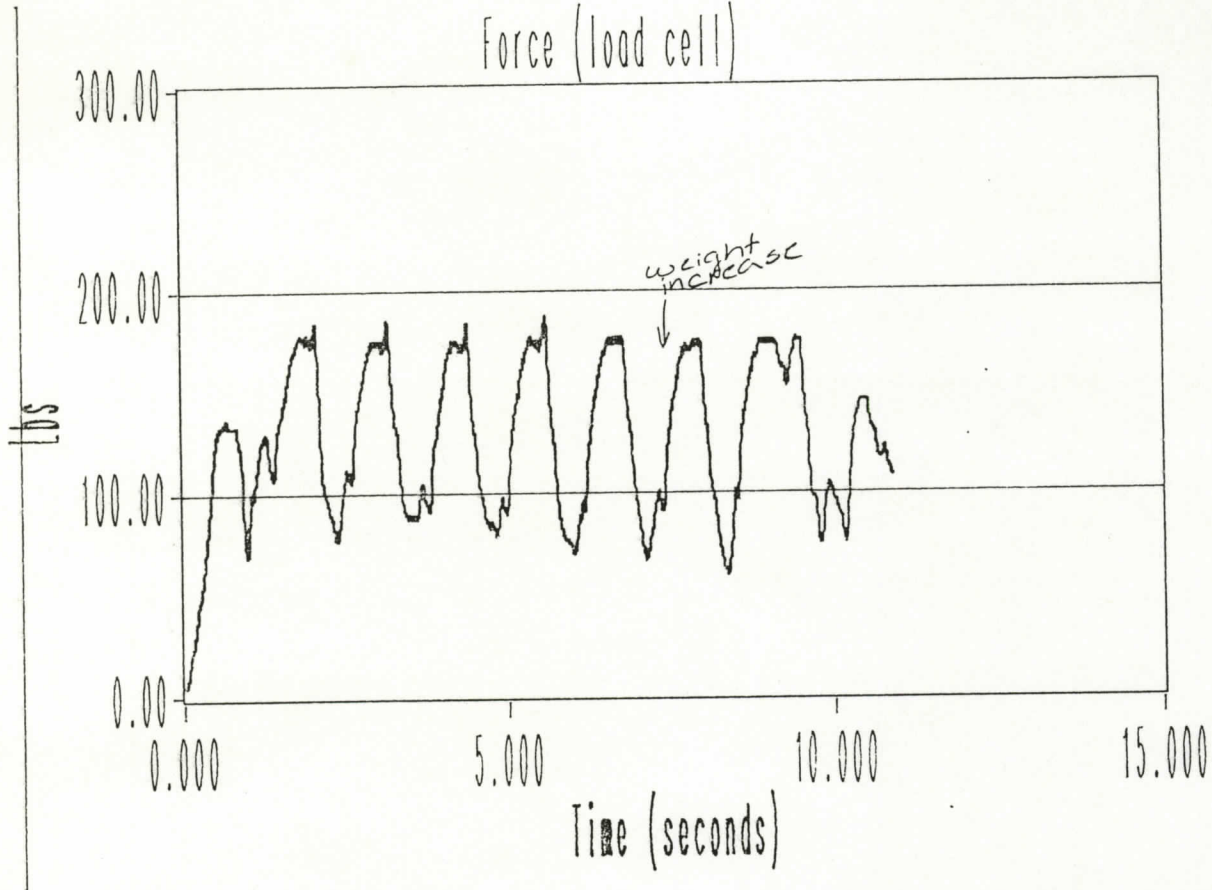
MAX FORCE = 169

SUBJECT 2
Glen
Klute

exercise was tiring on the knees

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA 7
18

PULL UPS

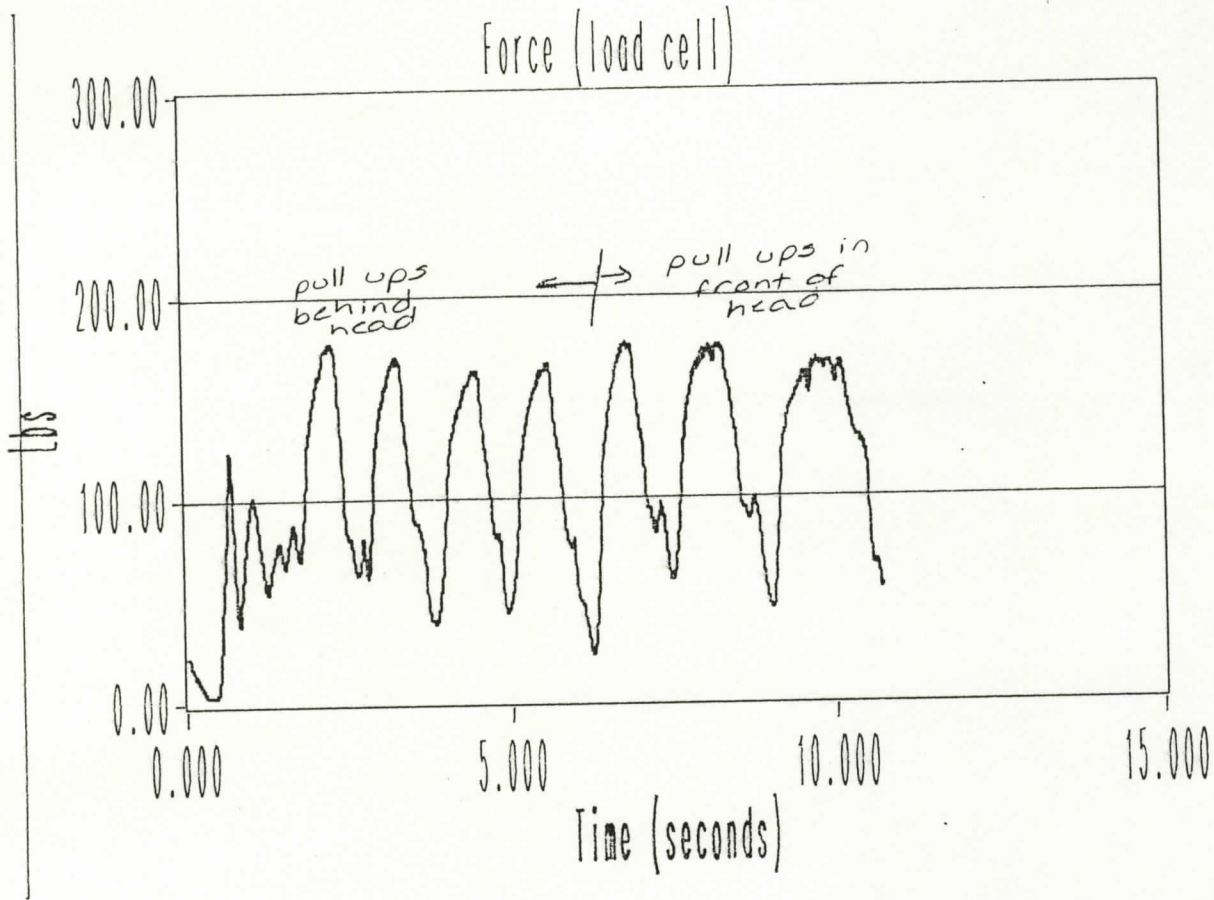
MAX FORCE = 187

SUBJECT 2

Glen
Klute

9-19

KC-135 Isotonic Data Display



PARABOLA #8
19

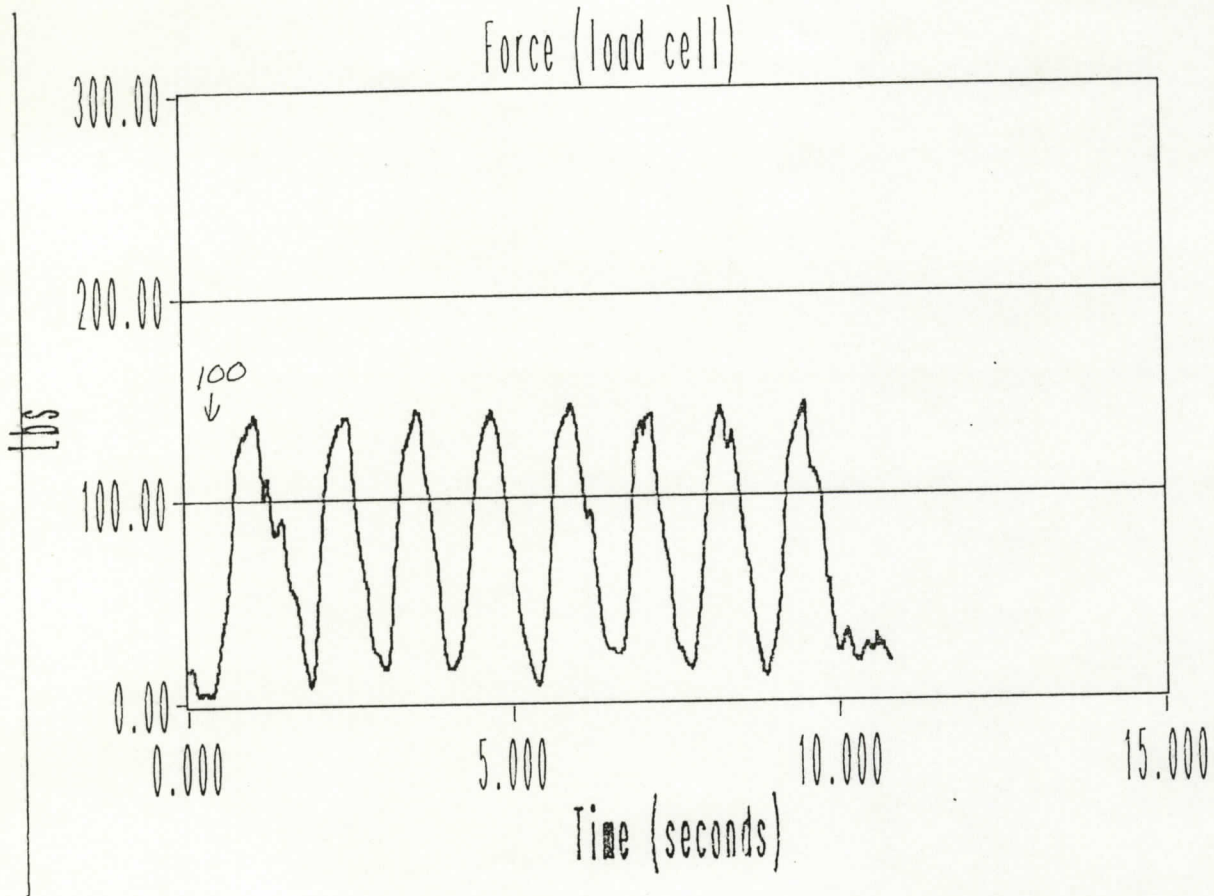
PULL UPS

MAX FORCE = 178

SUBJECT 2

Glen
Klute

KC-135 Isotonic Data Display



PARABOLA 79
20

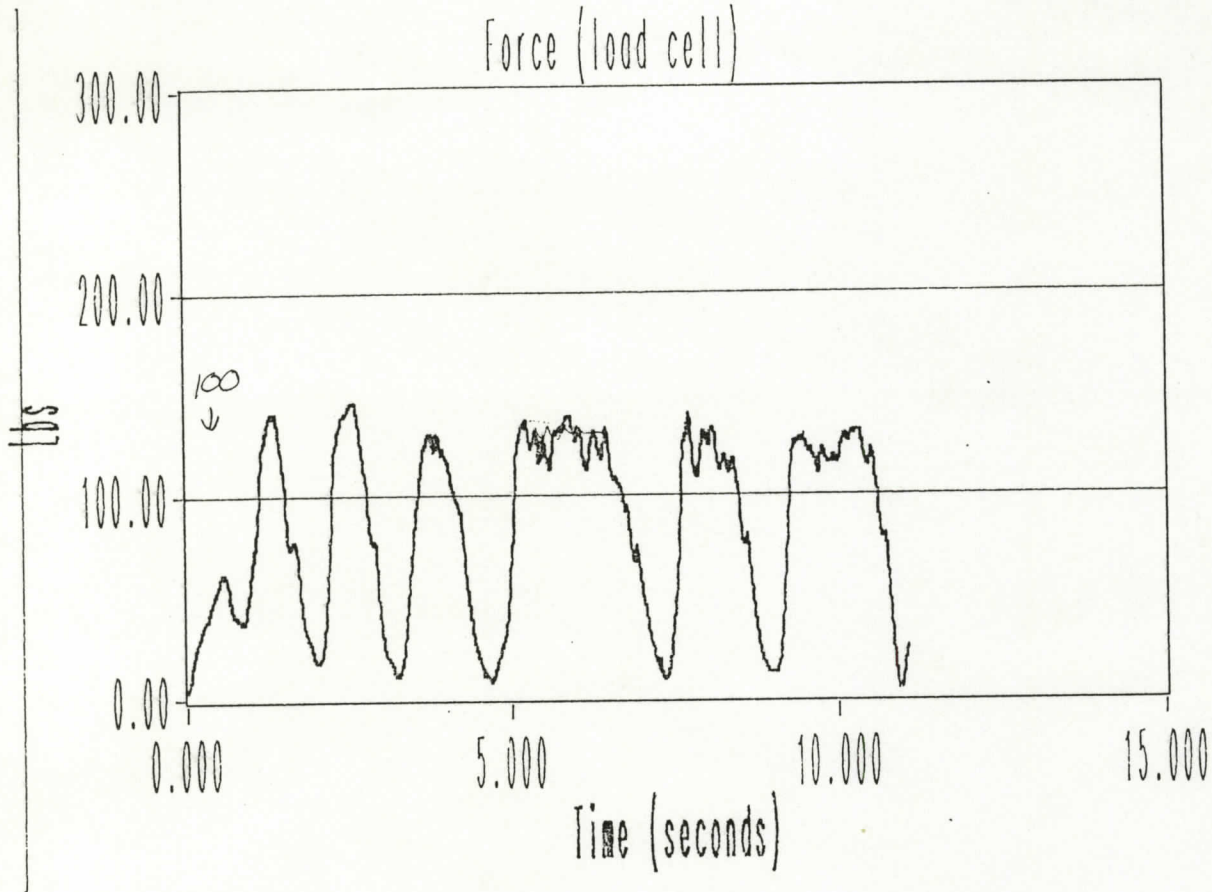
BAR DIPS

MAX FORCE = 145

SUBJECT 2
Glen
klute

KC-135 Isotonic Data Display

Force (load cell)



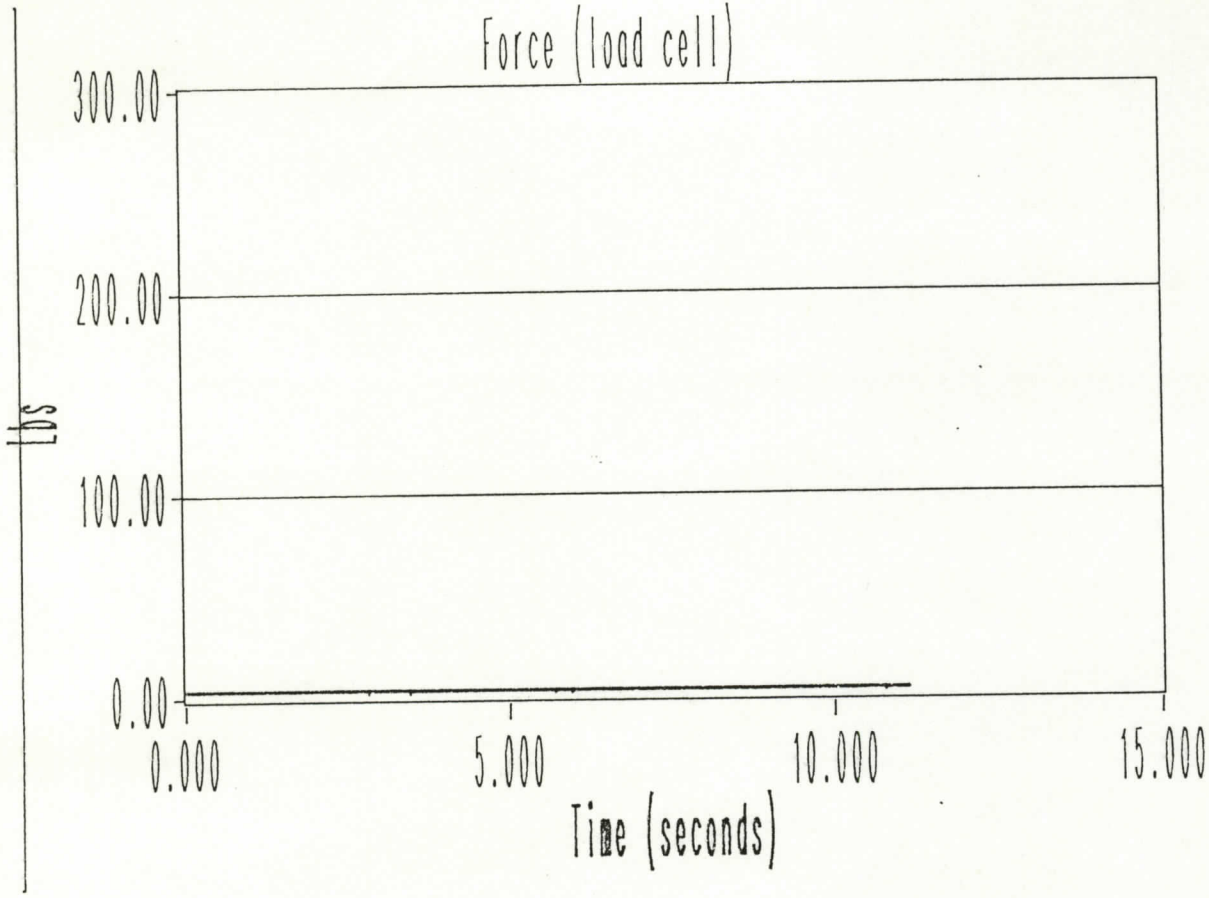
PARABOLA 110
21

BAR DIPS

MAX FORCE = 146

SUBJECT 2
Glen
Klute

KC-135 Isotonic Data Display



PARABOLA #1
22

BAR DIPS

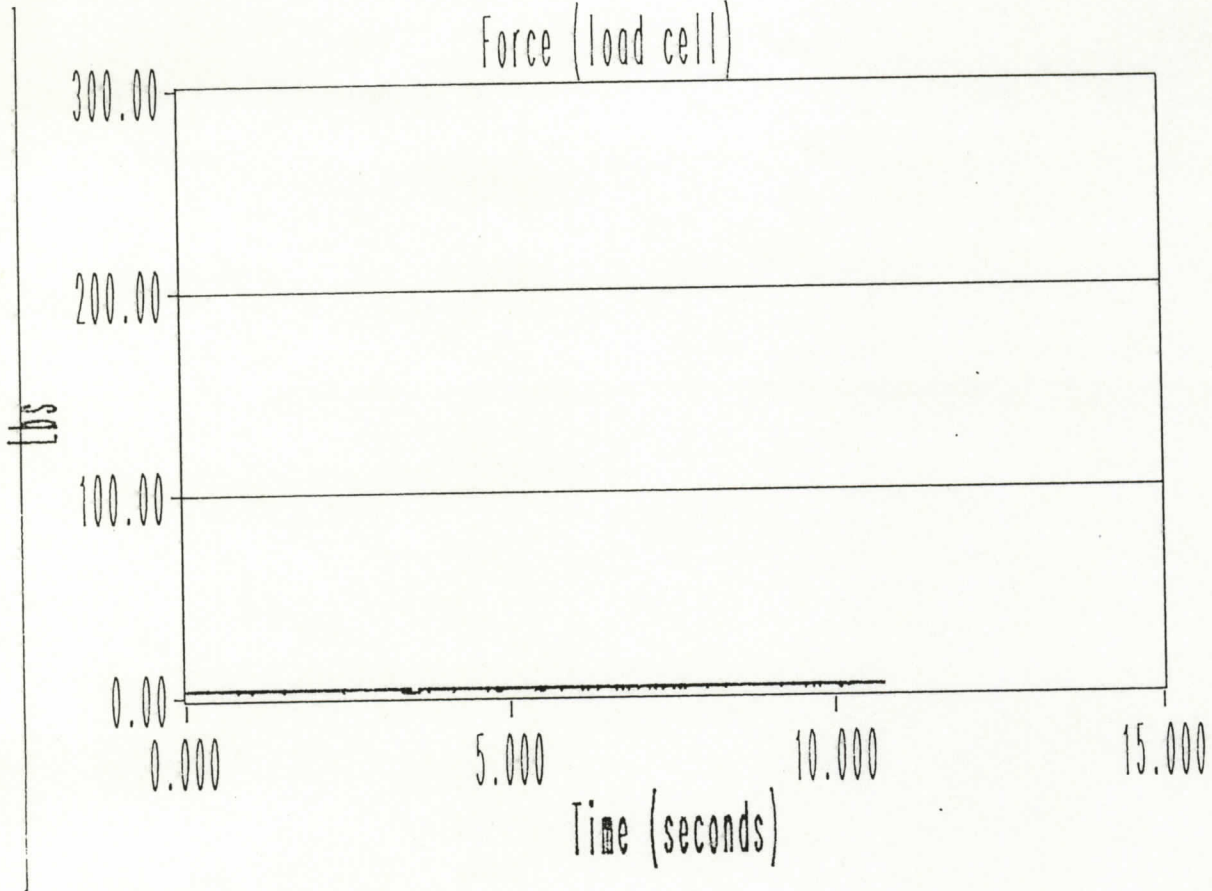
MAX FORCE = 4

SUBJECT 3

no test, changing subjects

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #2
23

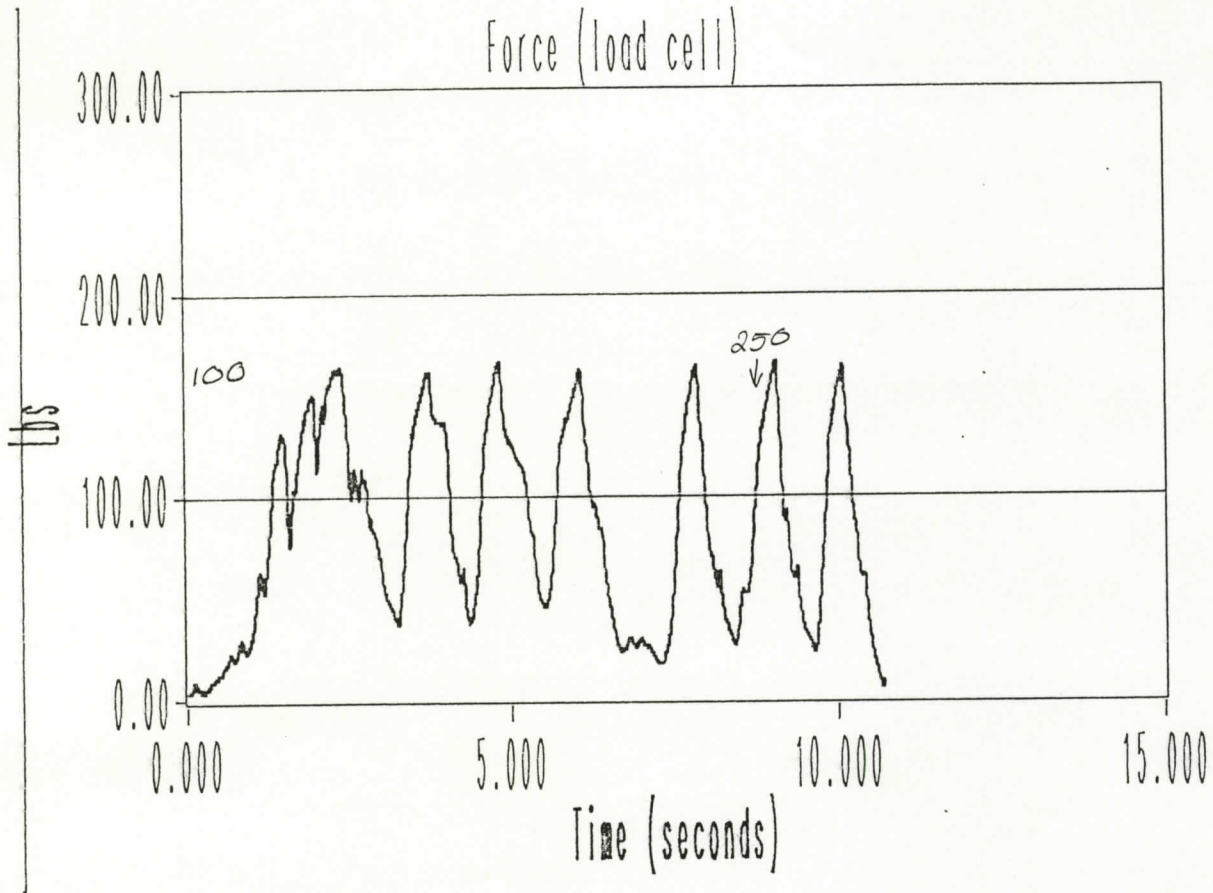
SQUATS

MAX FORCE = 4

SUBJECT 3

no test, changing subjects

KC-135 Isotonic Data Display



PARABOLA #1
24

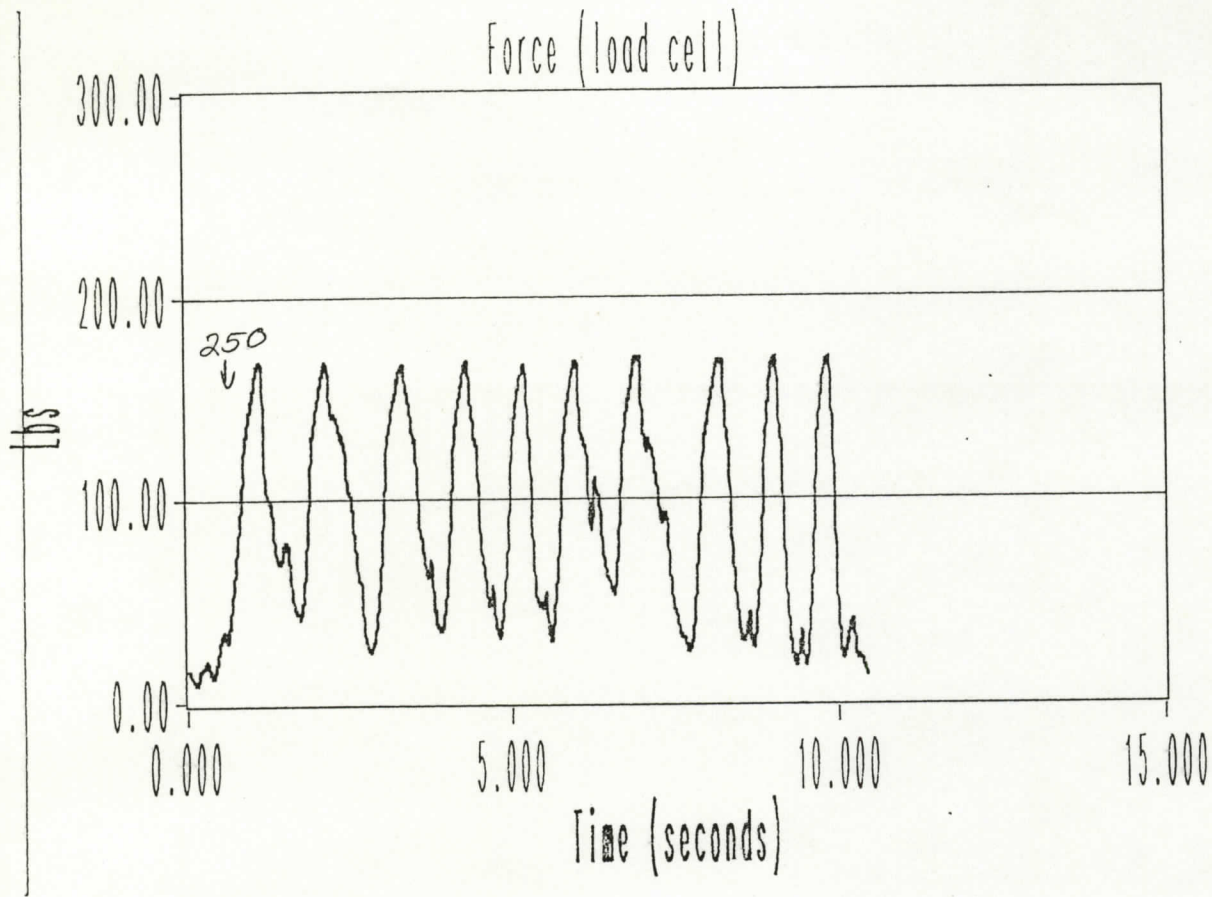
SQUATS

MAX FORCE = 167

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display



PARABOLA 1/2
25

SQUATS

MAX FORCE = 171

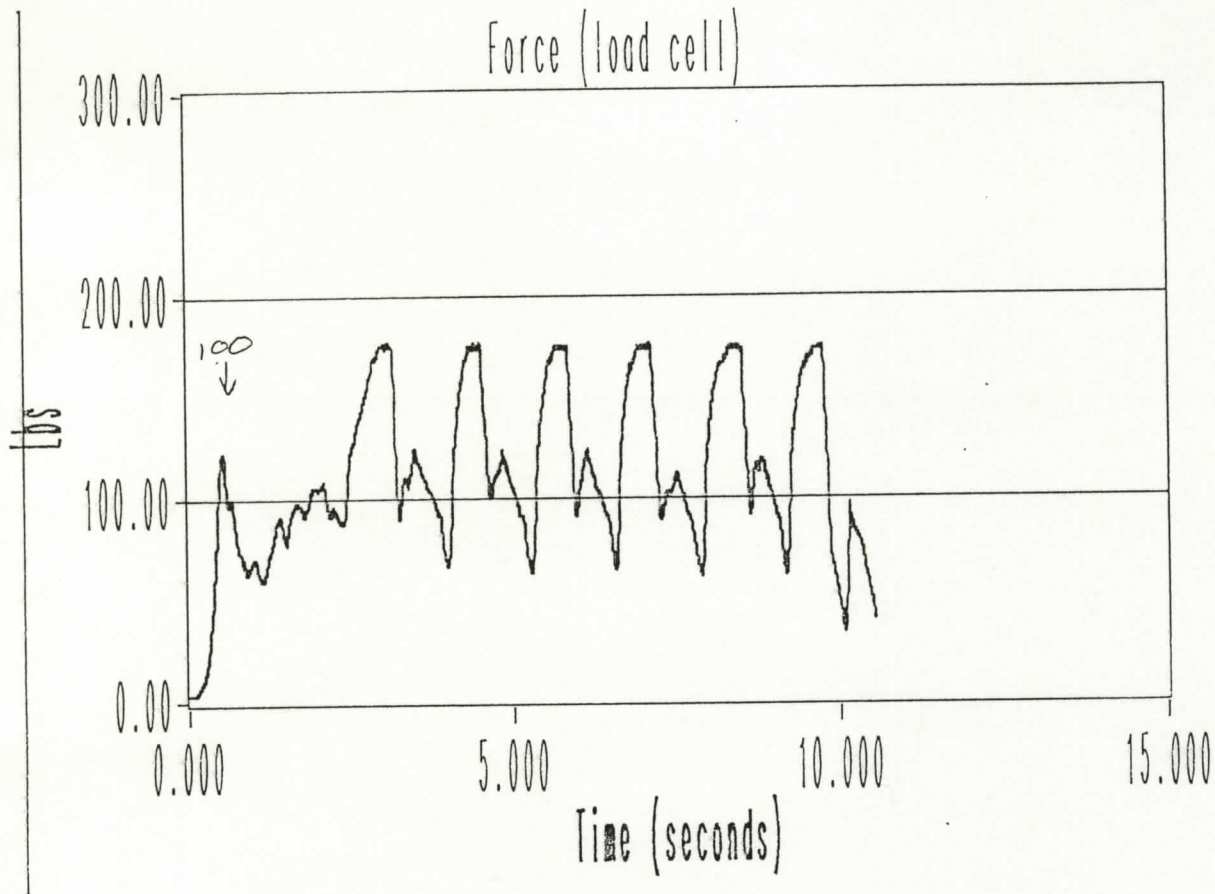
SUBJECT 3

John
Kiowski

* 2 foot range of motion noted

4-19

KC-135 Isotonic Data Display



PARABOLA #3
26

PULL UPS

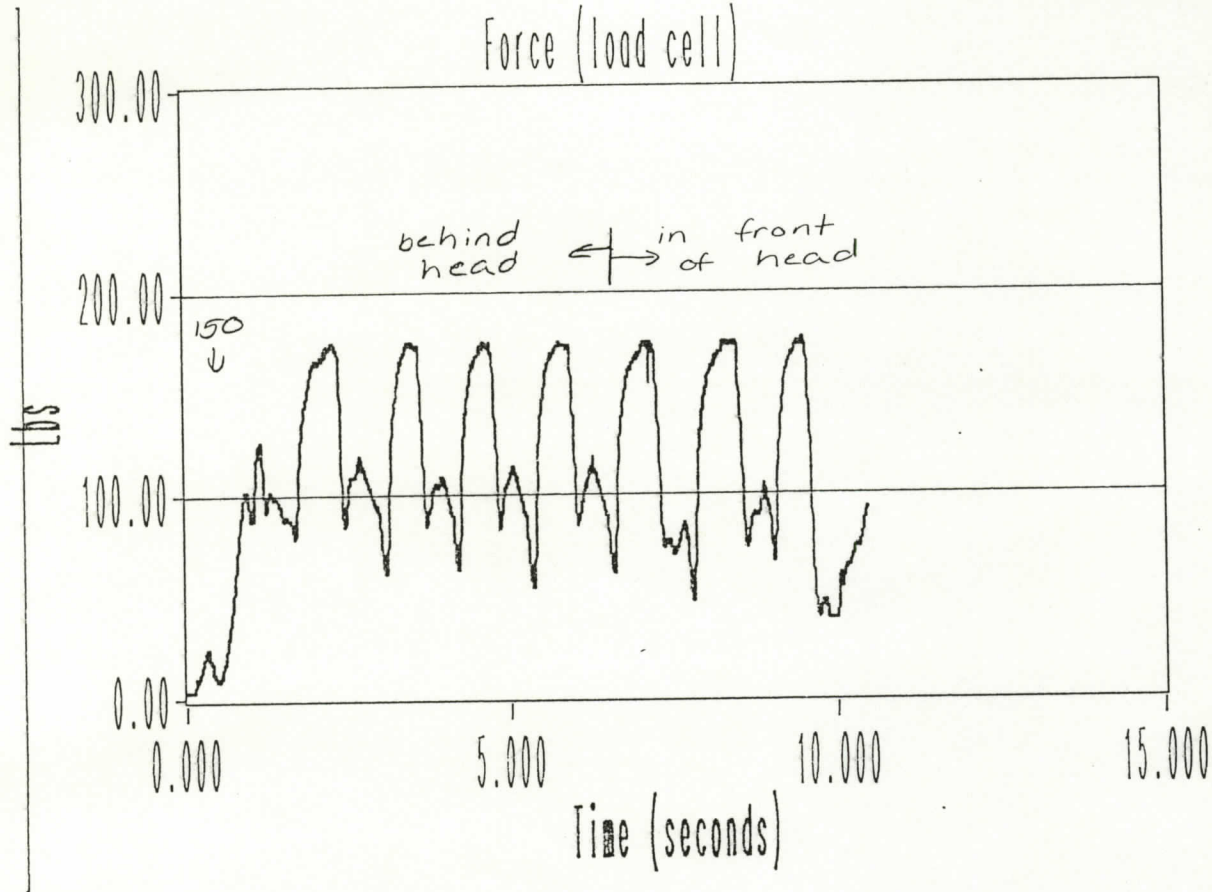
MAX FORCE = 178

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #4
27

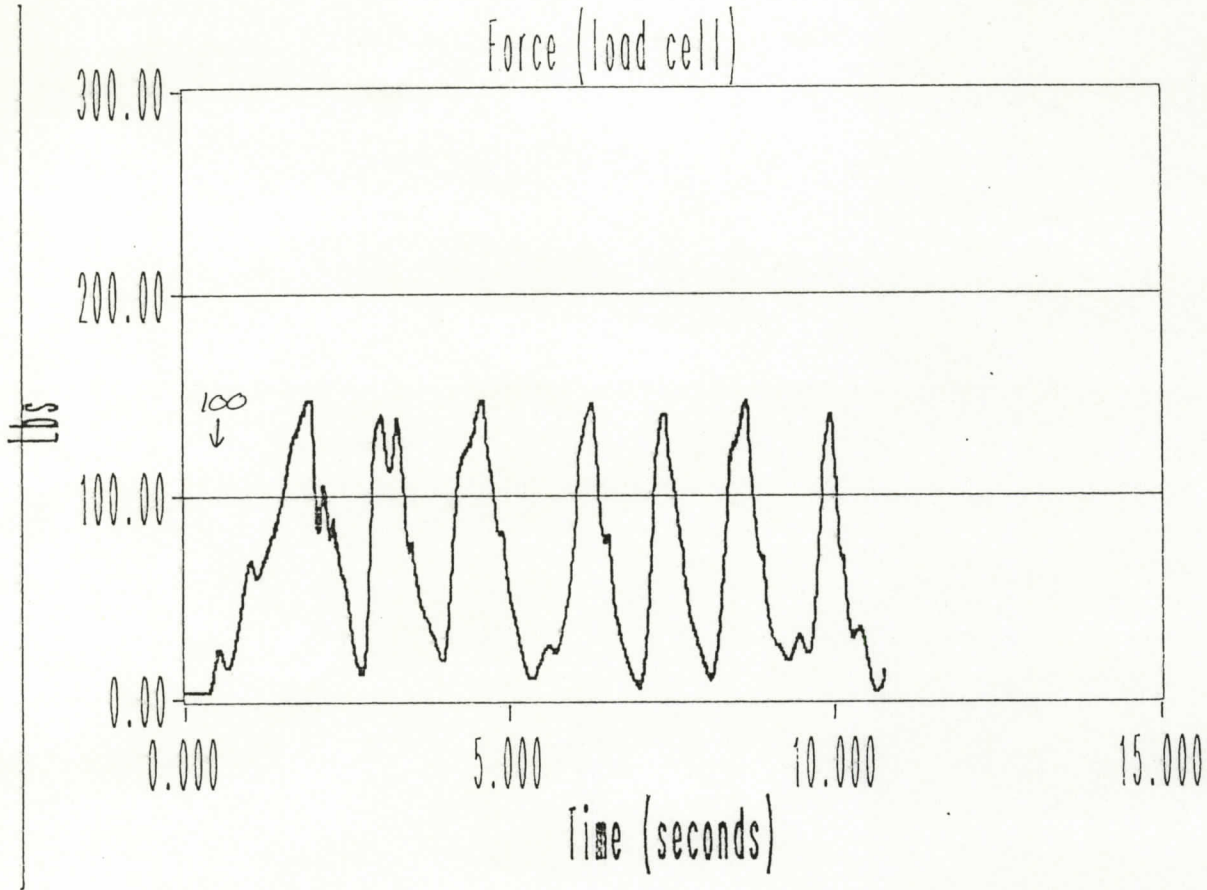
PULL UPS

MAX FORCE = 177

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display



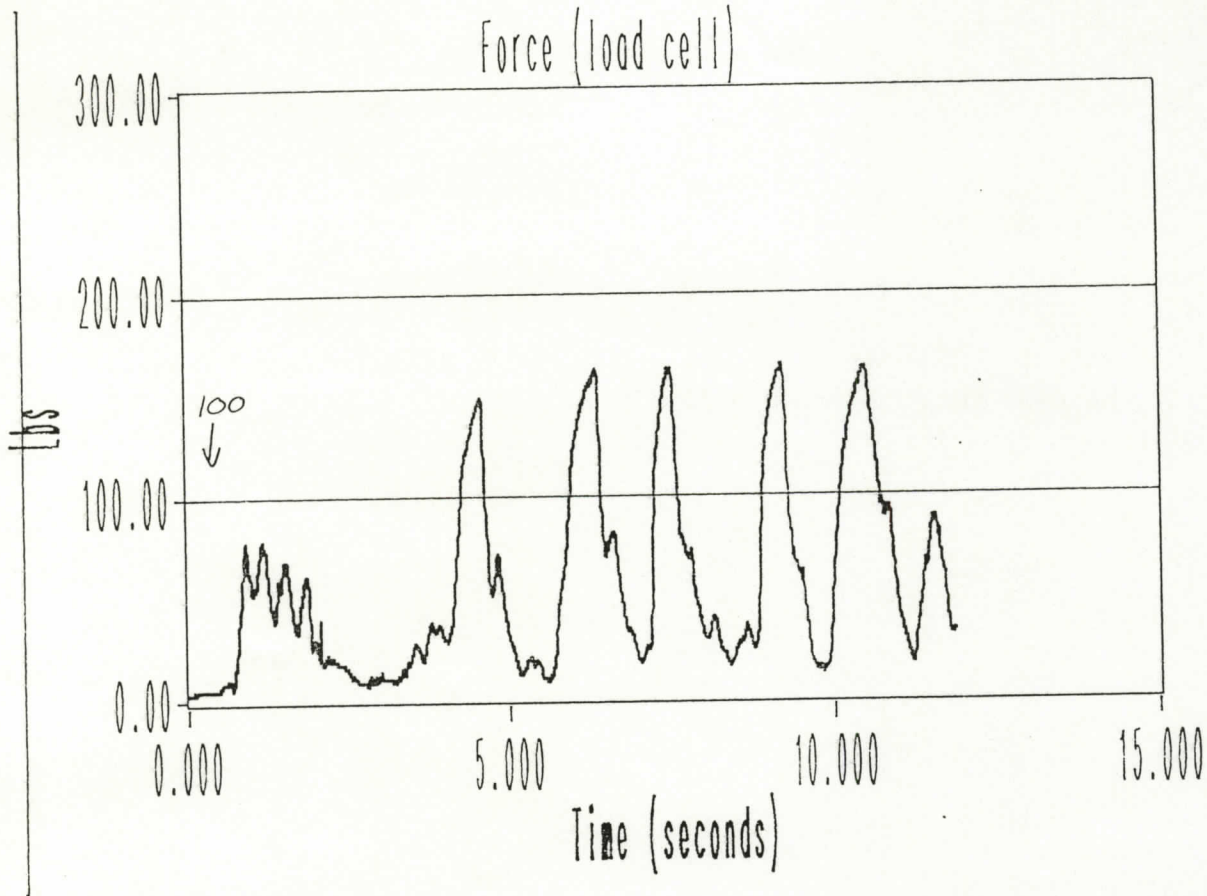
PARABOLA #5
28

BAR DIPS

MAX FORCE = 148

SUBJECT 3
John
Kiowski

KC-135 Isotonic Data Display



PARABOLA #7
29

ELBOW CURLS

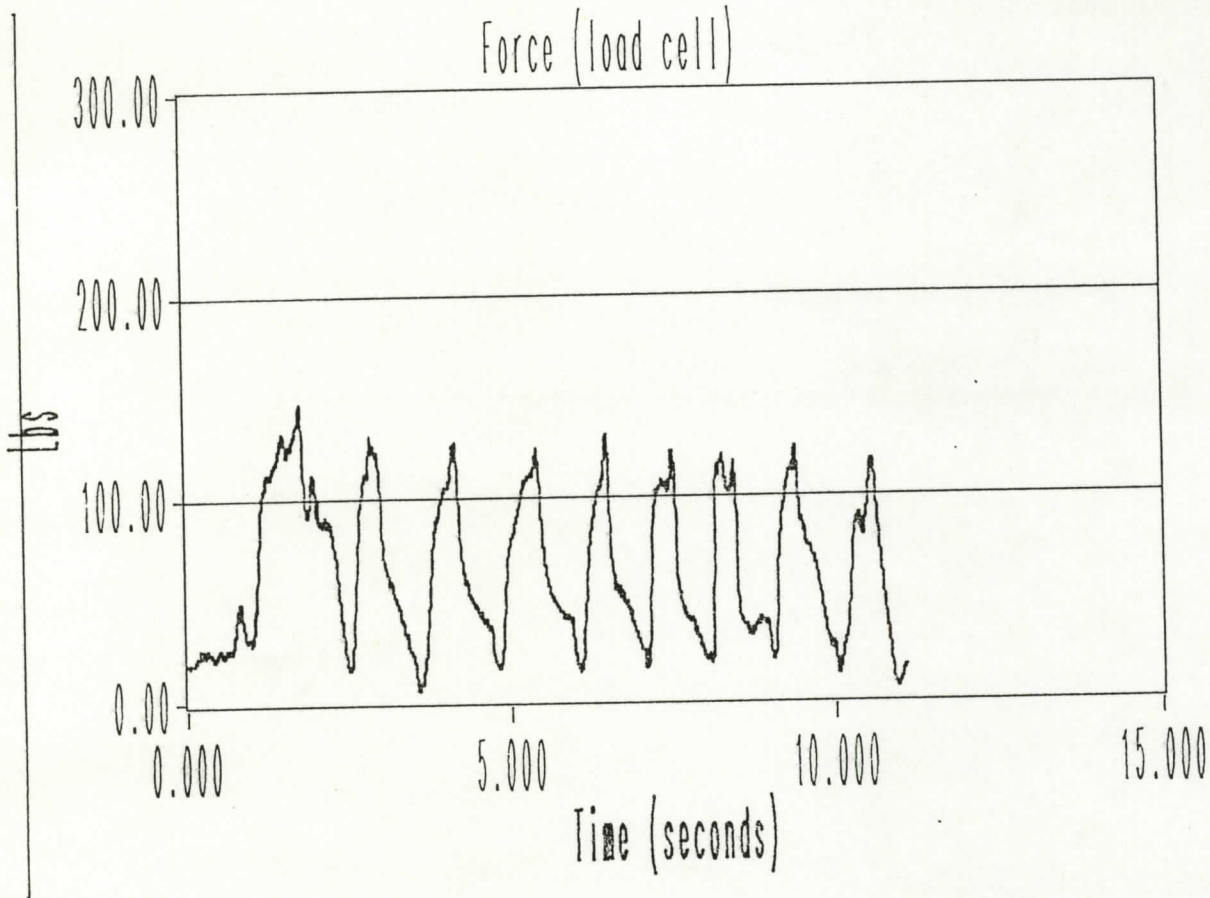
MAX FORCE = 165

SUBJECT 3

John
Kiowski

full curl not completed
the 100 lbs was a heavy load to lift

KC-135 Isotonic Data Display



PARABOLA 48
30

ELBOW CURLS

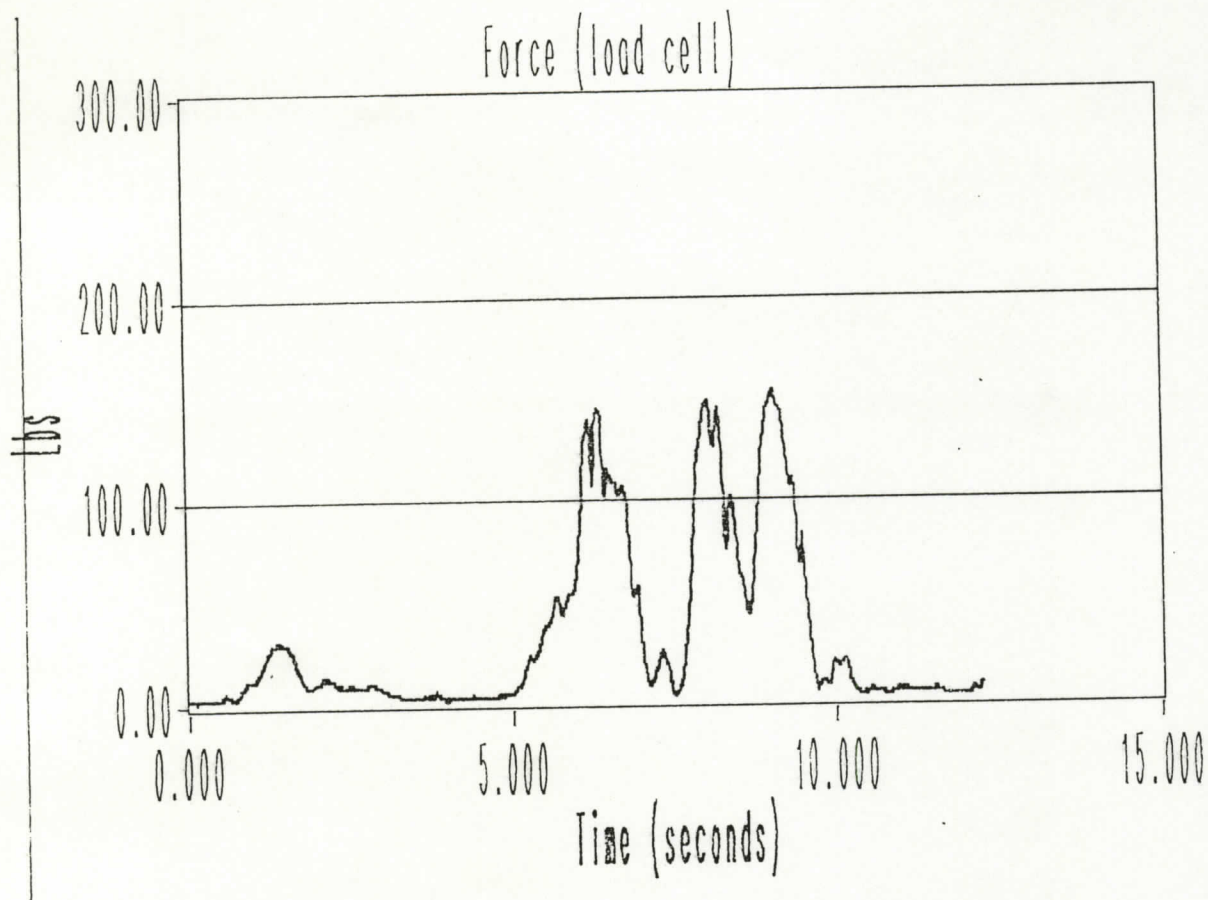
MAX FORCE = 147

SUBJECT 3

John
Kiowski

subject required spotting
throughout exercise

KC-135 Isotonic Data Display



PARABOLA #9

31.

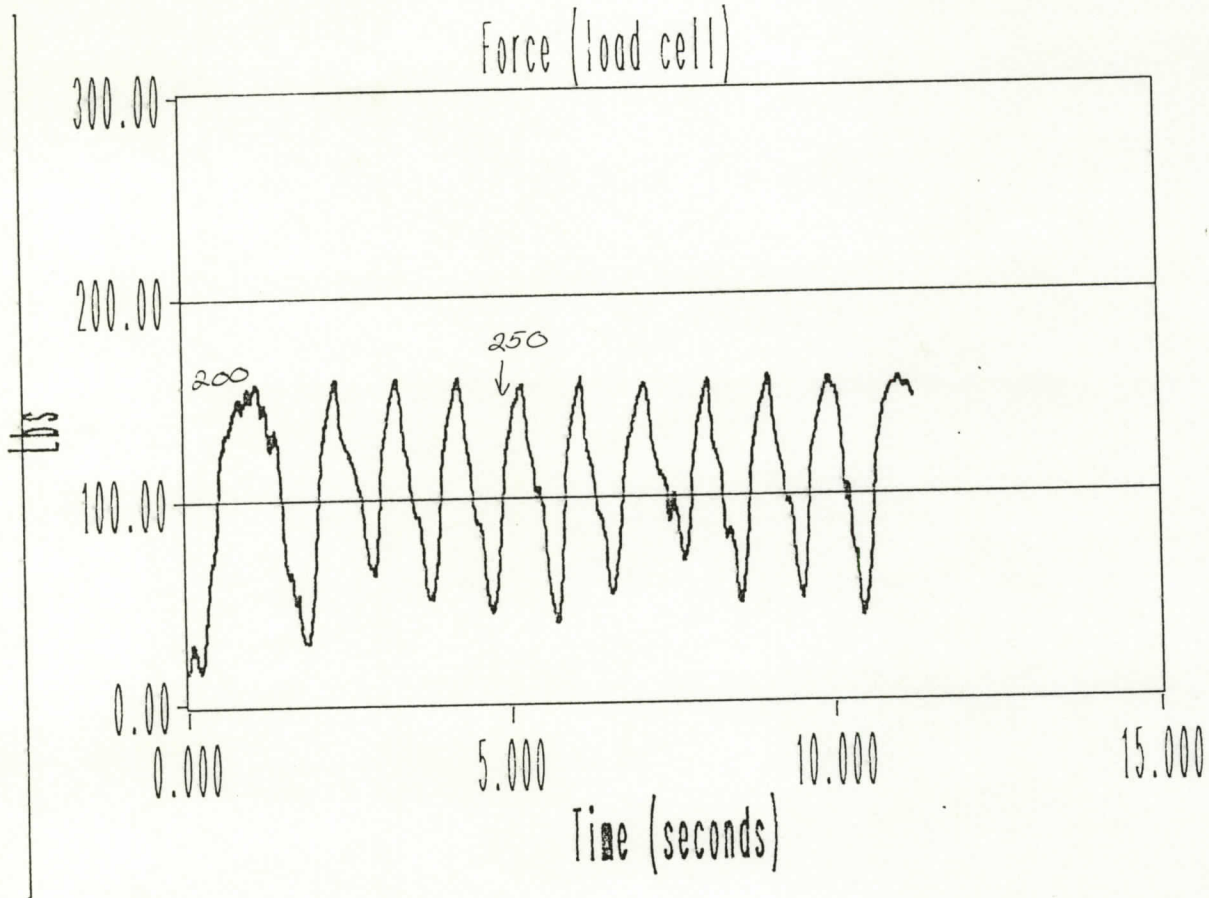
SQUATS

MAX FORCE = 154

SUBJECT 4

parabola not recorded on video

KC-135 Isotonic Data Display



PARABOLA 1
32

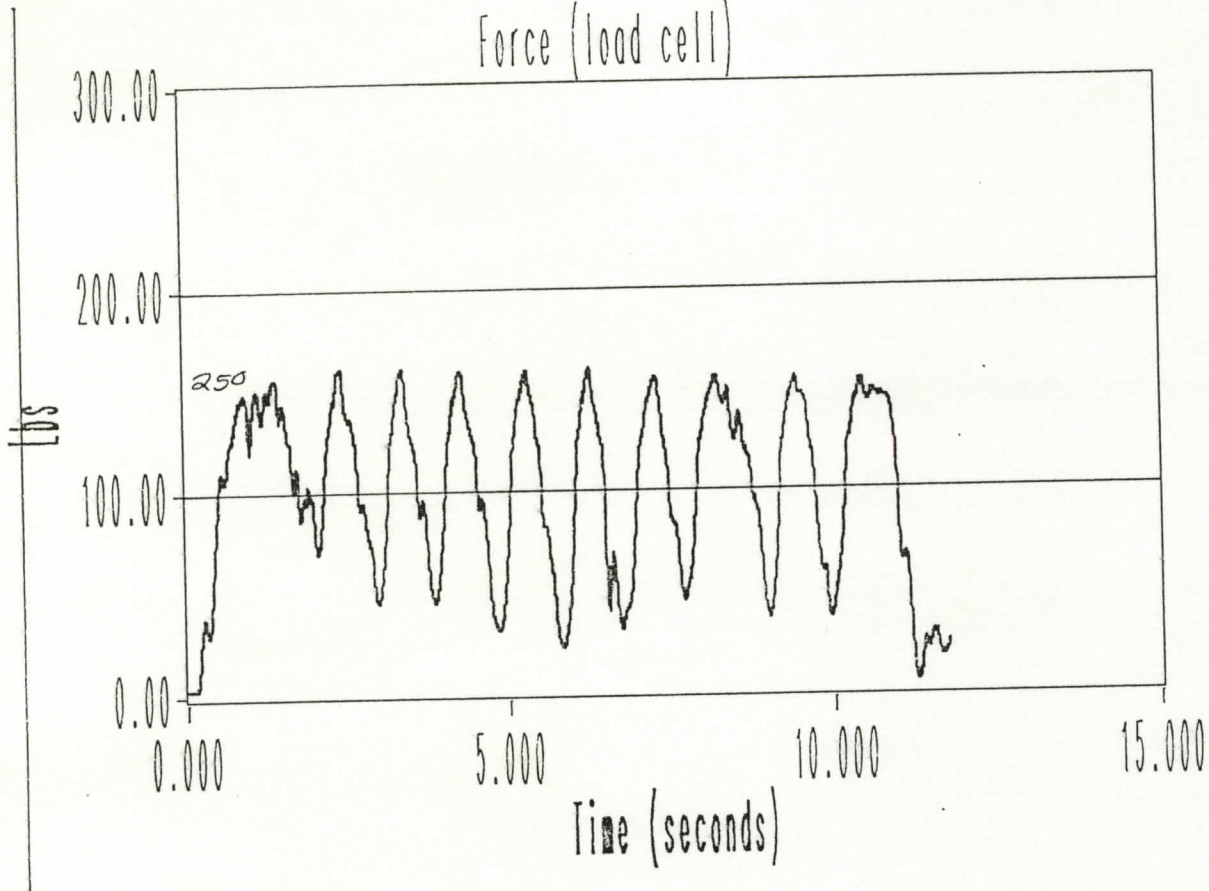
SQUATS

MAX FORCE = 160

SUBJECT 4
Rick
Smith

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA $\frac{1}{2}$

33

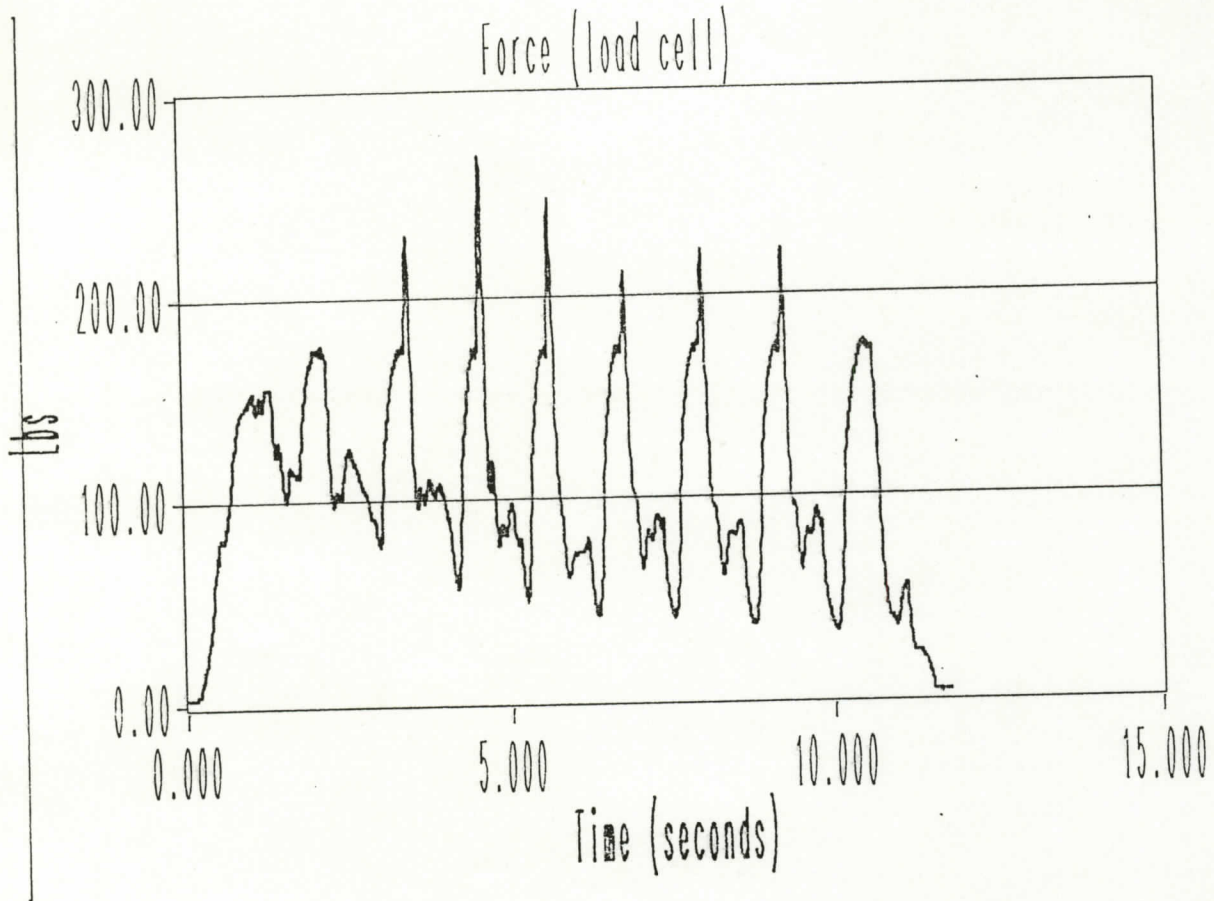
SQUATS

MAX FORCE = 162

SUBJECT 4

Rick
Smith

KC-135 Isotonic Data Display



PARABOLA 1/3
34

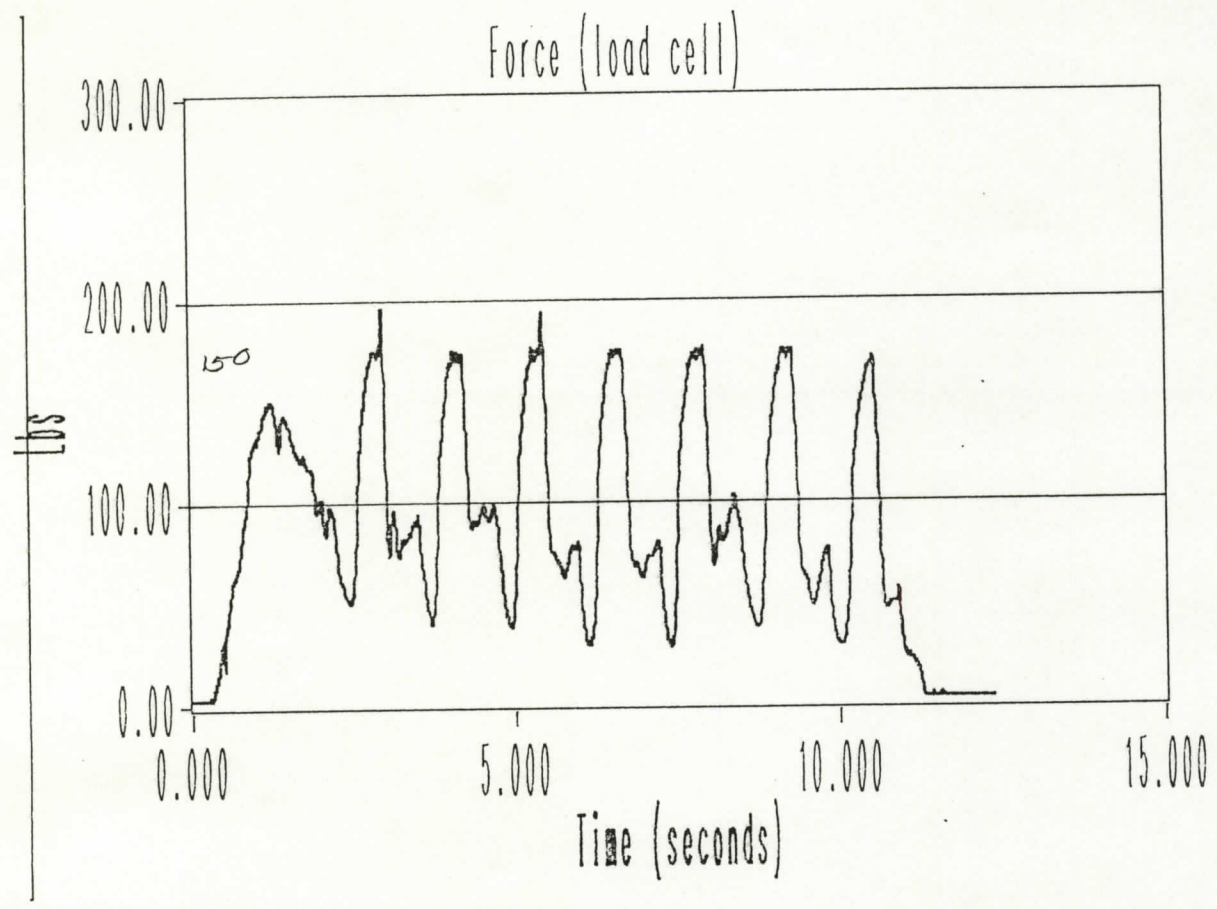
PULL UPS

MAX FORCE = 271

SUBJECT 4

Rick
Smith

KC-135 Isotonic Data Display



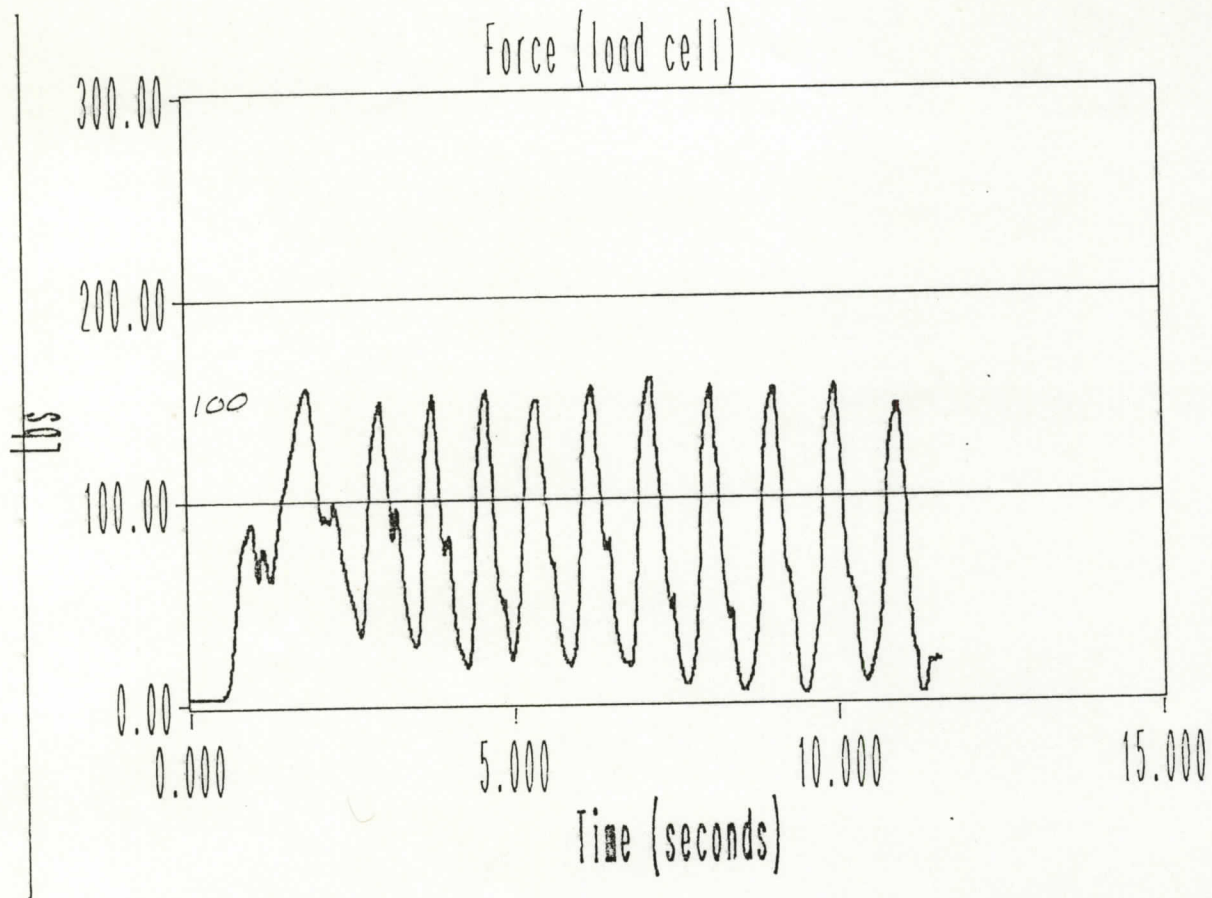
PARABOLA #4
35

PULL UPS

MAX FORCE = 197

SUBJECT 4
Rick
Smith

KC-135 Isotonic Data Display



PARABOLA 7/5
36

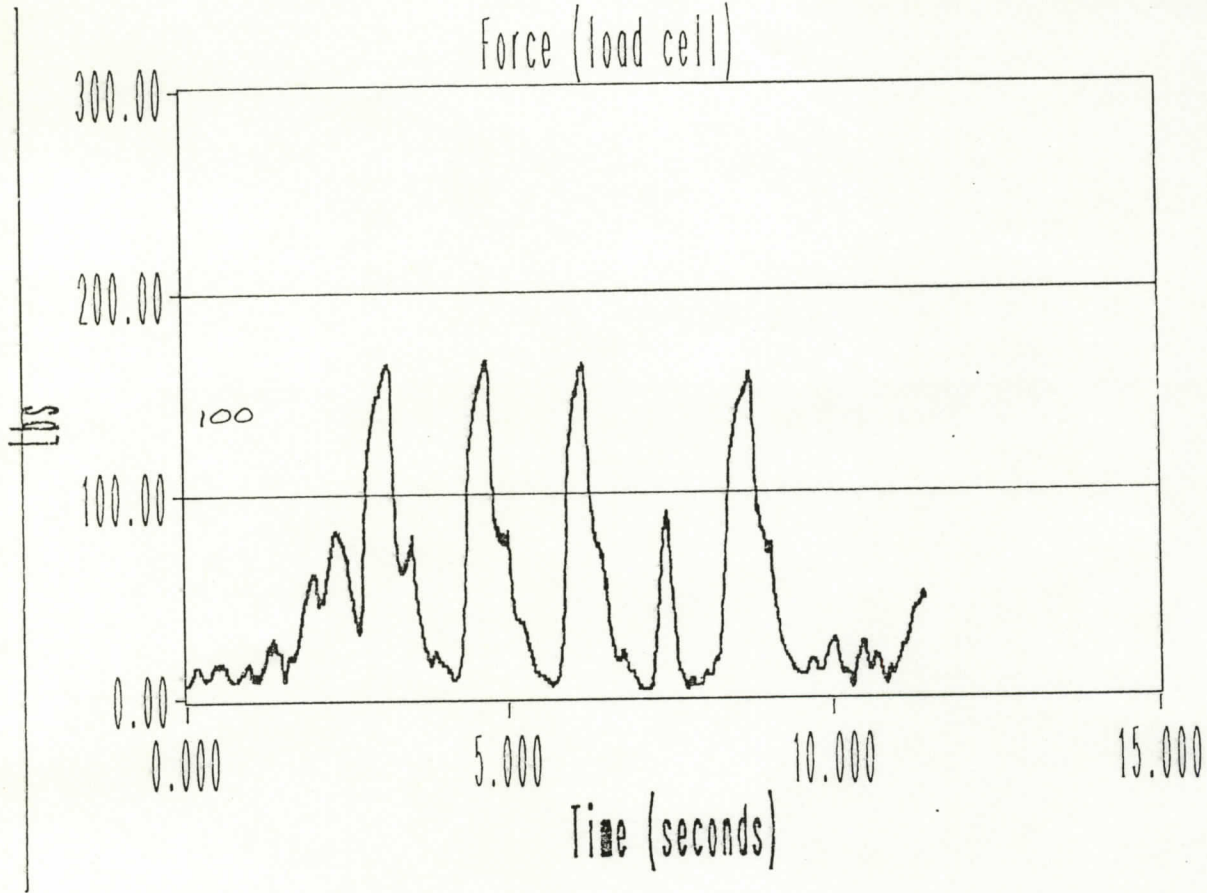
BAR DIPS

MAX FORCE = 160

SUBJECT 4
Rick
Smith

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #6

37

~~BAR DIPS~~

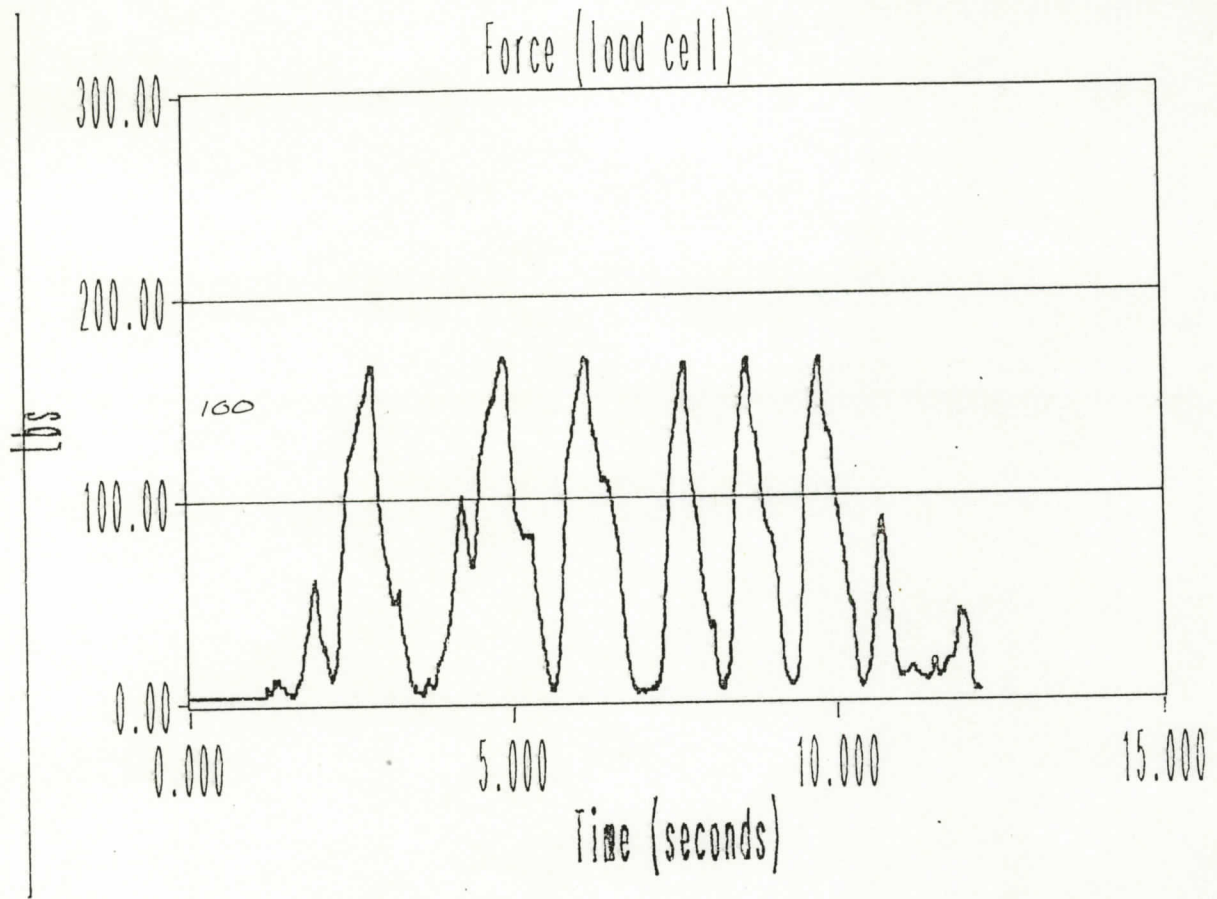
elbow
curls

MAX FORCE = 167

SUBJECT 4

John
Kiowski

KC-135 Isotonic Data Display



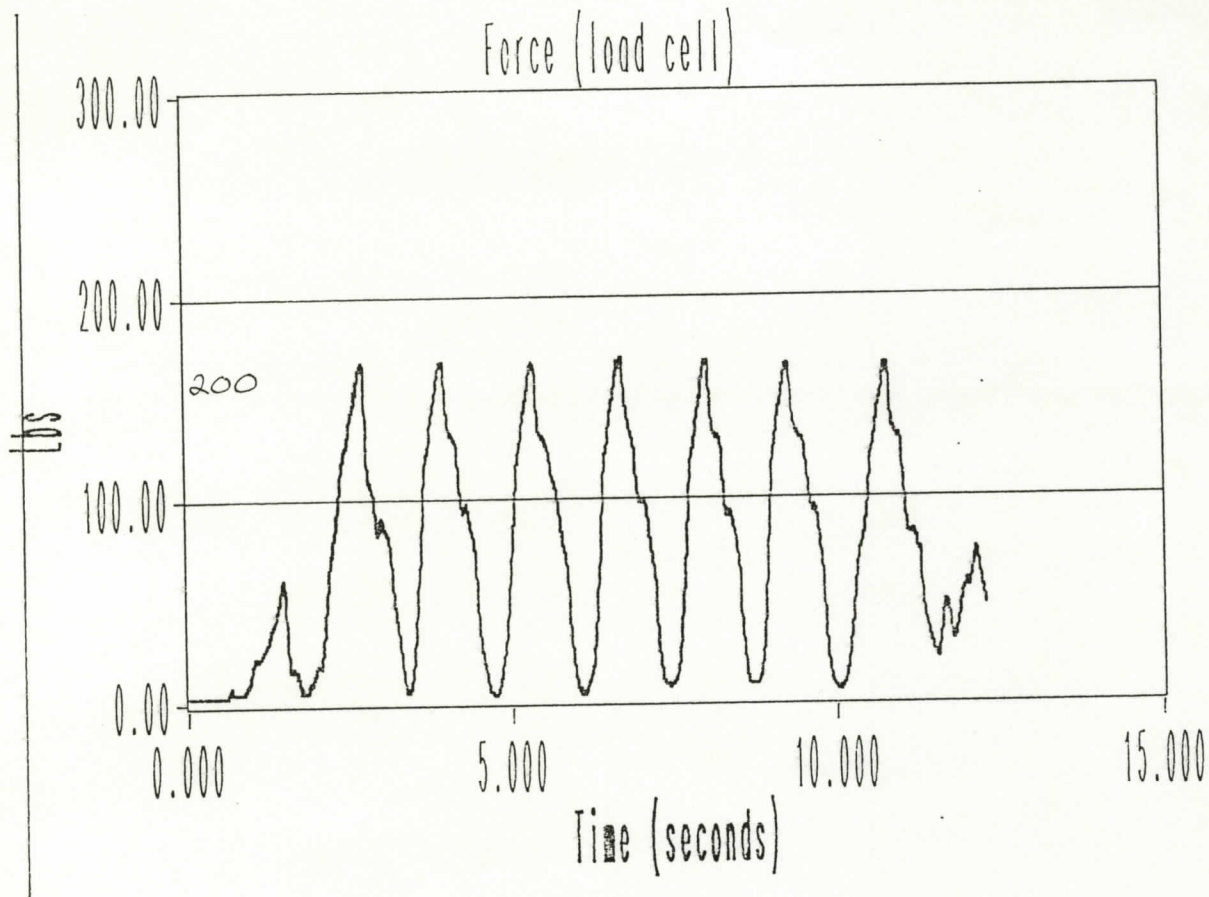
PARABOLA $\frac{7}{38}$

~~BAR DIPS~~
dead
lifts

MAX FORCE = 171

SUBJECT 4
John
Kiewski

KC-135 Isotonic Data Display

PARABOLA $\frac{1}{8}$

39

~~BAR DIPS~~dead
lifts

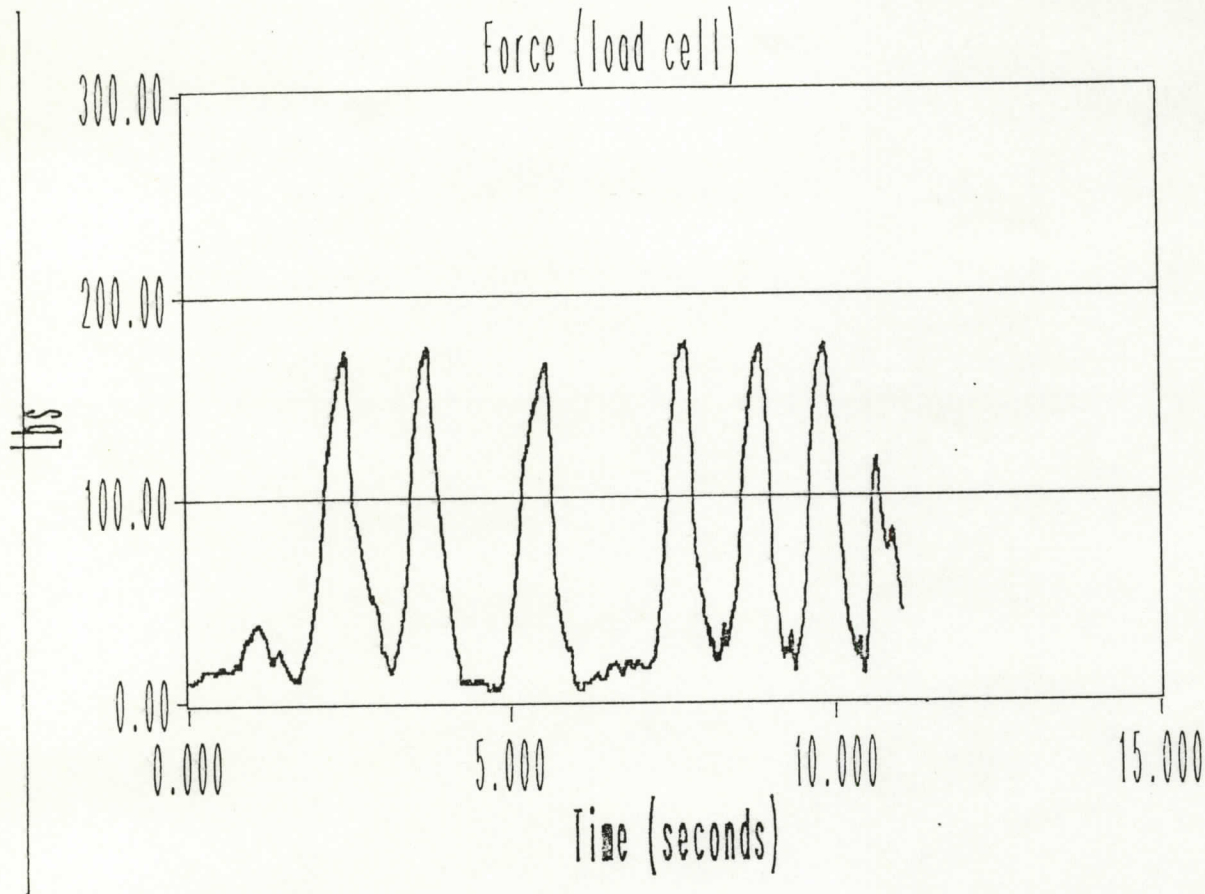
MAX FORCE = 171

SUBJECT 4

John
Kiowski

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #9
40

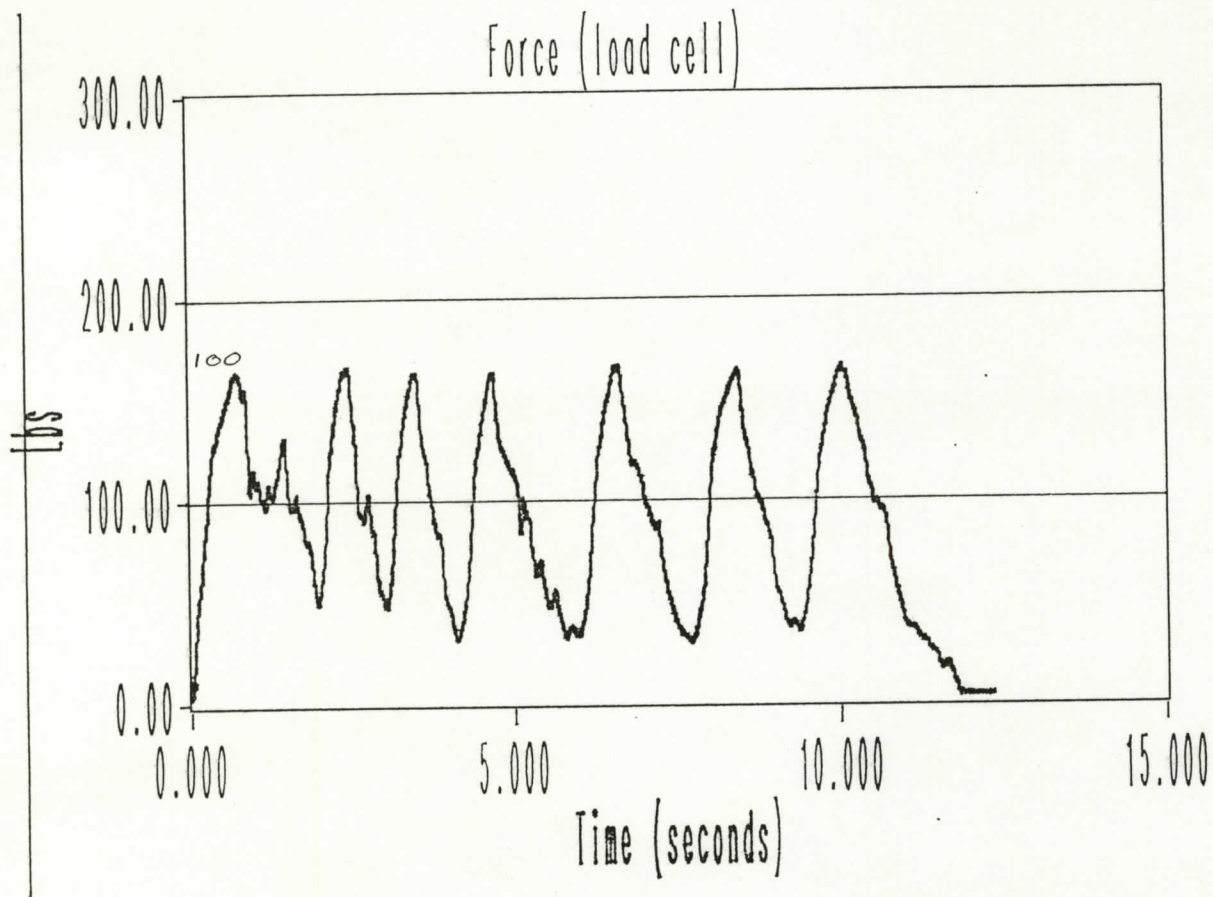
~~BAR DIPS~~
dead
lifts

MAX FORCE = 177

SUBJECT 4
John
Kiowski

not filmed

KC-135 Isotonic Data Display



PARABOLA #1

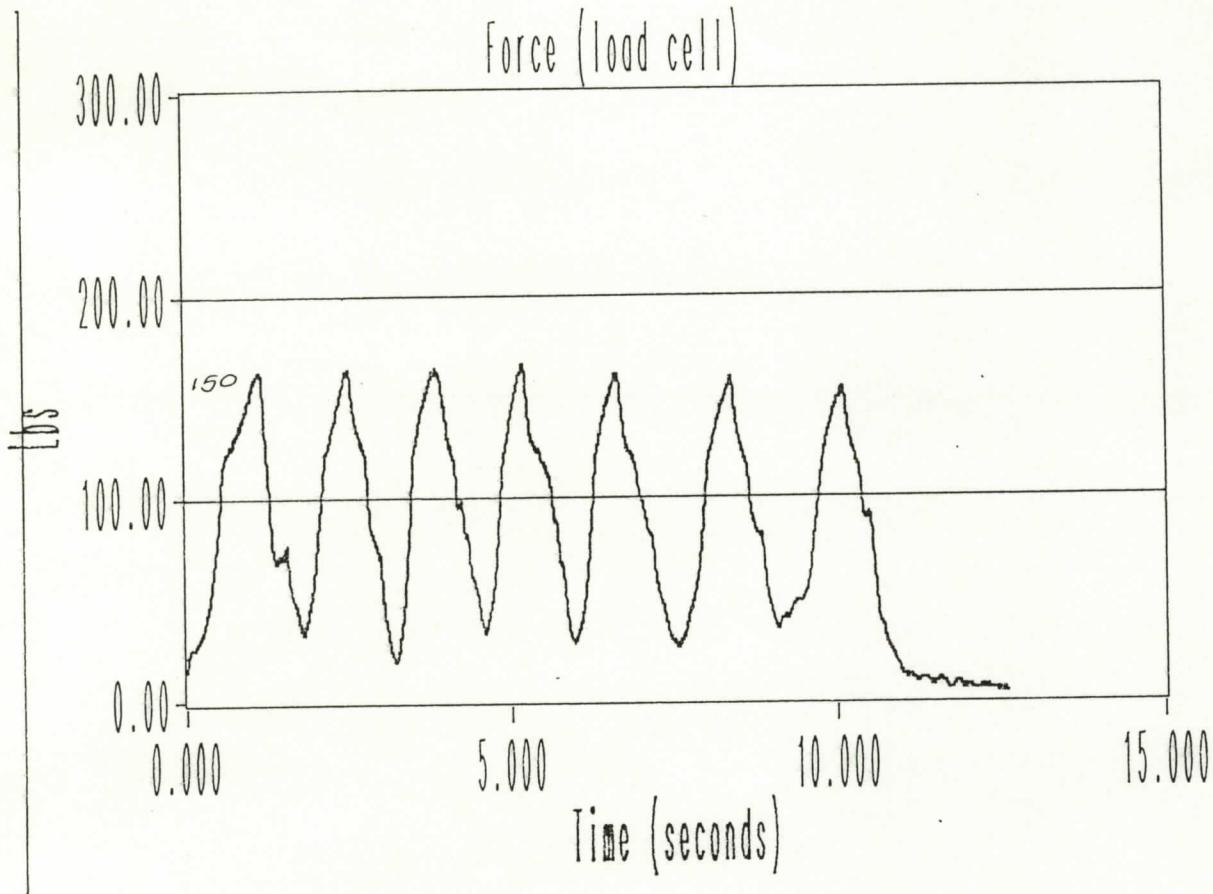
SQUATS

MAX FORCE = 167

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display



PARABOLA #2

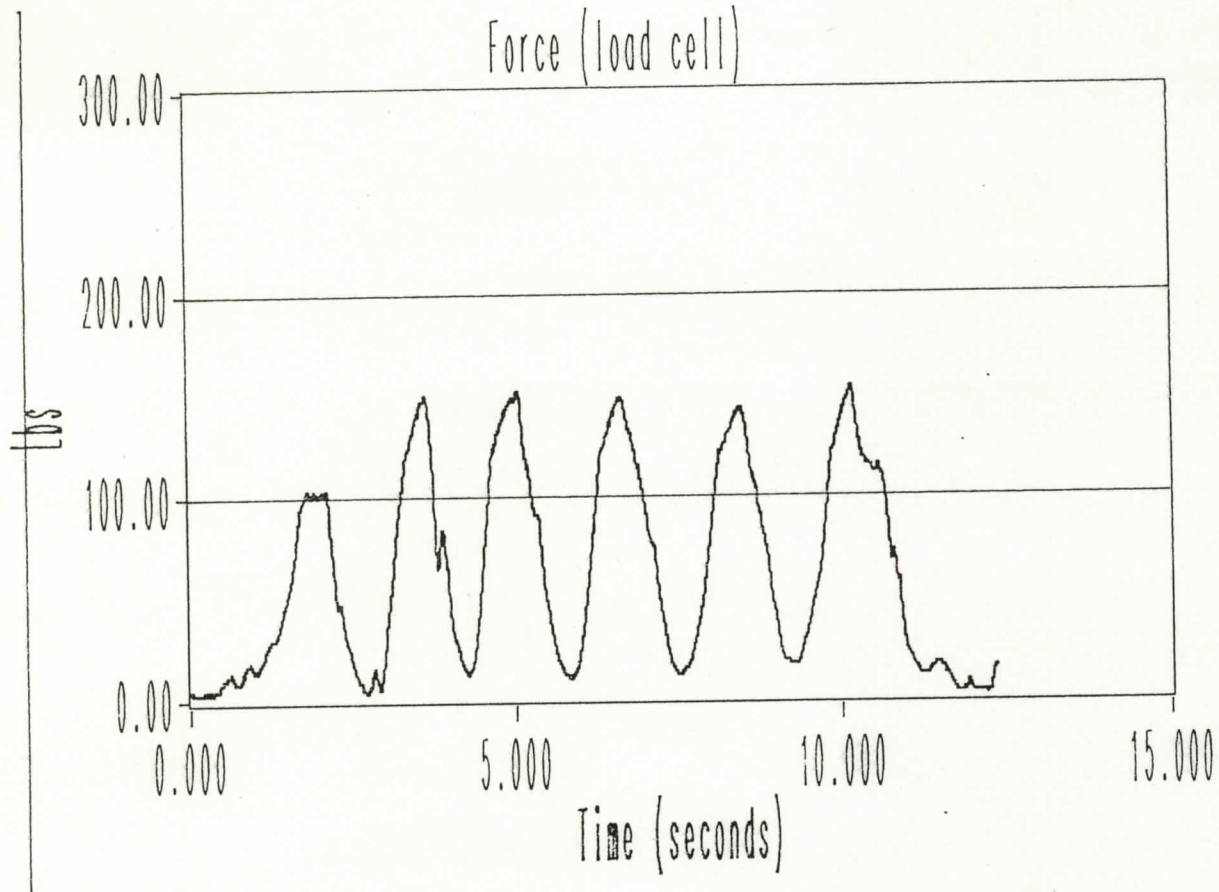
SQUATS

MAX FORCE = 167

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display



PARABOLA 1/3

SQUATS

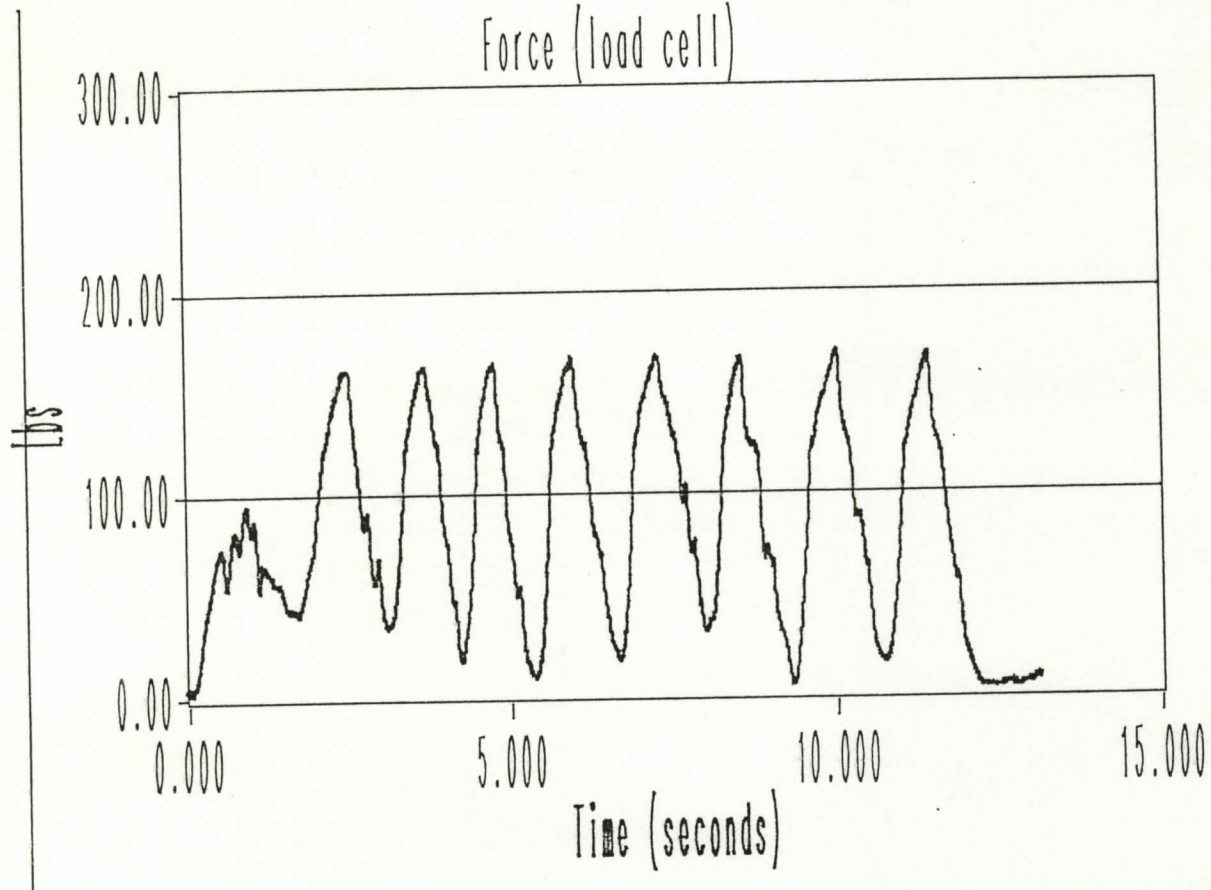
MAX FORCE = 154

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #4

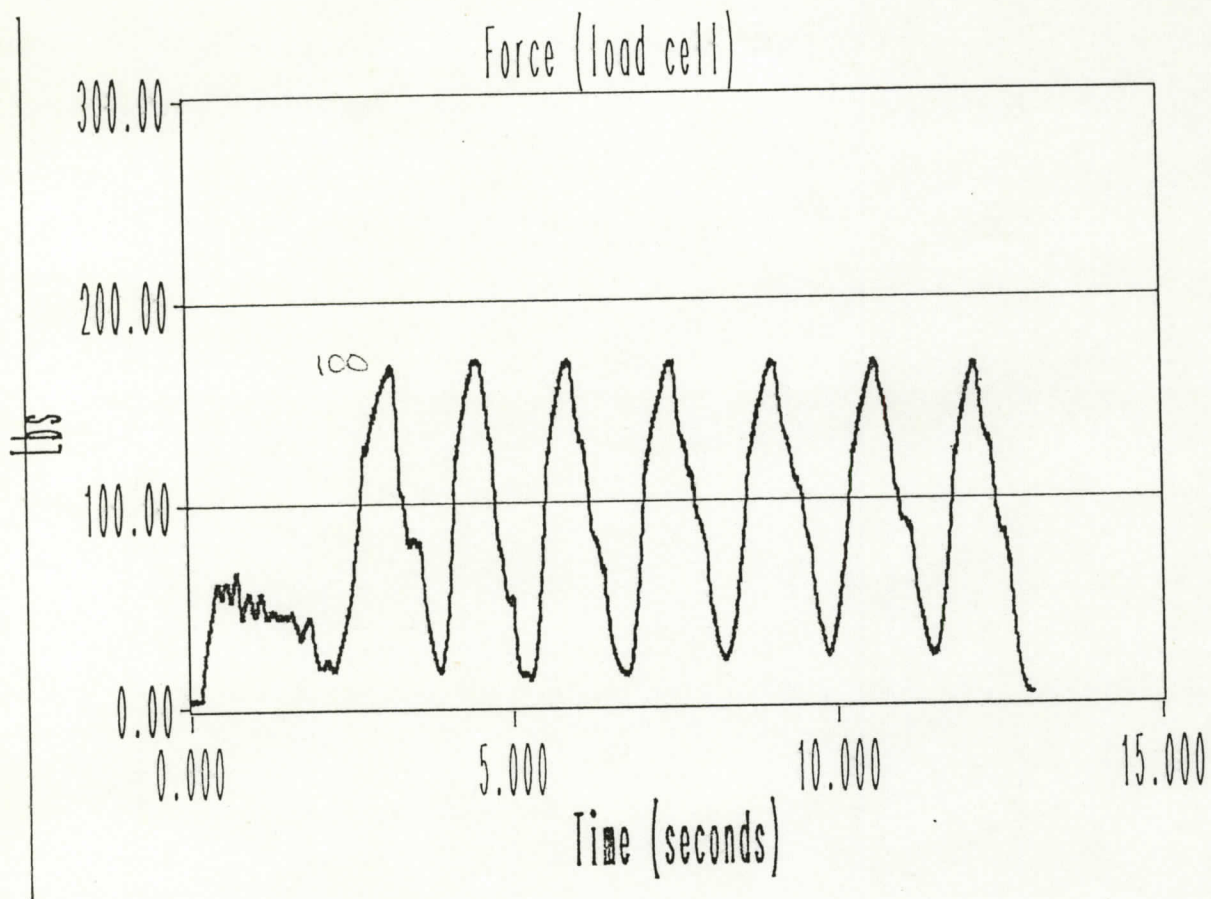
SQUATS

MAX FORCE = 170

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display



PARABOLA #5

~~SQUATS~~

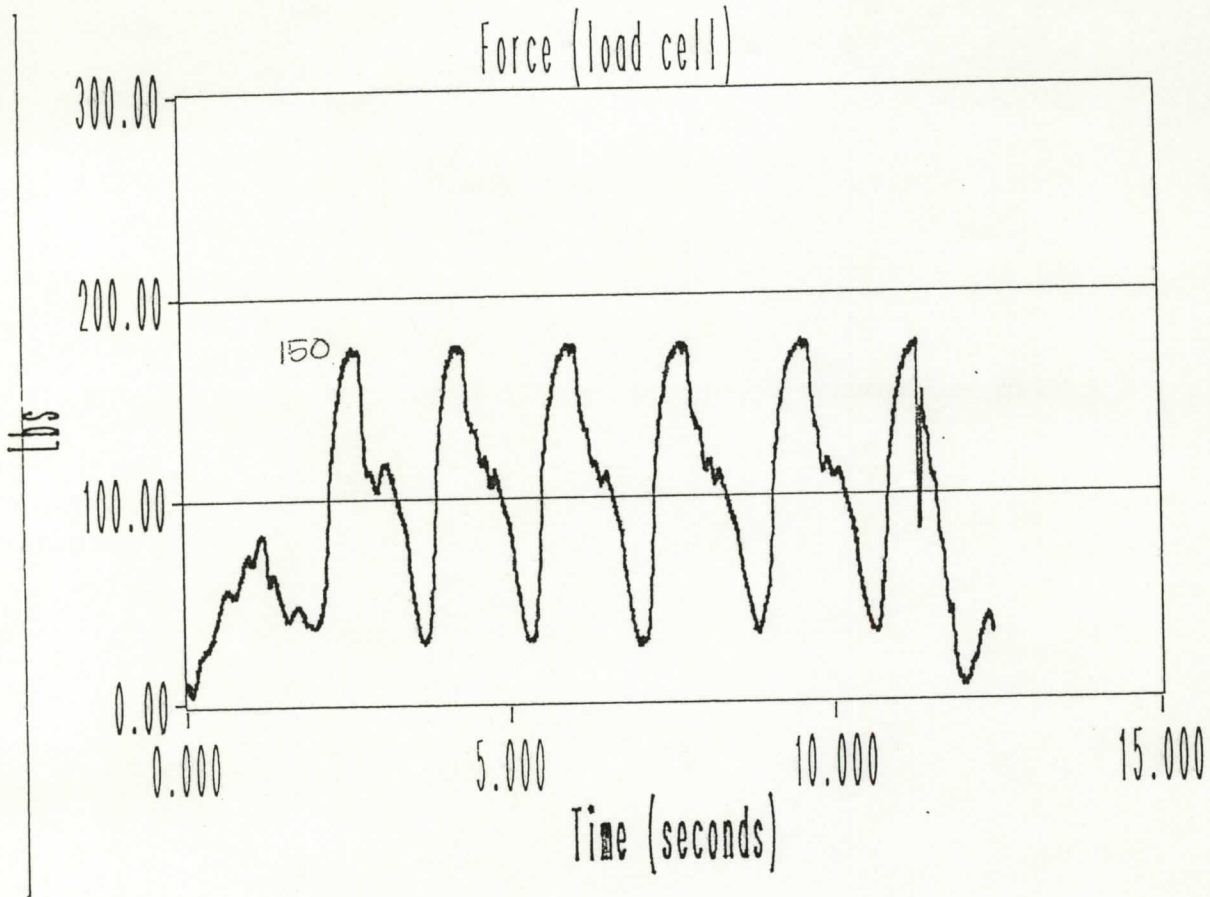
Pull-ups

MAX FORCE = 171

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display



PARABOLA #6

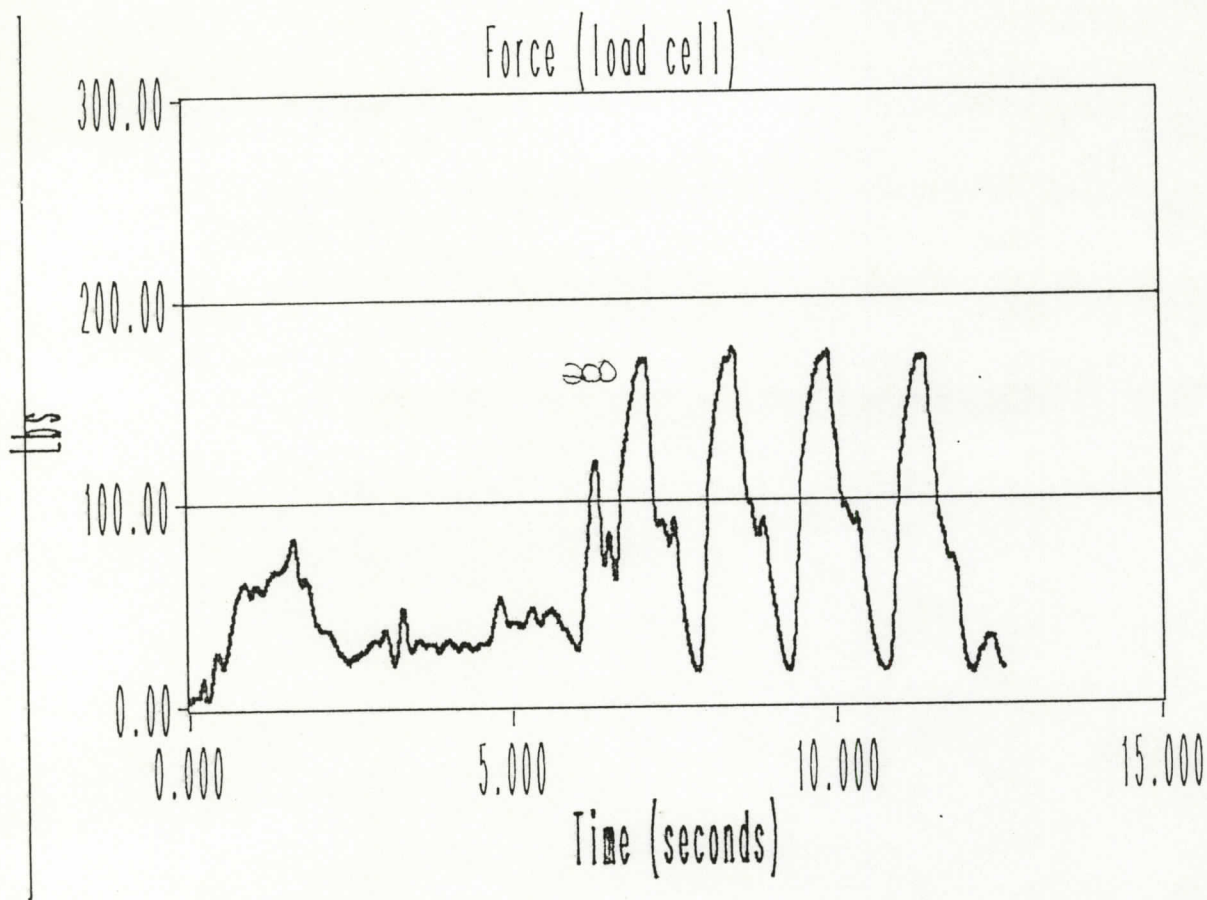
PULL UPS

MAX FORCE = 177

SUBJECT 1

John
NEBRASKA

KC-135 Isotonic Data Display



PARABOLA #7

PULL UPS

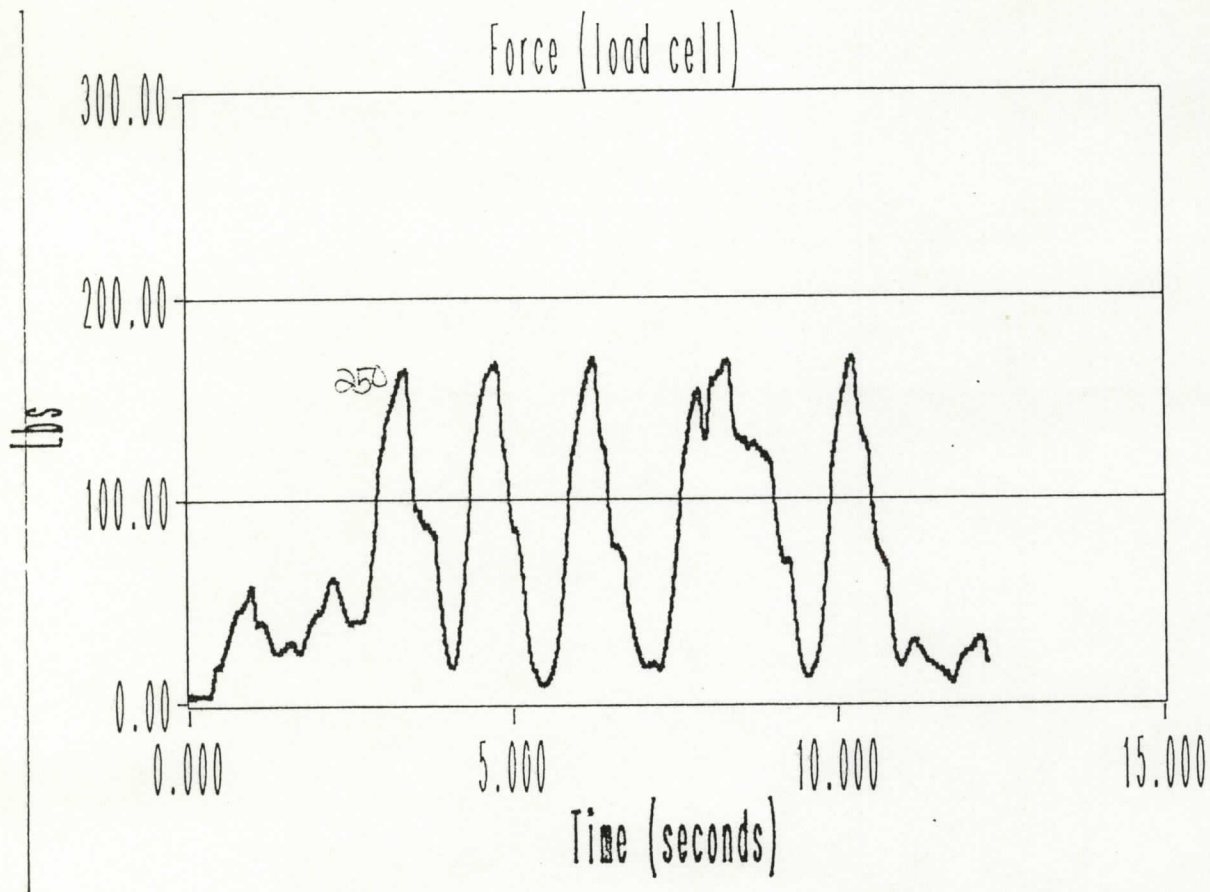
MAX FORCE = 175

SUBJECT 1

John
McBrine

Having problem adjusting equipment in beginning

KC-135 Isotonic Data Display



PARABOLA #8

PULL UPS

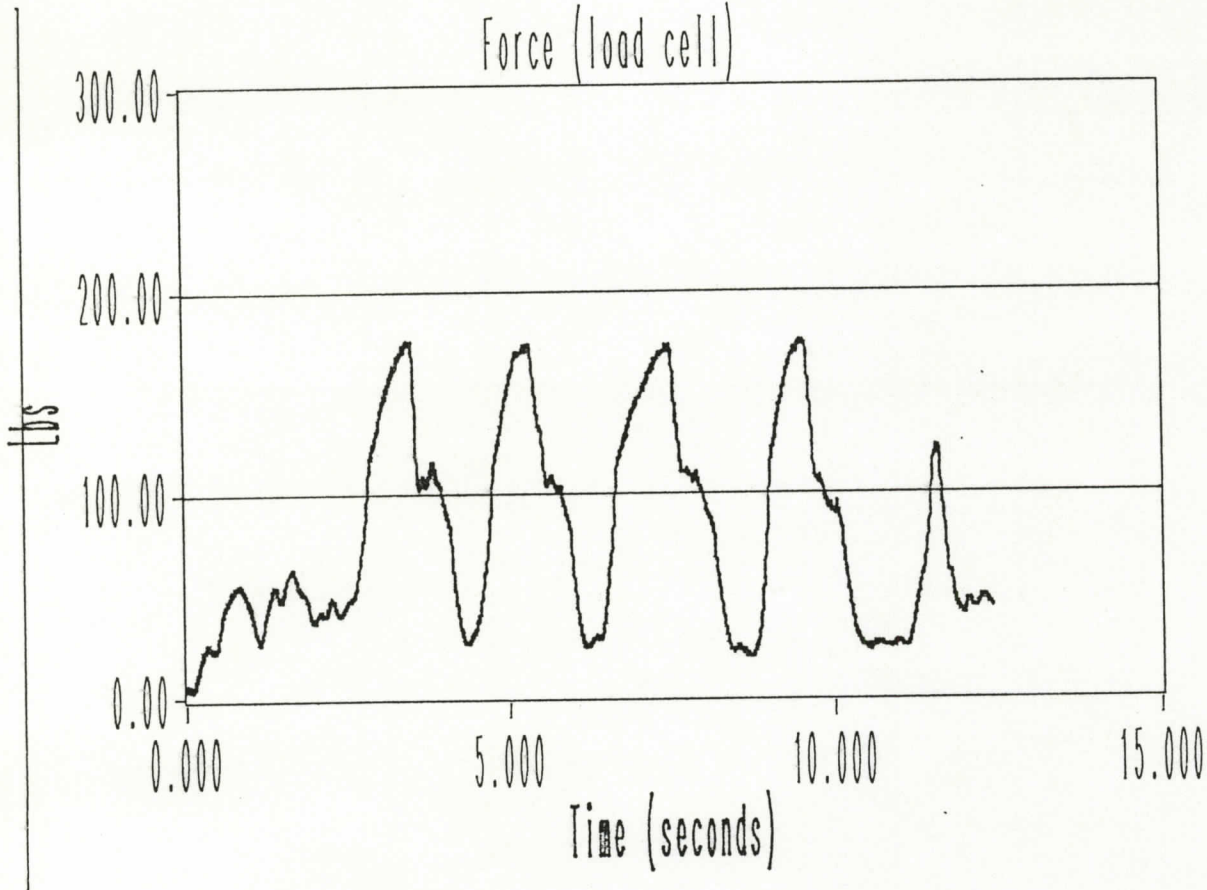
MAX FORCE = 170

SUBJECT 1

John
McPhee

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA 79

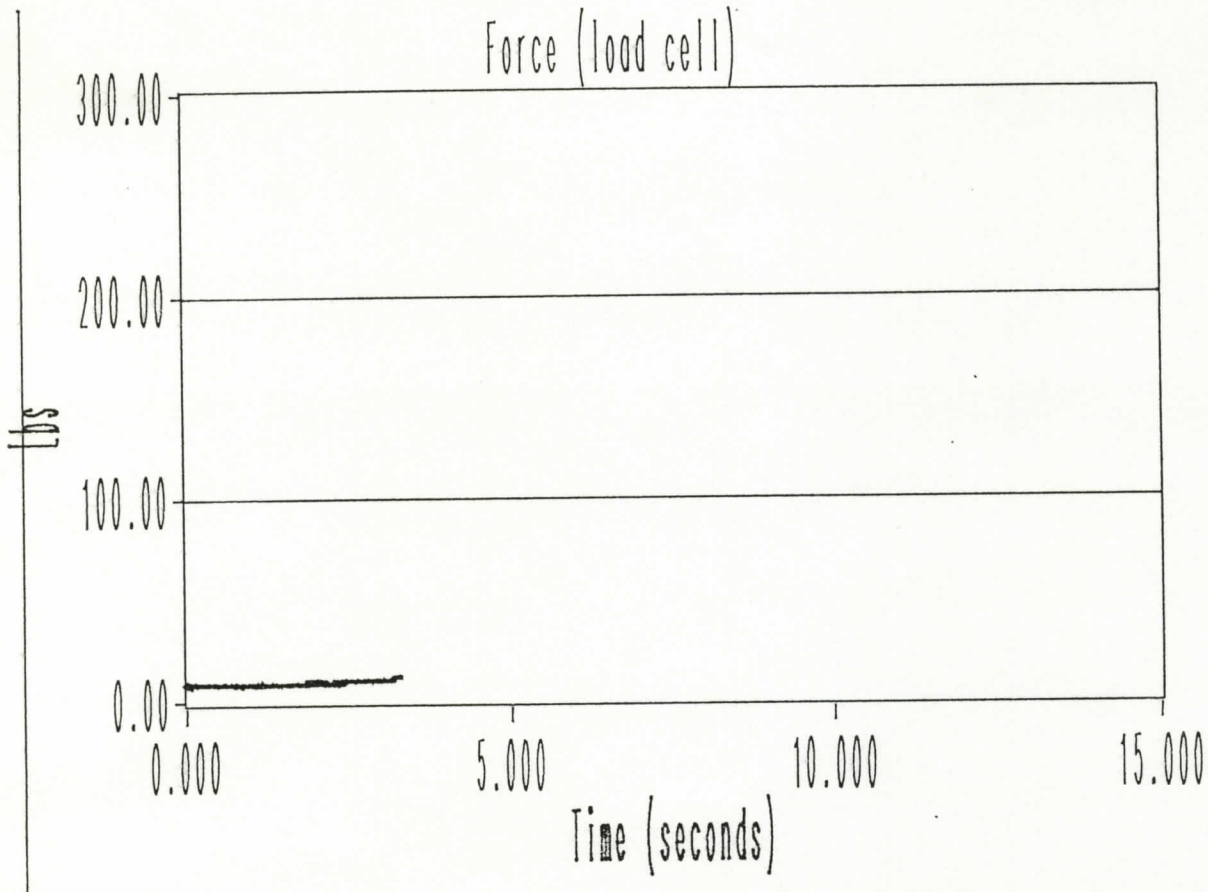
PULL UPS

MAX FORCE = 176

SUBJECT 1

John
McBrine

KC-135 Isotonic Data Display



PARABOLA #10

BAR DIPS

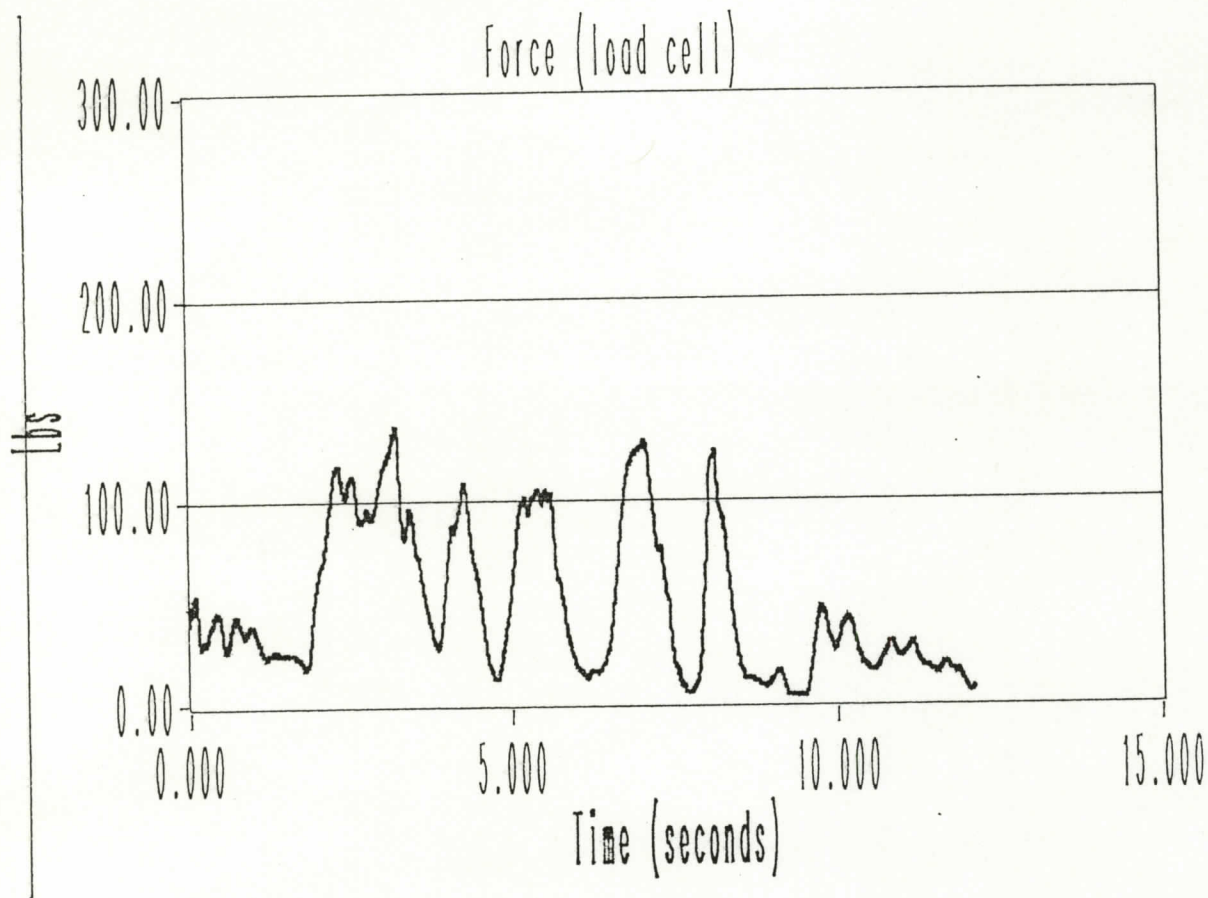
MAX FORCE = 13

SUBJECT 1

John
McFarlane

No exercise done

KC-135 Isotonic Data Display



PARABOLA #11

BAR DIPS

MAX FORCE = 137

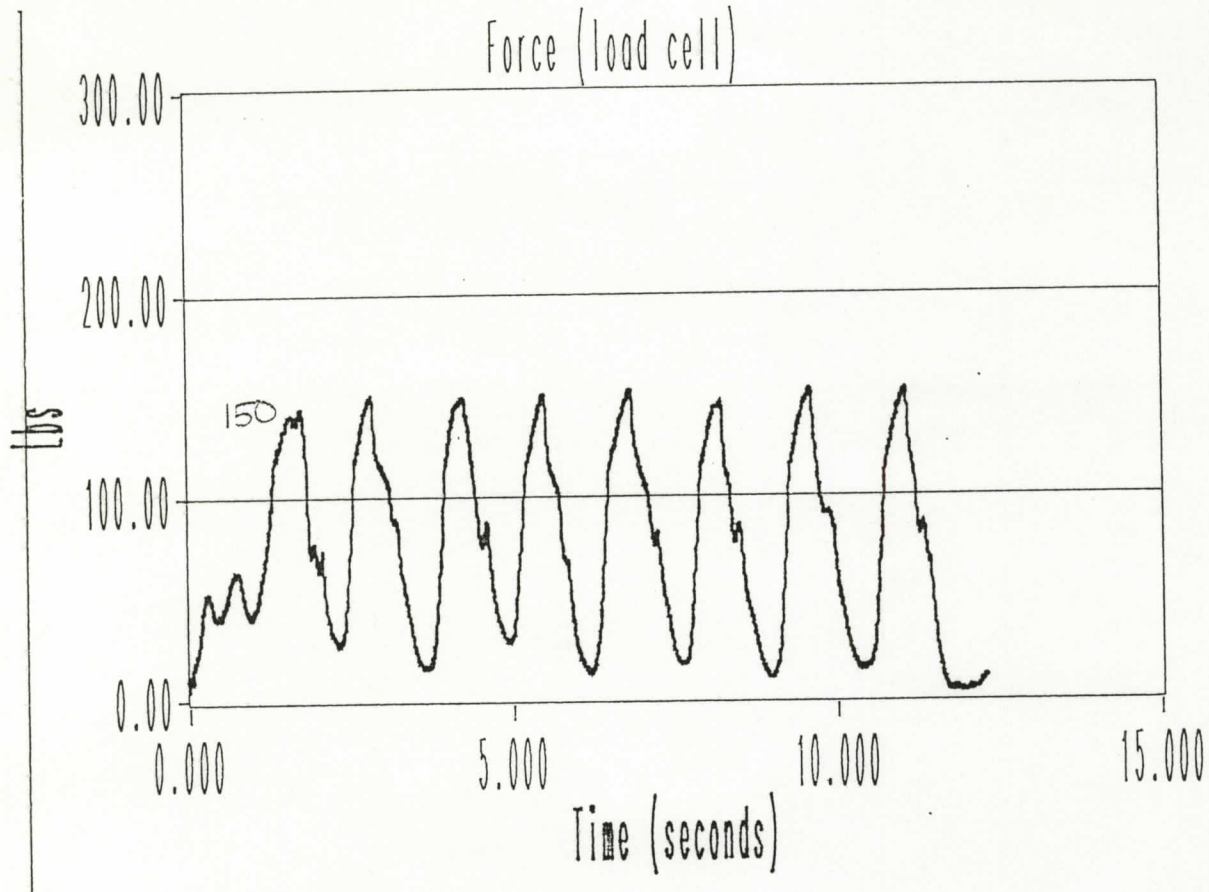
SUBJECT 1

John
McBrine

Exercise not executed properly towards end.

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #12

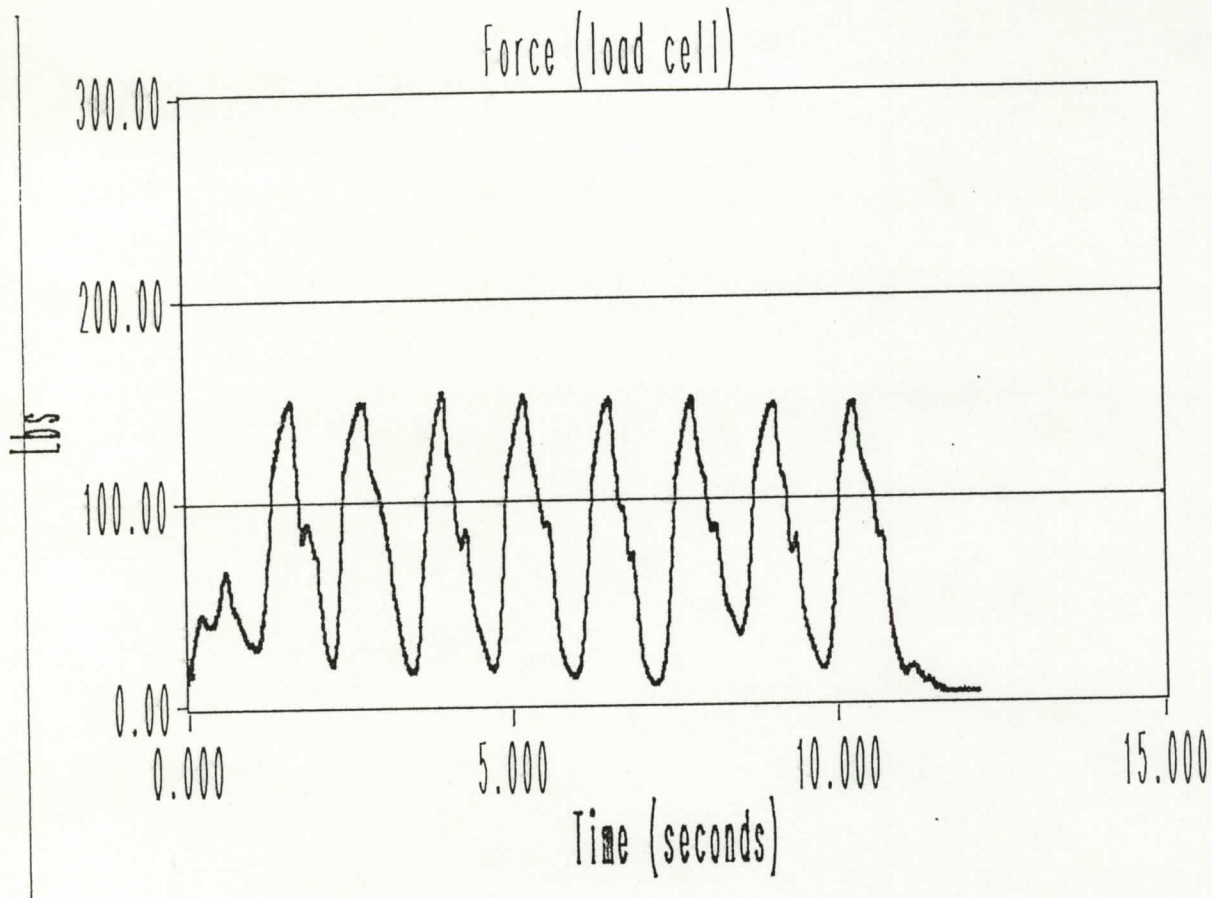
BAR DIPS

MAX FORCE = 153

SUBJECT 1

JOHN
ALBINE

KC-135 Isotonic Data Display



PARABOLA #13

BAR DIPS

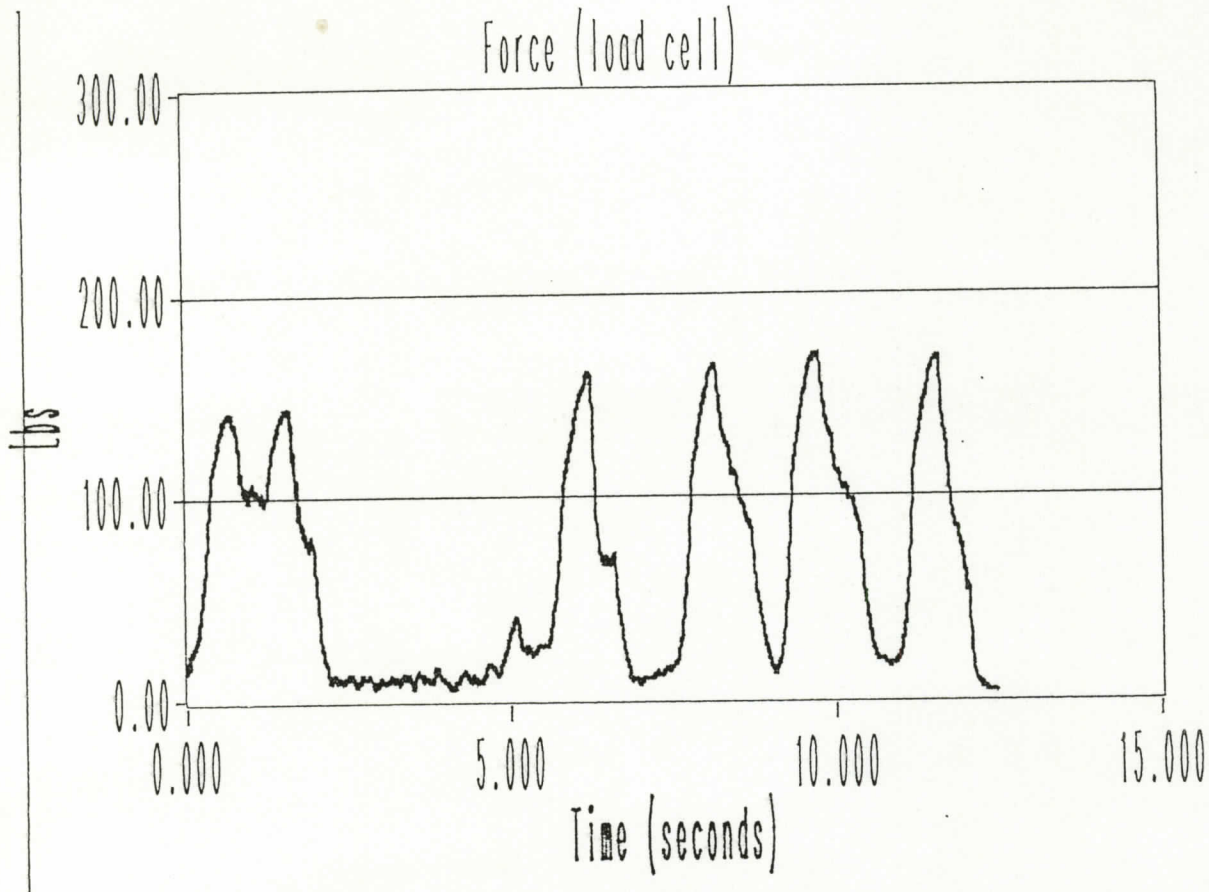
MAX FORCE = 154

SUBJECT 1

John
McEneaney

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #14

BAR DIPS

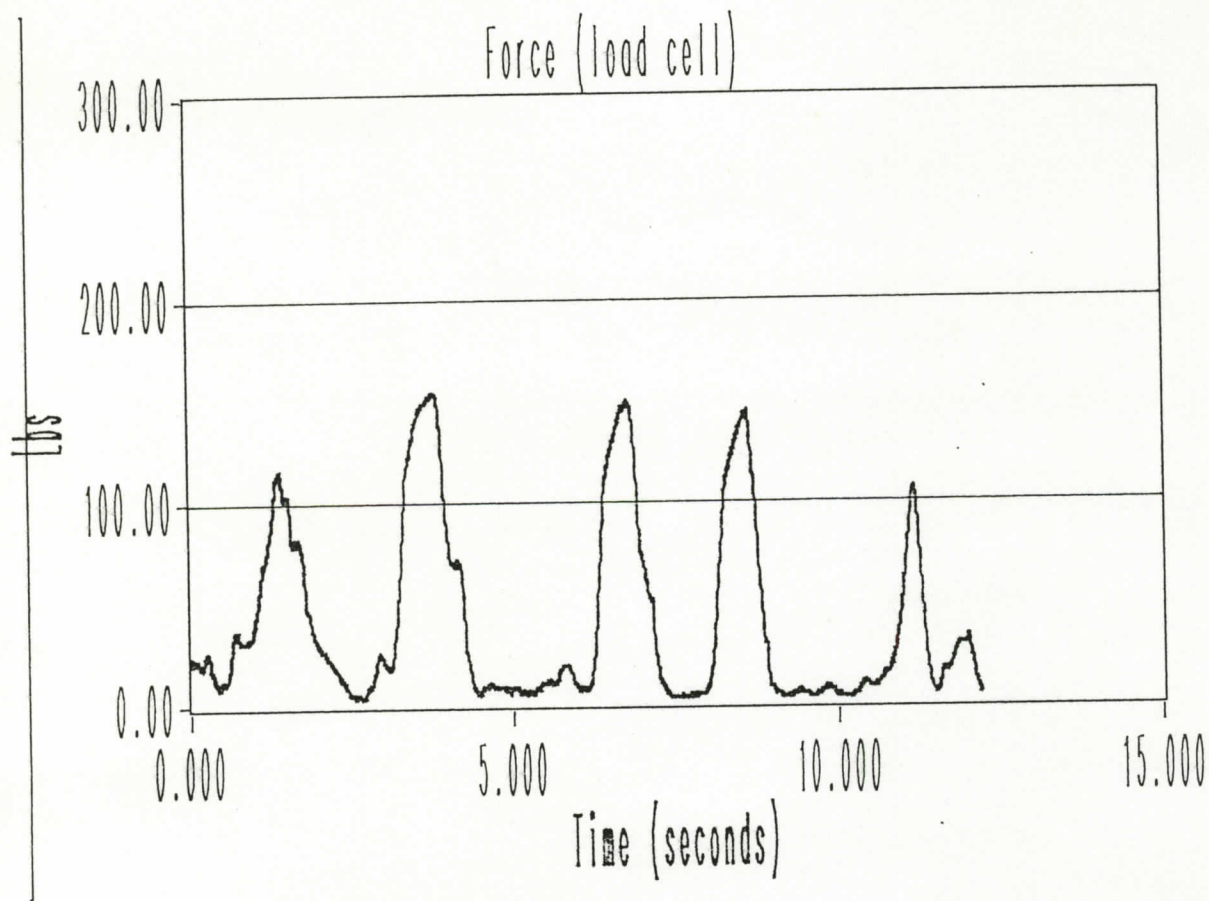
MAX FORCE = 171

SUBJECT 1

Dead
lifts

John
McNamee

KC-135 Isotonic Data Display



PARABOLA #15

TRUNK EXT

MAX FORCE = 154

SUBJECT 2

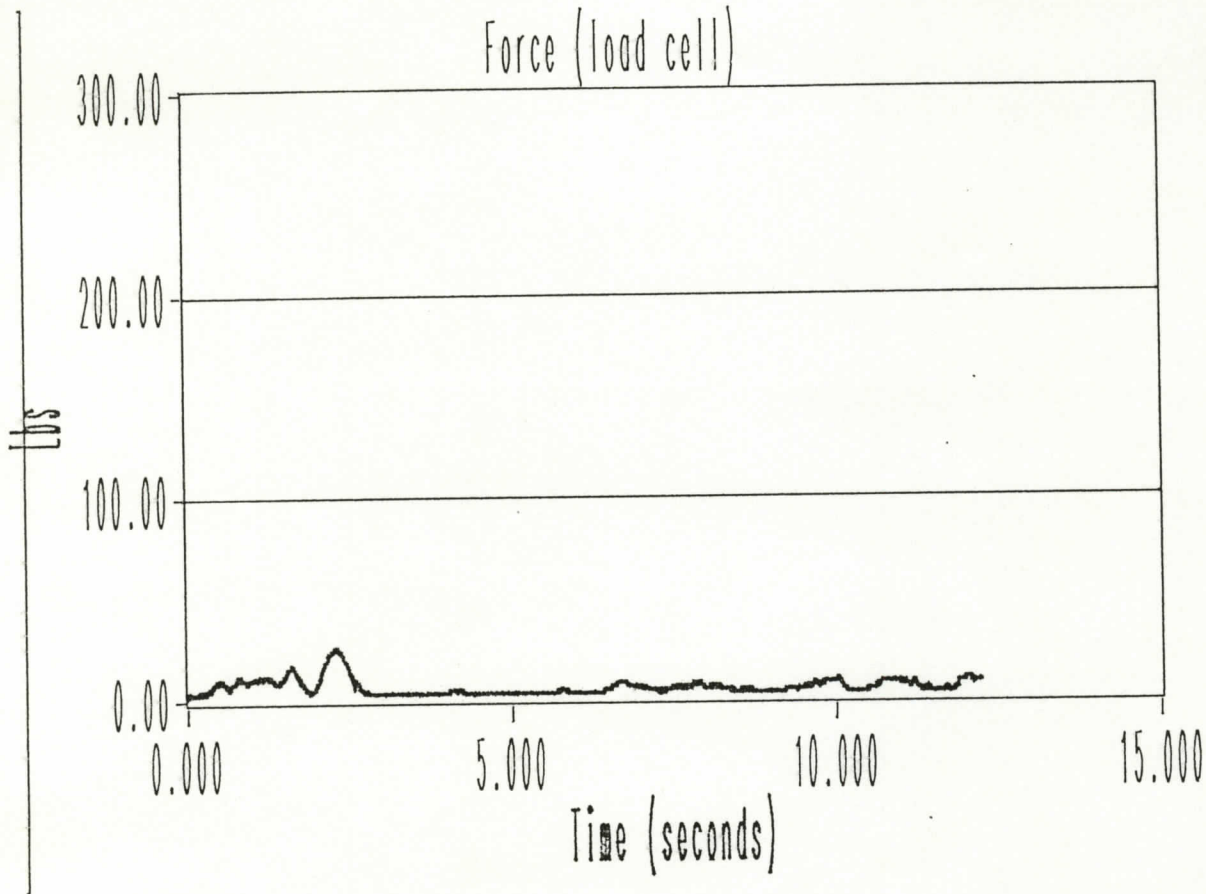
Squats

Judy
Hayes

Tension not adjusted properly

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #16

~~TRUNK EXT~~

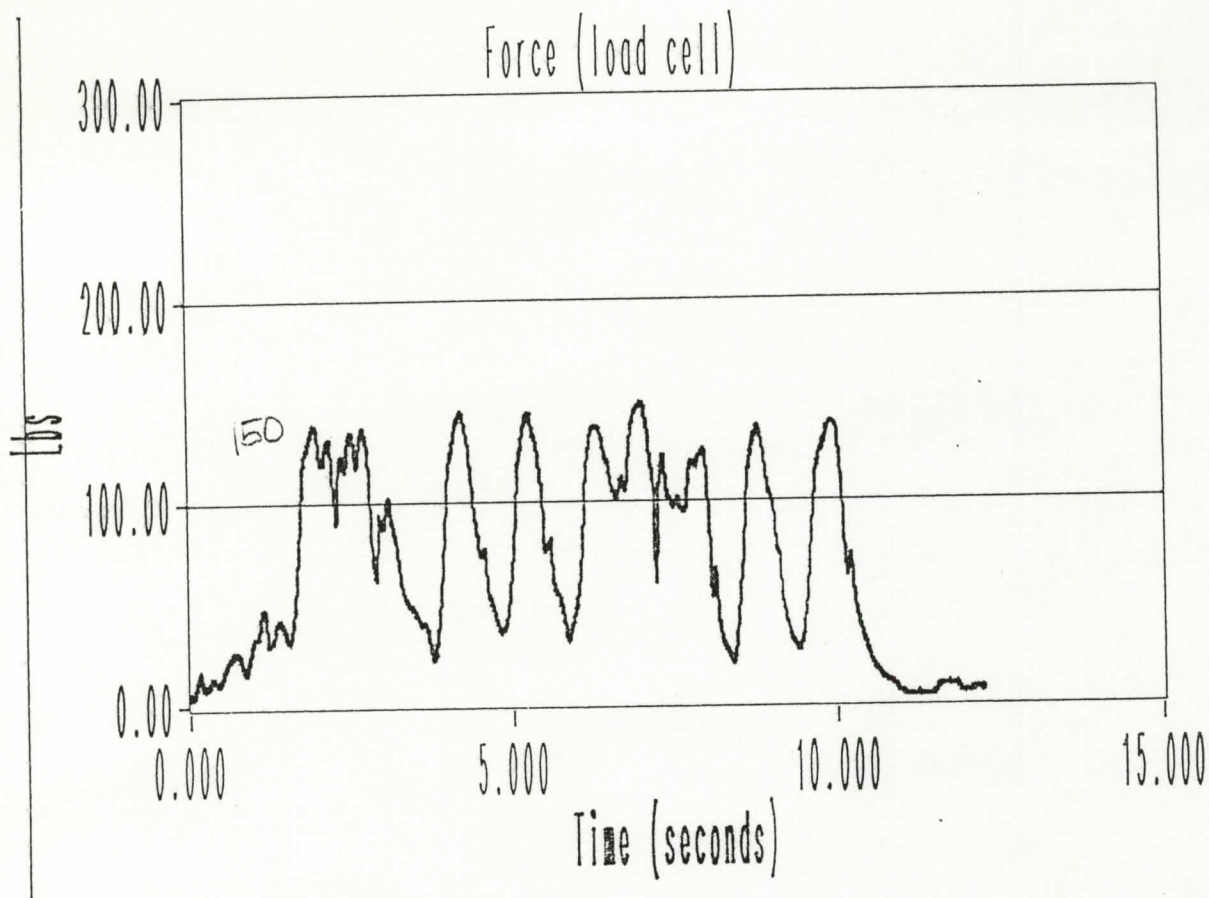
MAX FORCE = 26

SUBJECT 2

Judy
Hays

No exercise done

KC-135 Isotonic Data Display



PARABOLA #17

TRUNK-EXT

MAX FORCE = 150

SUBJECT 2

Equator

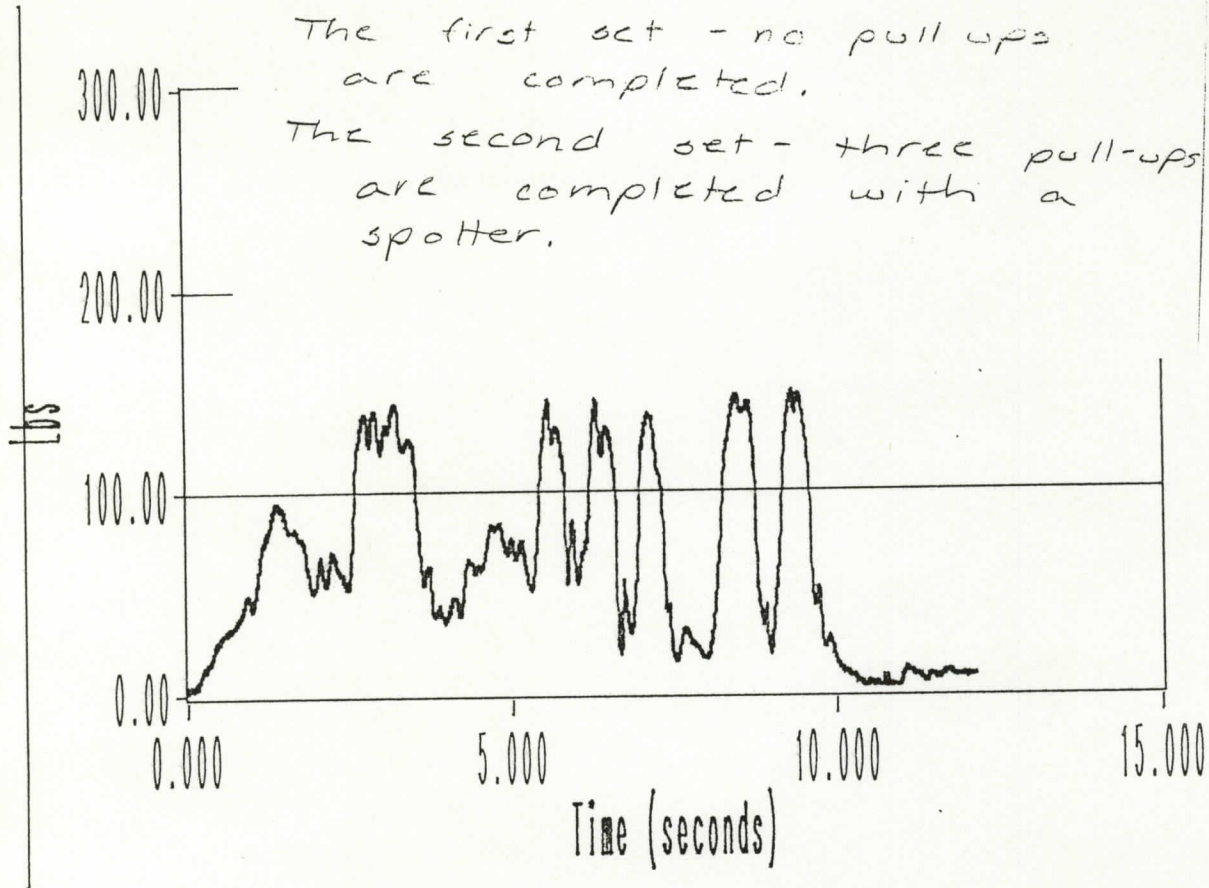
Judy
Hays

Parabola 18, 19, + 20
do not match film.

Judy Hayes attempts two
sets of pull-ups.

The first set - no pull ups
are completed.

The second set - three pull-ups
are completed with a
spotter.



PARABOLA #18

~~SQUATS~~

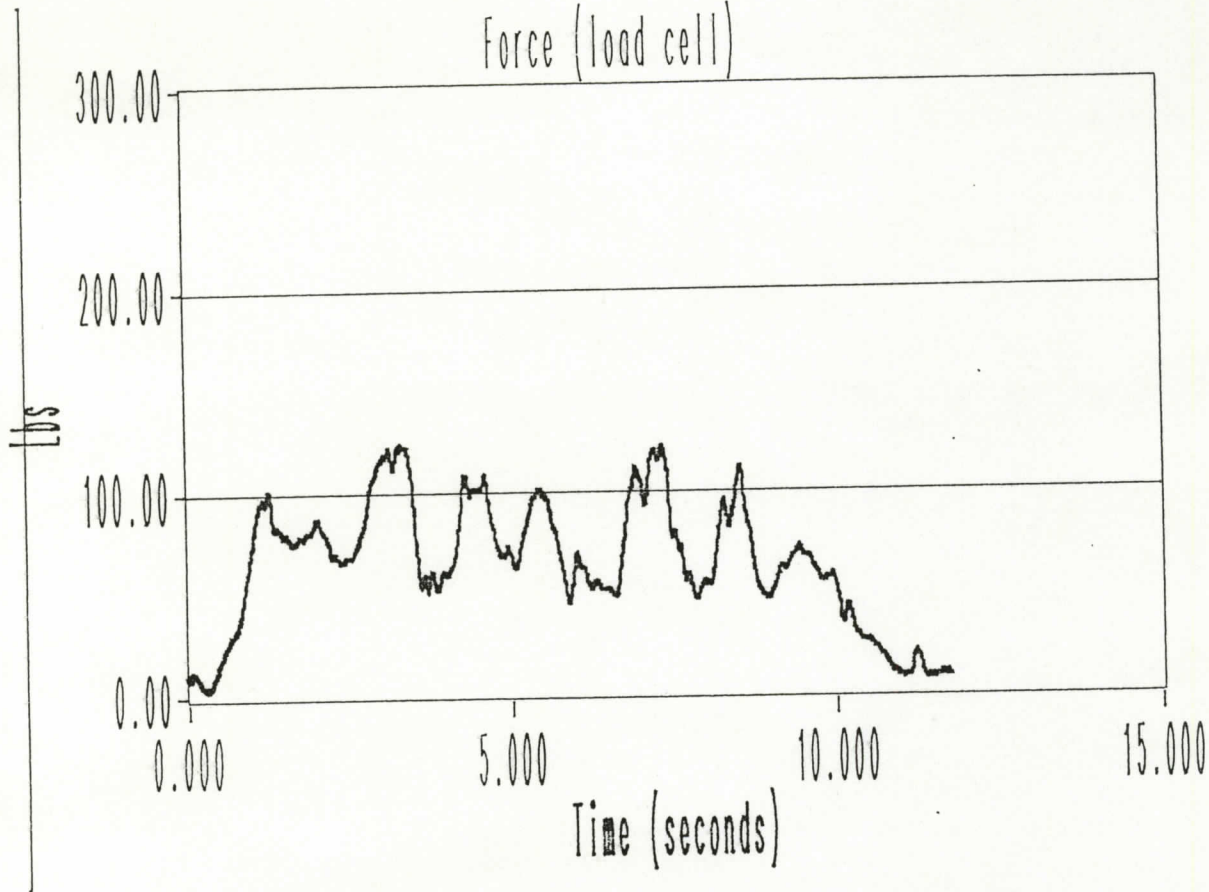
MAX FORCE = 150

SUBJECT 2

Judy
Hayes

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #19

~~SQUATS~~
pull ups

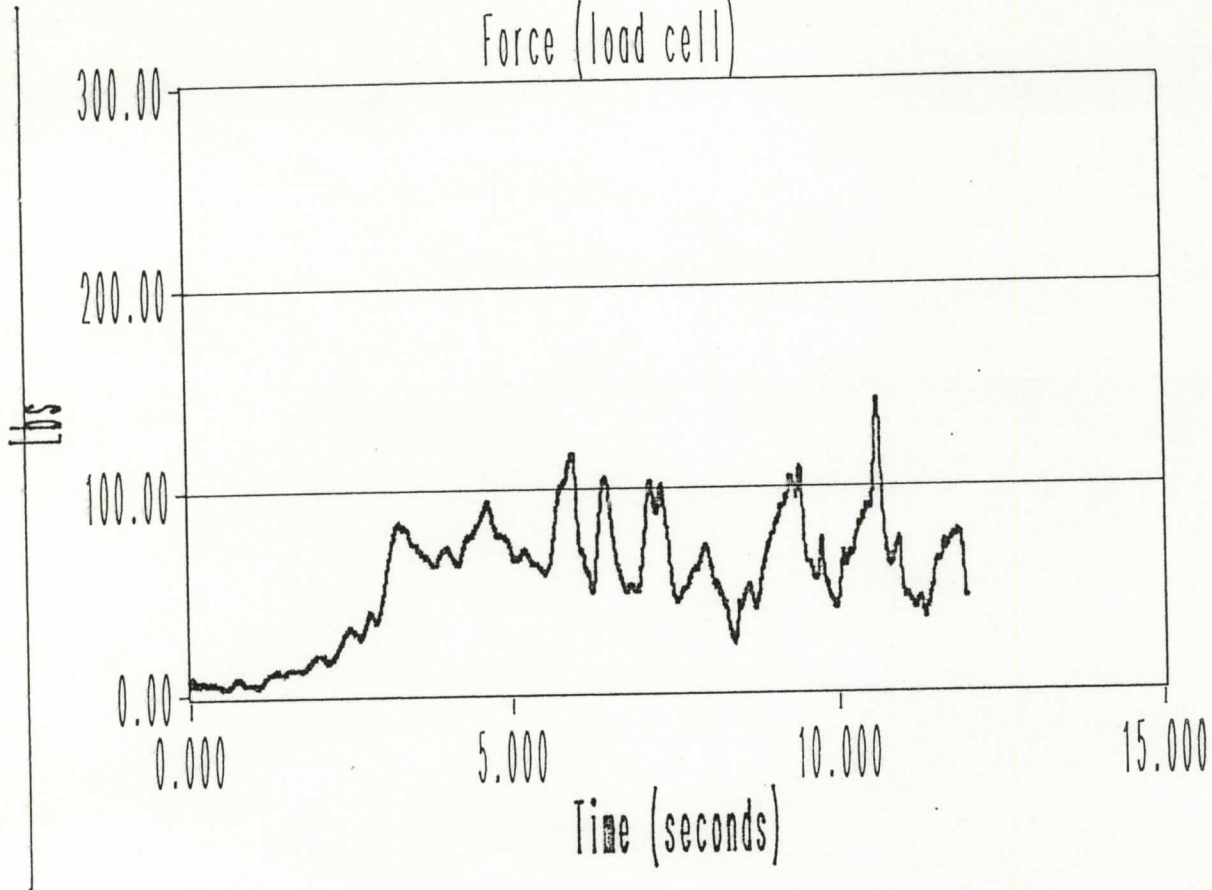
MAX FORCE = 124

SUBJECT 2

Judy
Hays

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA 420

PULL UPS

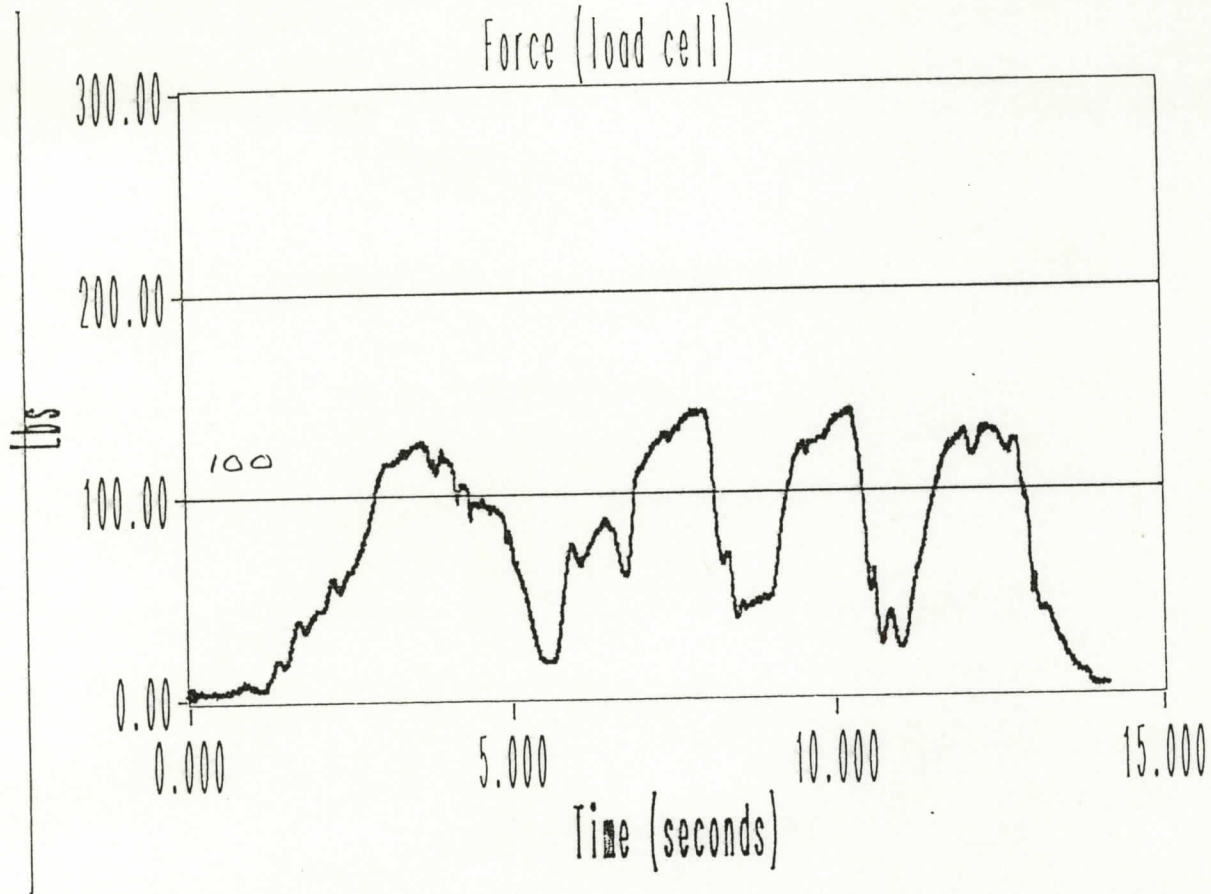
MAX FORCE = 144

SUBJECT 2

Judy
Hayes

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #21

BAR DIPS

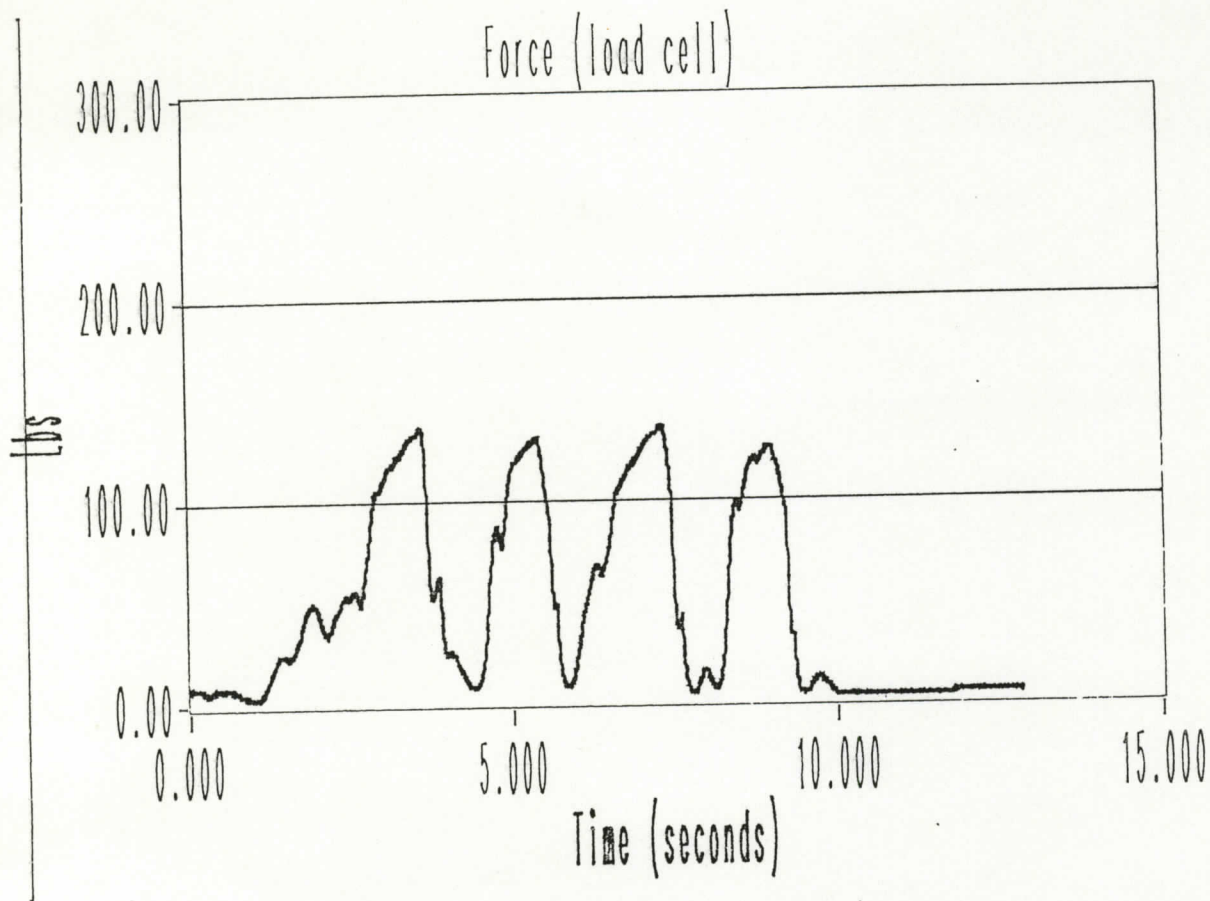
MAX FORCE = 141

SUBJECT 2

Judy
Hayes

Used legs to complete bar dips

KC-135 Isotonic Data Display



PARABOLA #22

BAR DIPS

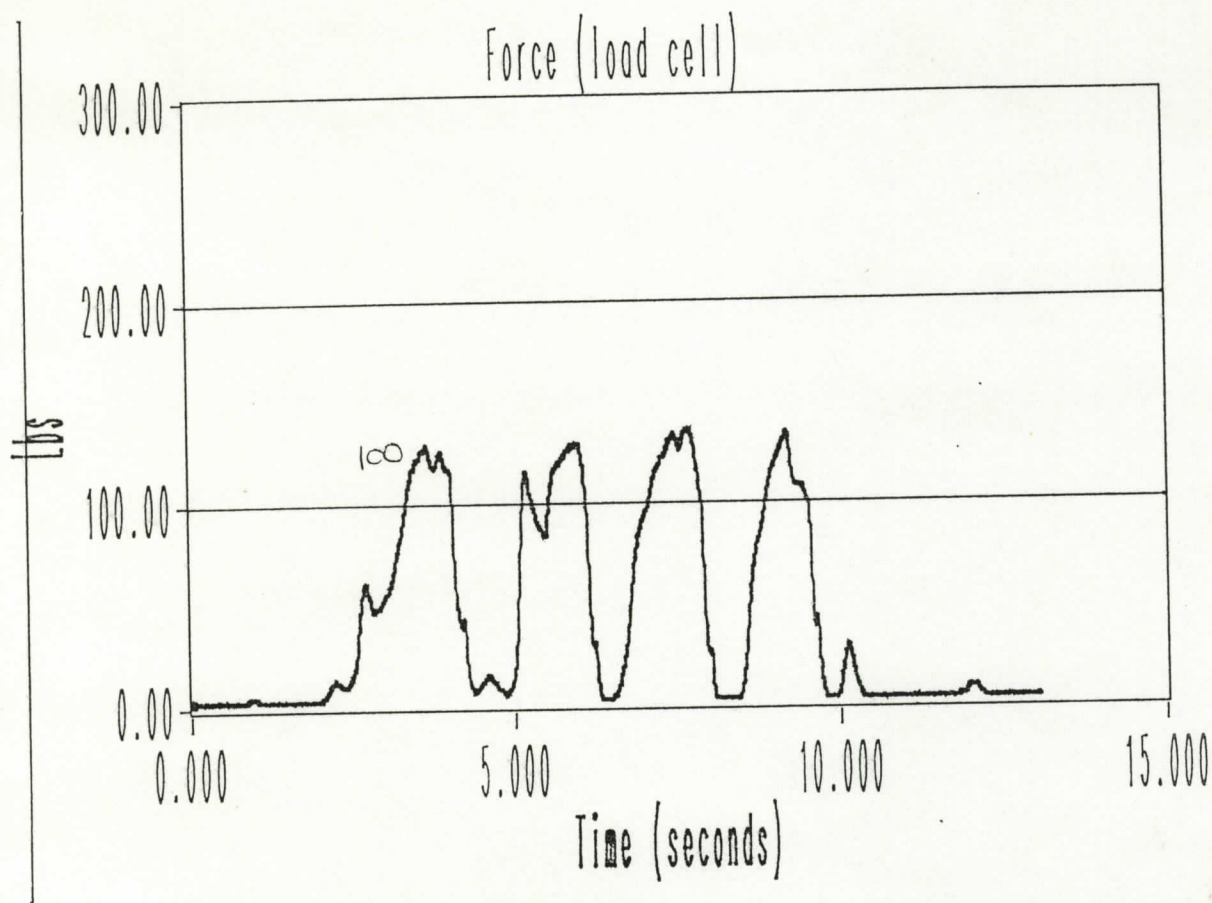
MAX FORCE = 137

SUBJECT 2

Judy
-age-

that + use legs to complete bar dips

KC-135 Isotonic Data Display



PARABOLA #23

BAR DIPS

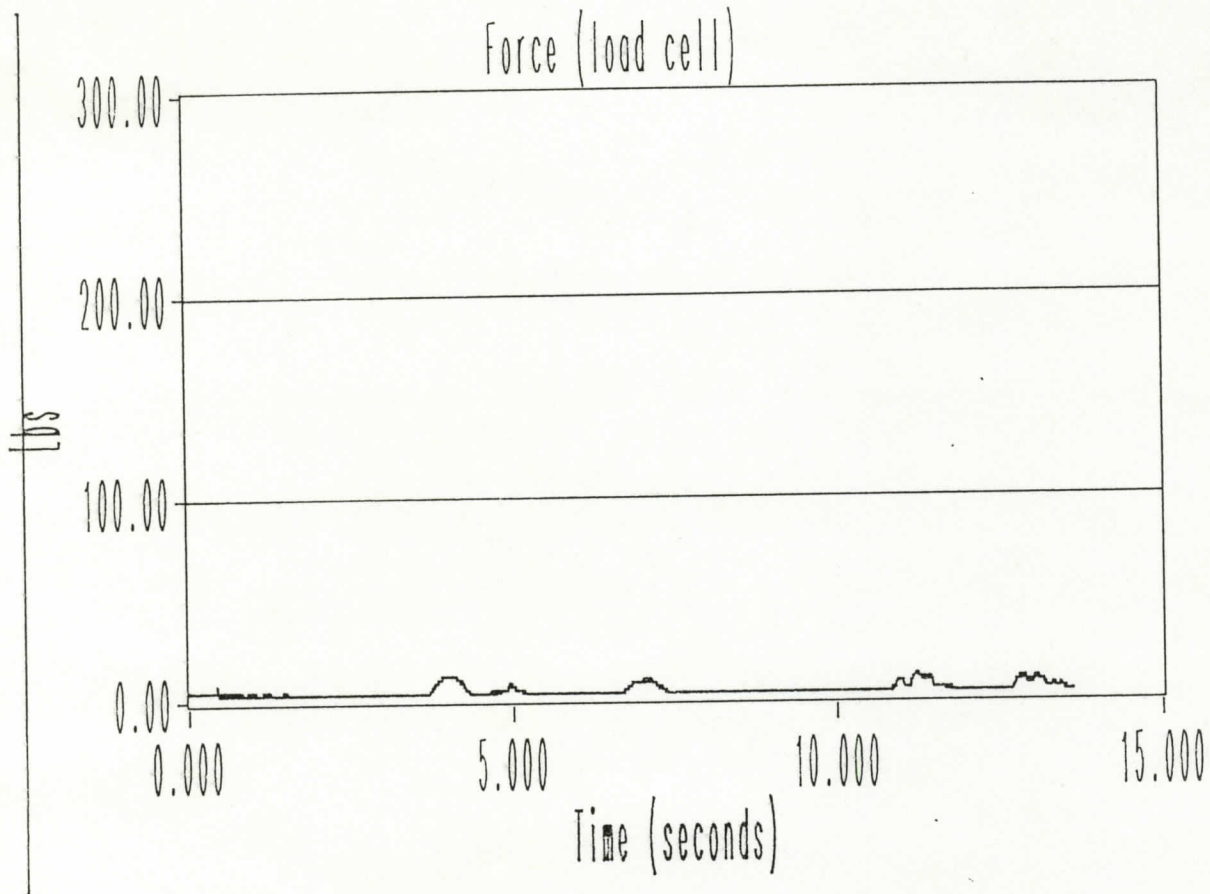
MAX FORCE = 136

SUBJECT 2

Judy
Hayes

had to use legs to complete bar dips

KC-135 Isotonic Data Display



PARABOLA 724

~~SQUATS~~

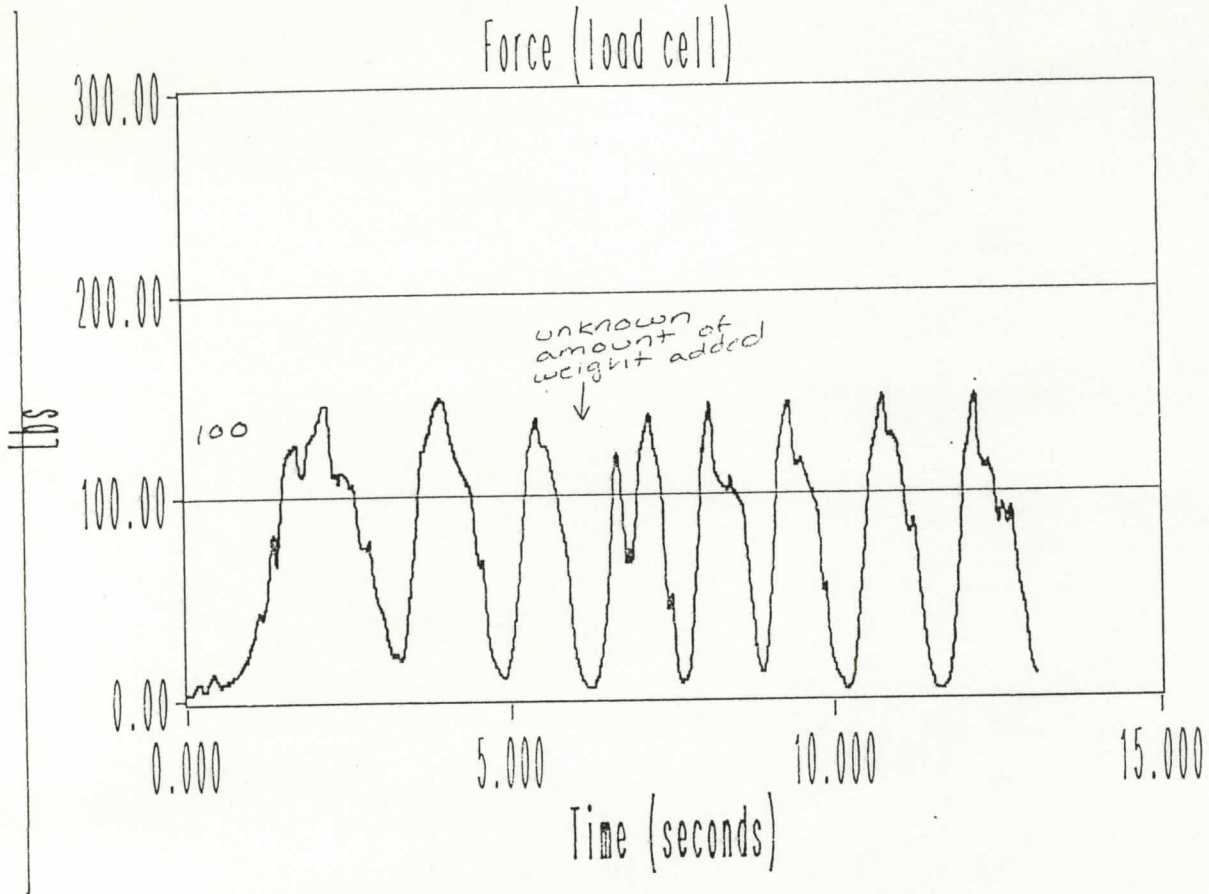
MAX FORCE = 13

SUBJECT 3

John
Kiowski

no exercise done

KC-135 Isotonic Data Display



PARABOLA 1/25

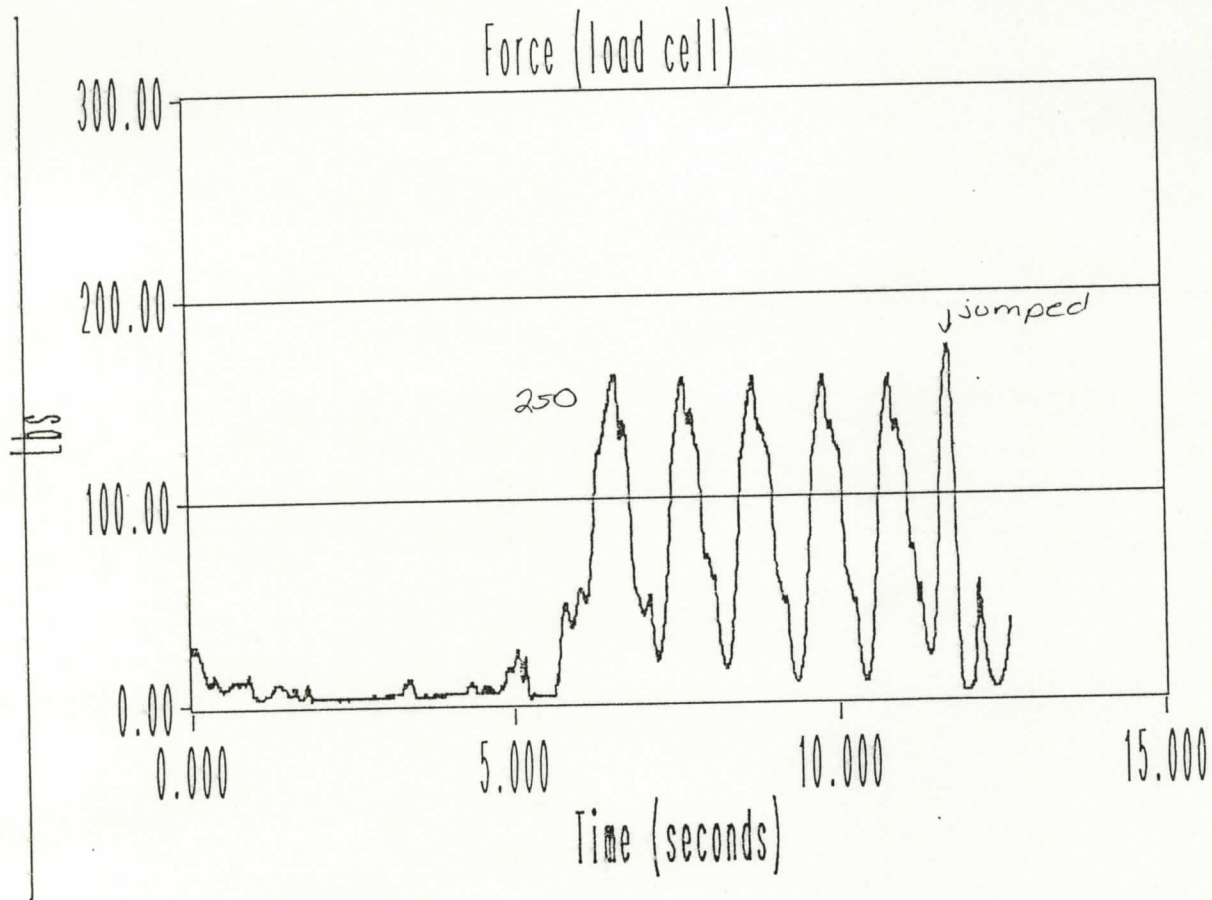
SQUATS

MAX FORCE = 150

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display



PARABOLA #26

SQUATS

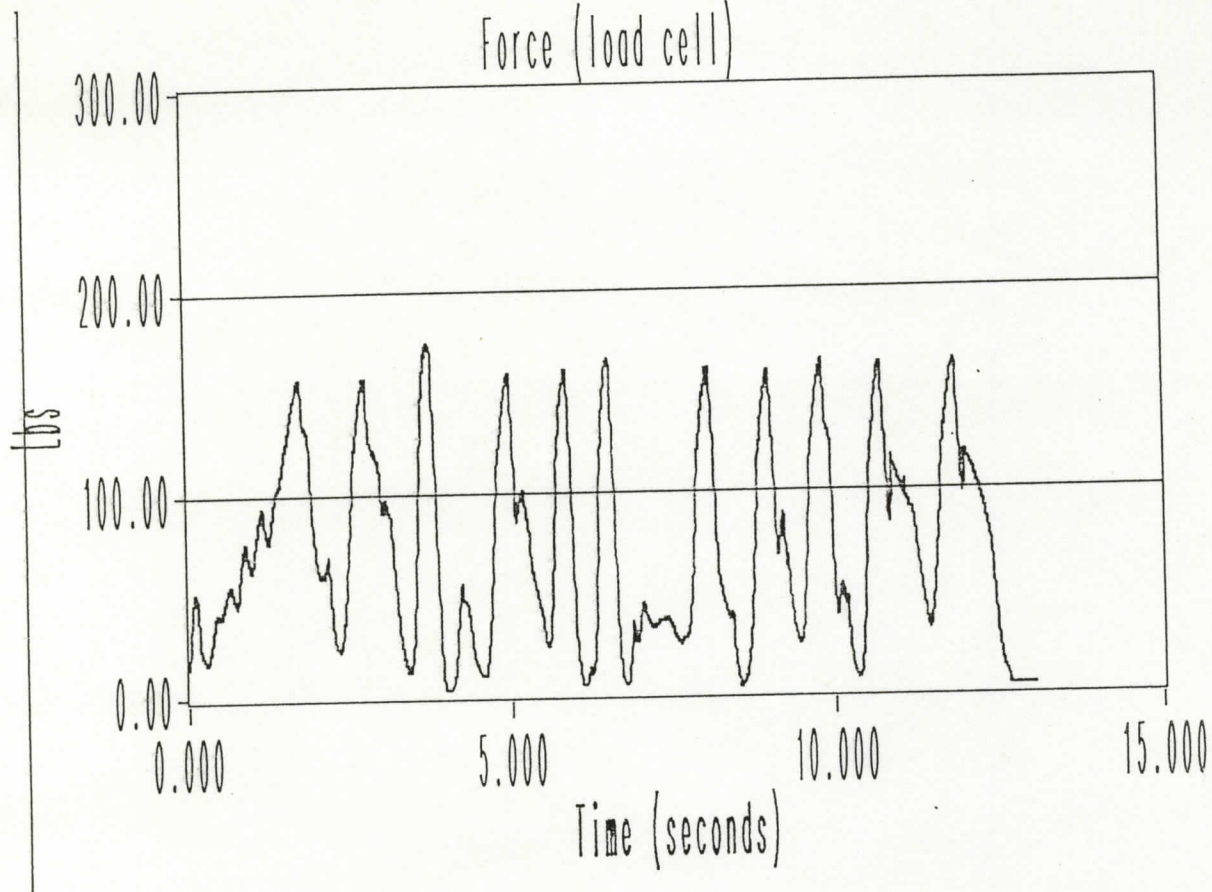
MAX FORCE = 174

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #27

SQUATS

MAX FORCE = 176

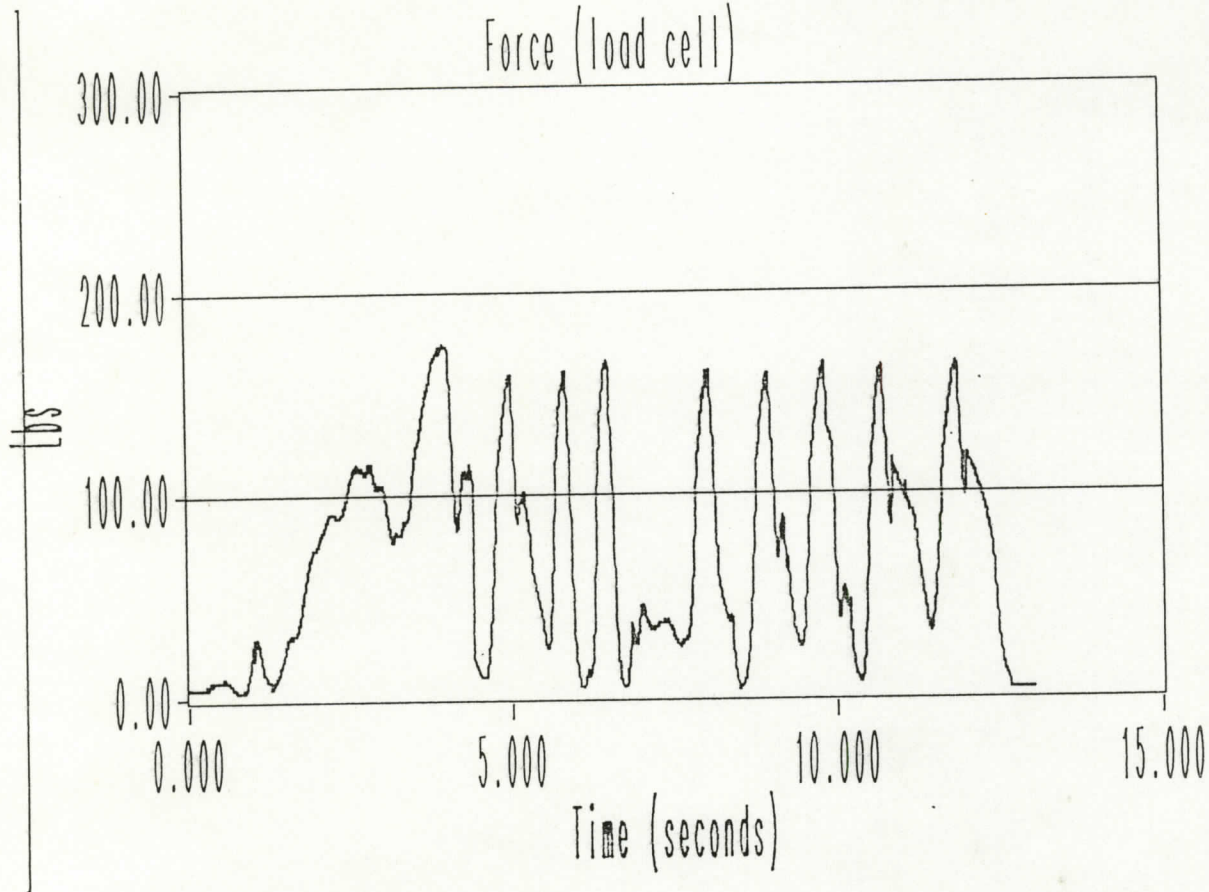
SUBJECT 3

John
Kiowski

subject was able to jump during exercise

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #28

~~SQUATS~~

MAX FORCE = 175

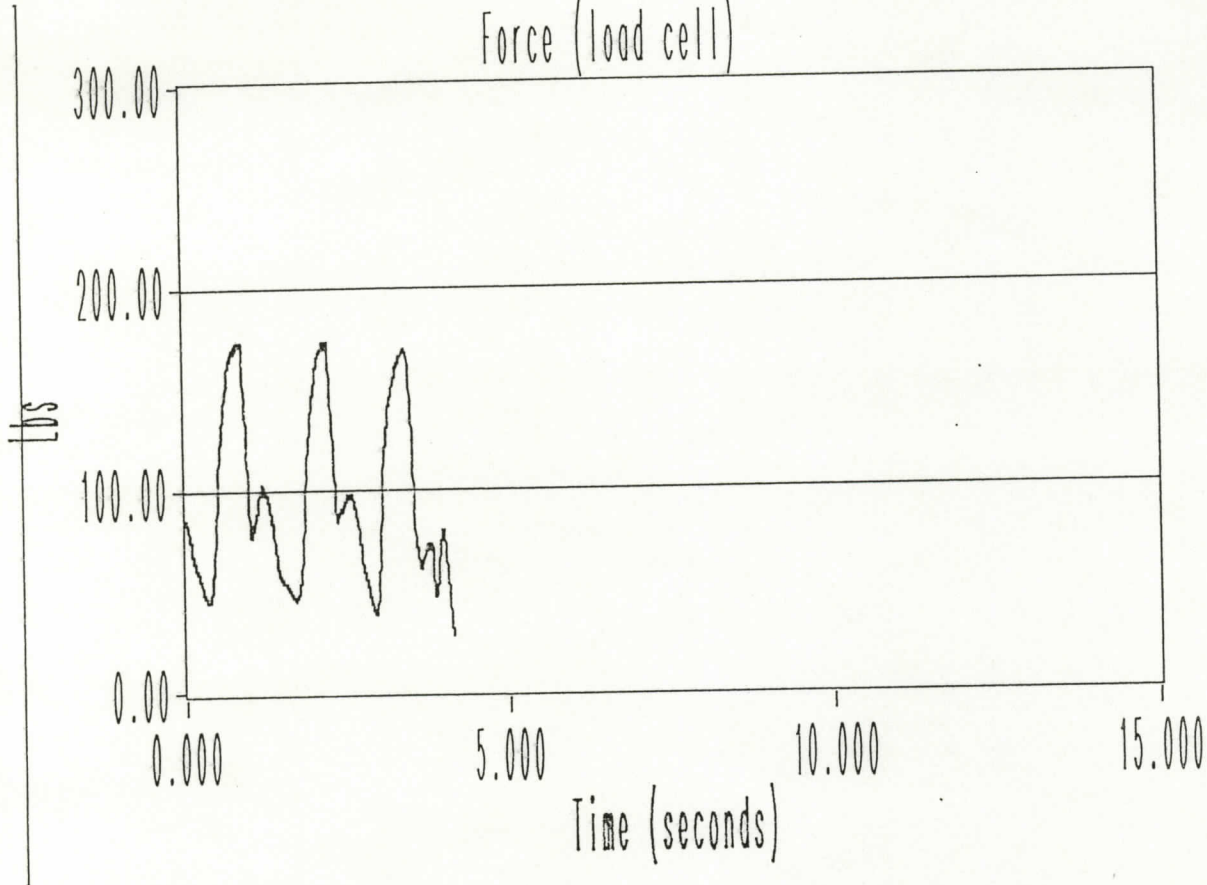
SUBJECT 3

John
Kiowski

Exercise not filmed.

KC-135 Isotonic Data Display

Force (load cell)



PARABOLA #29

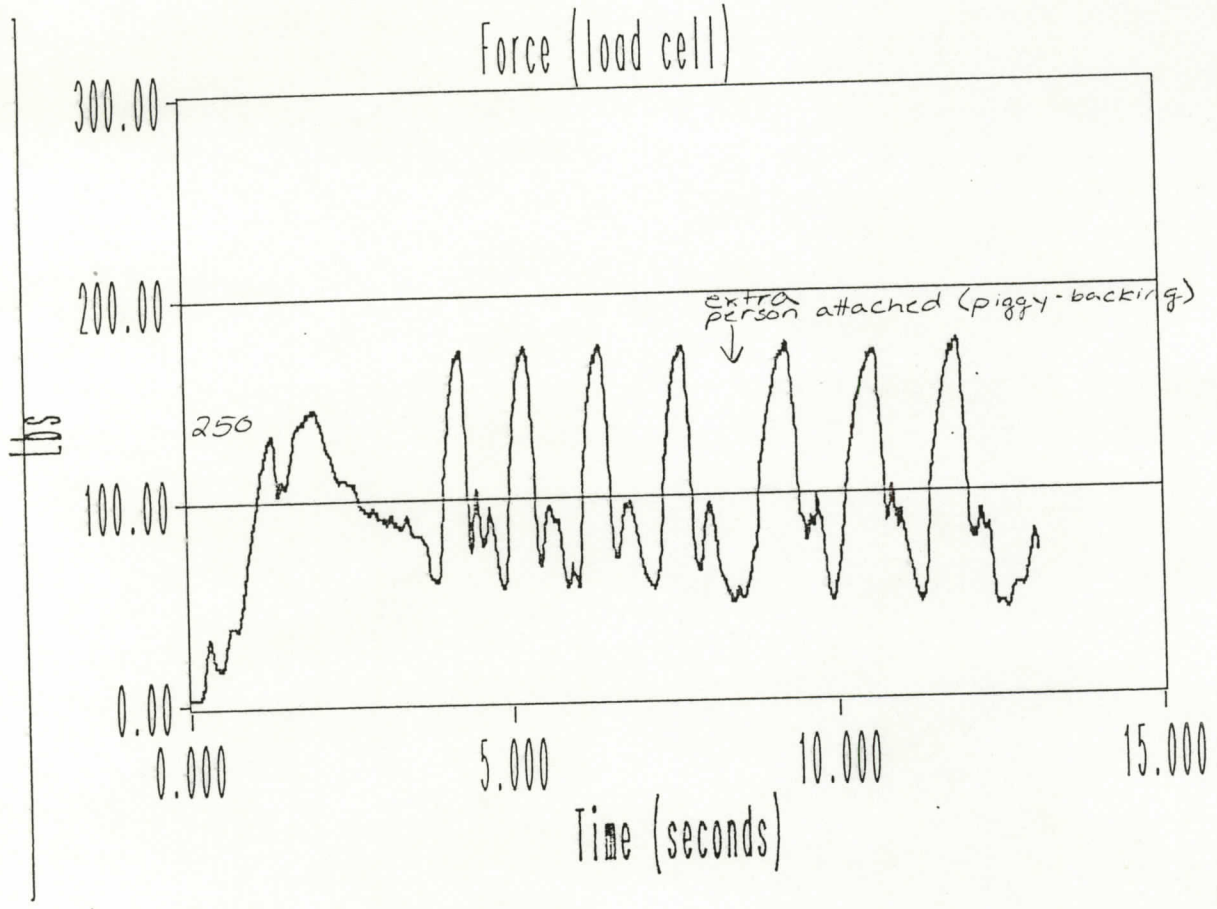
~~SQUATS~~
pull ups

MAX FORCE = 174

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display



PARABOLA 30

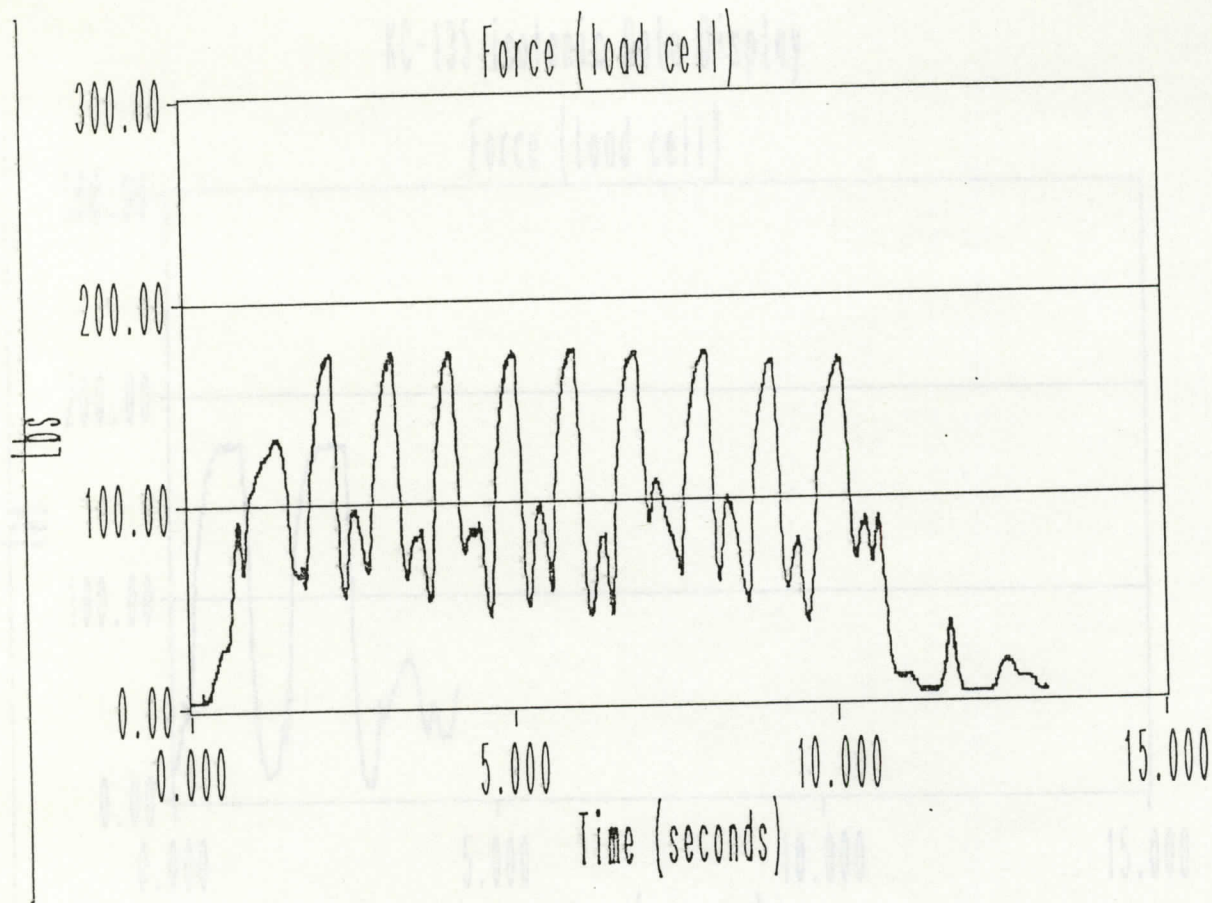
~~SQUATS~~
pull ups

MAX FORCE = 175

SUBJECT 3

John
Kiowski

KC-135 Isotonic Data Display



PARABOLA #31

~~SQUATS~~

MAX FORCE = 176

SUBJECT 3

pull ups

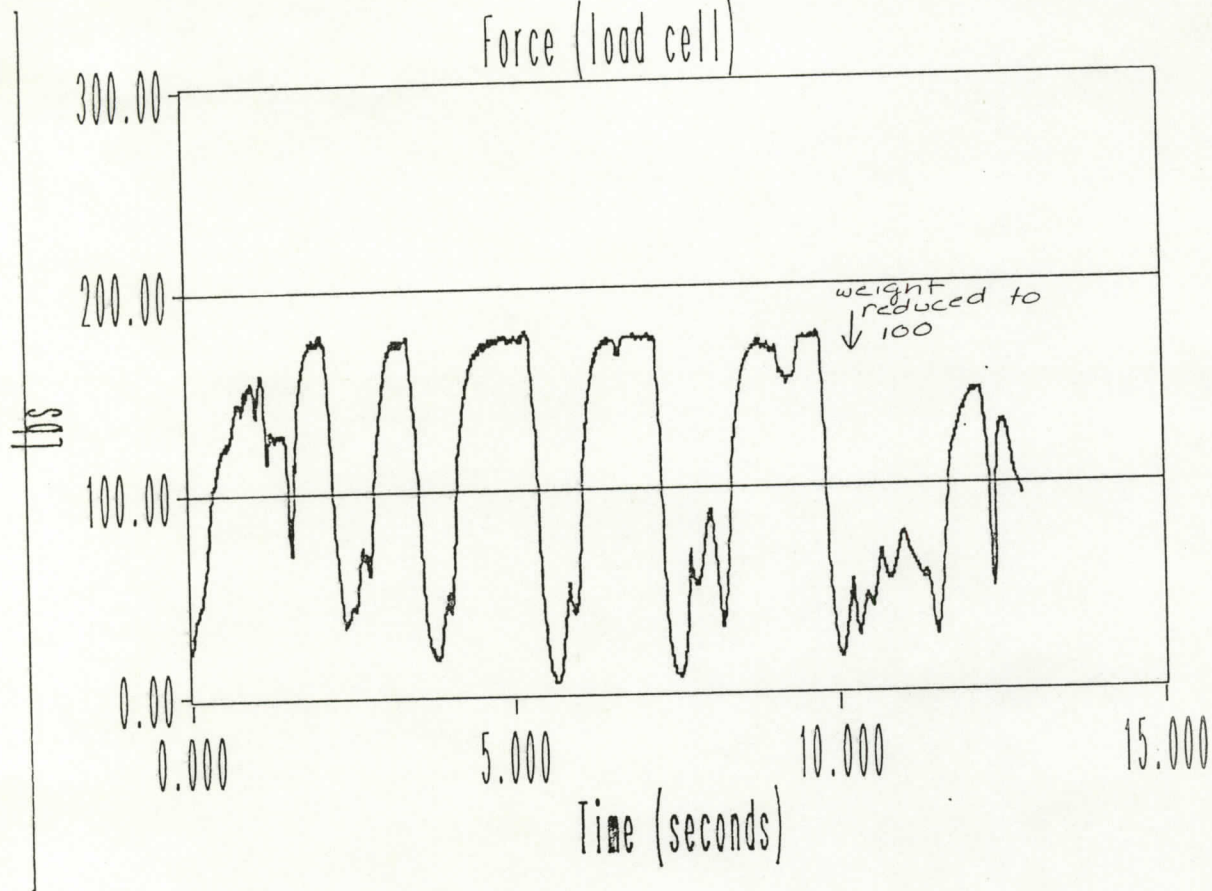
John
Kiowski

Mark
Bowman

* Seven pull ups completed, but only two were recorded

KC-135 Isotonic Data Display

Force (load cell)



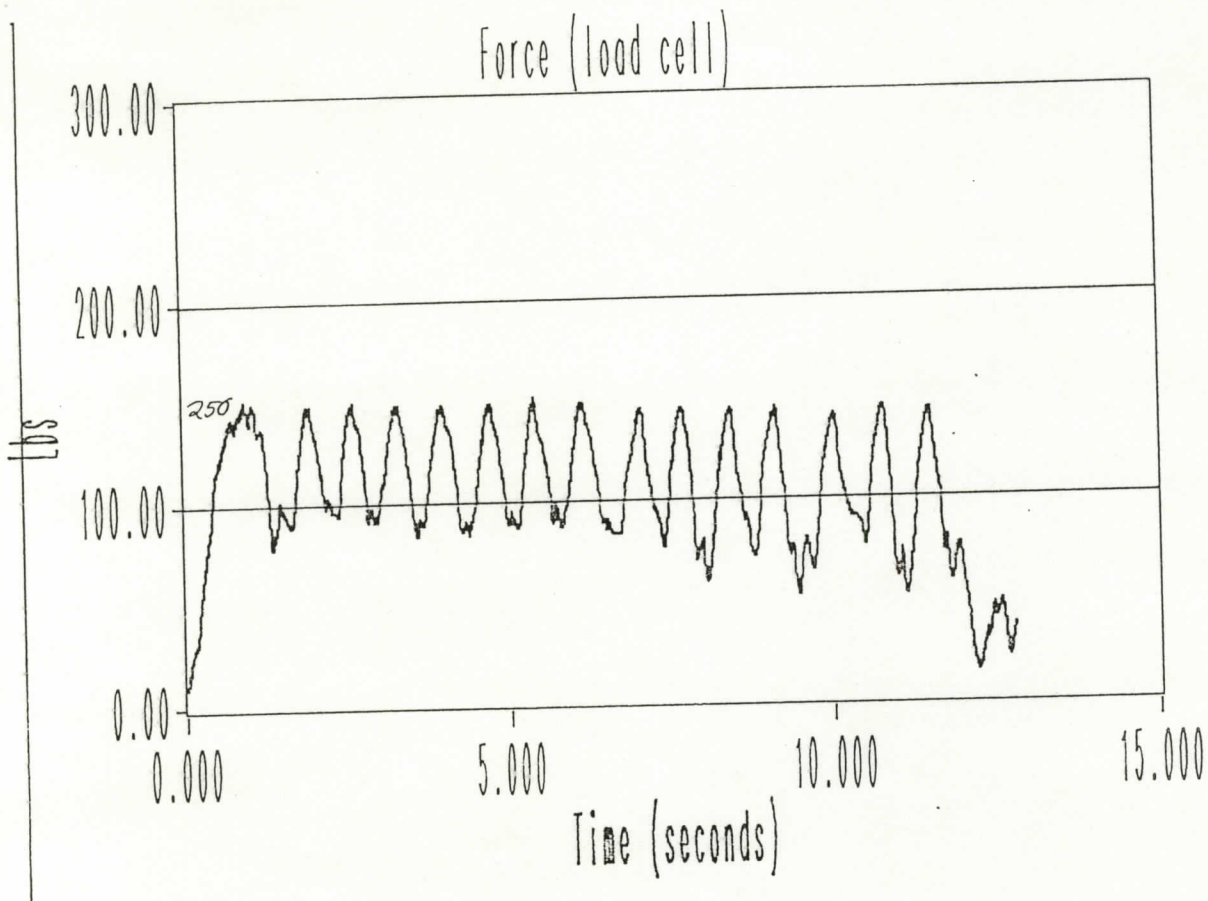
PARABOLA ~~135~~
33

~~SQUATS~~
pull ups

MAX FORCE = 179

SUBJECT 4
Mark
Bowman

KC-135 Isotonic Data Display



PARABOLA ~~136~~
34

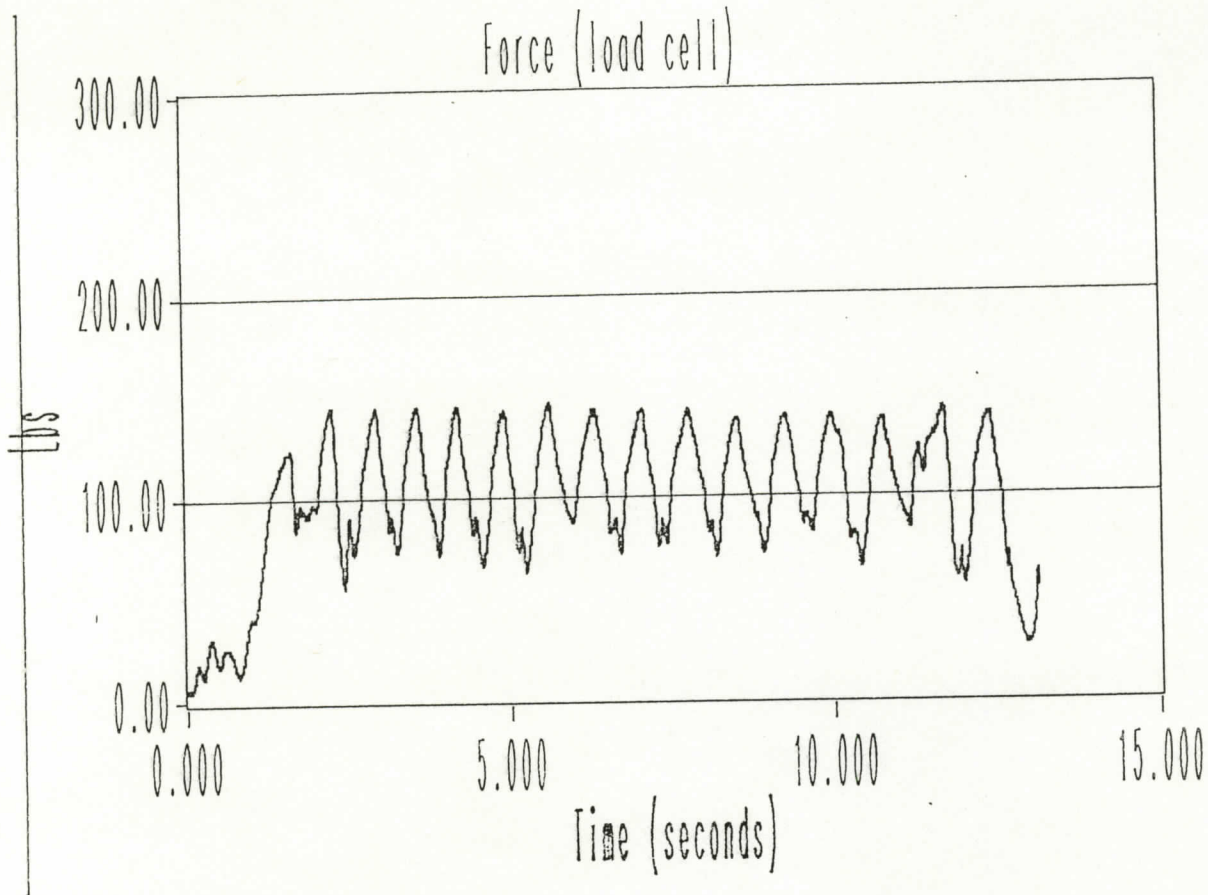
SQUATS

MAX FORCE = 153

SUBJECT 4

Mark
Bowman

KC-135 Isotonic Data Display



PARABOLA ~~137~~
35

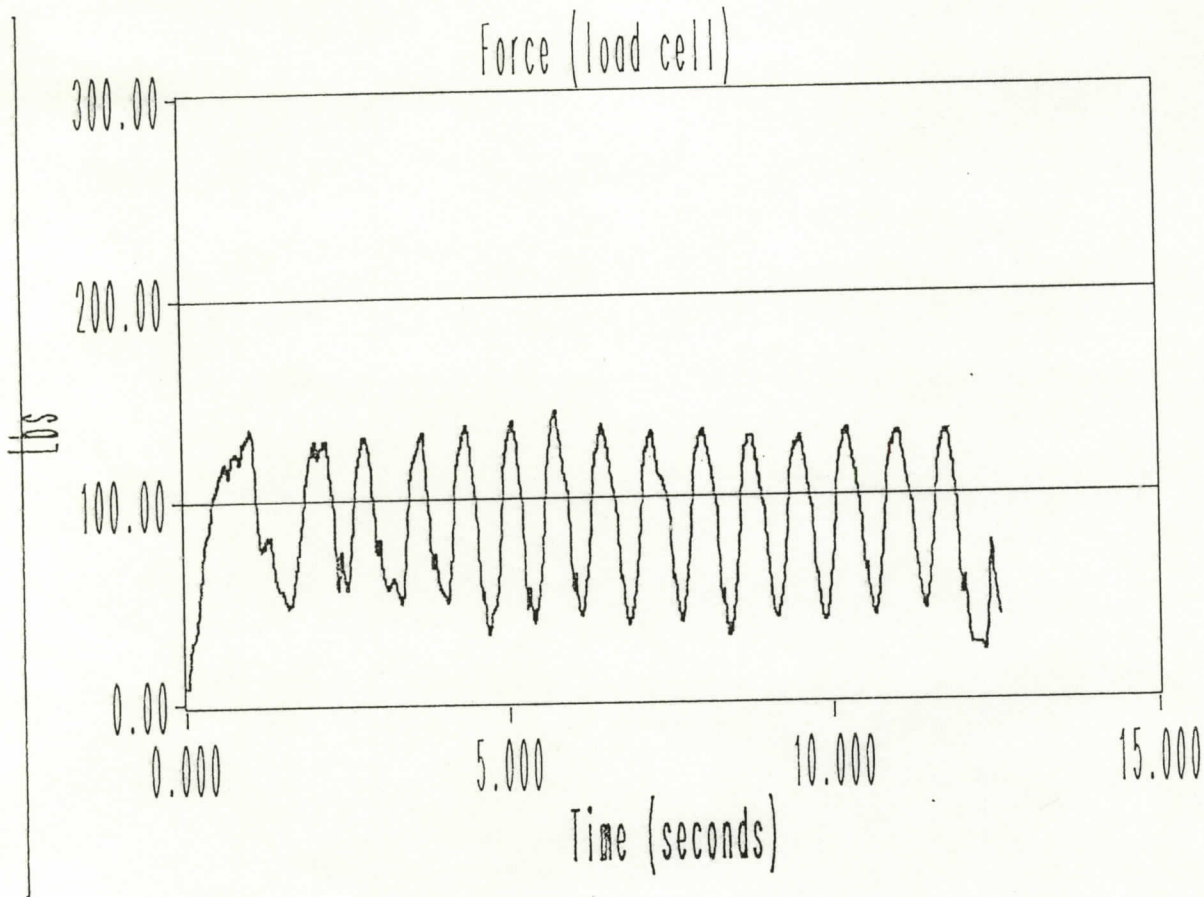
SQUATS

MAX FORCE = 147

SUBJECT 4

Mark
Bowman

KC-135 Isotonic Data Display



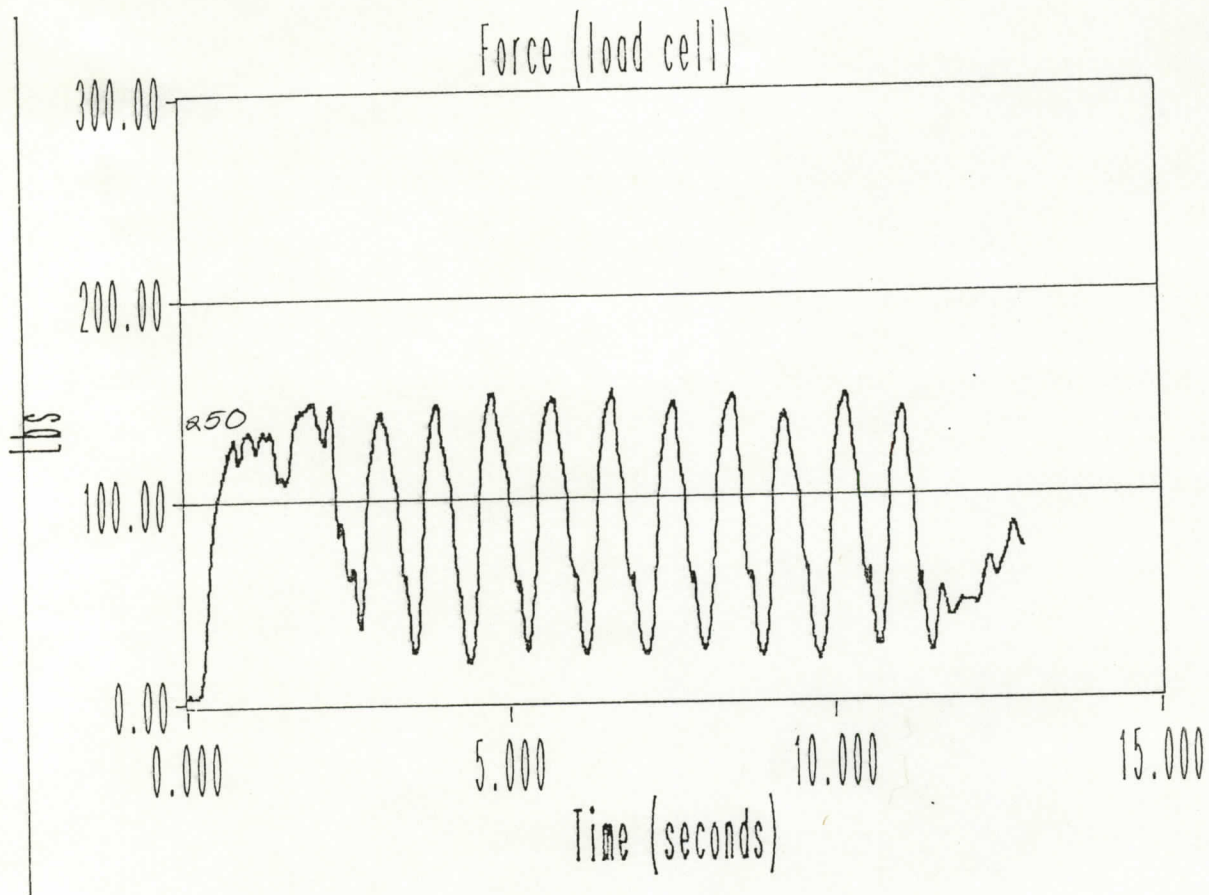
PARABOLA ~~138~~
36

SQUATS

MAX FORCE = 144

SUBJECT 4
Mark
Bowman

KC-135 Isotonic Data Display

PARABOLA ~~139~~

37

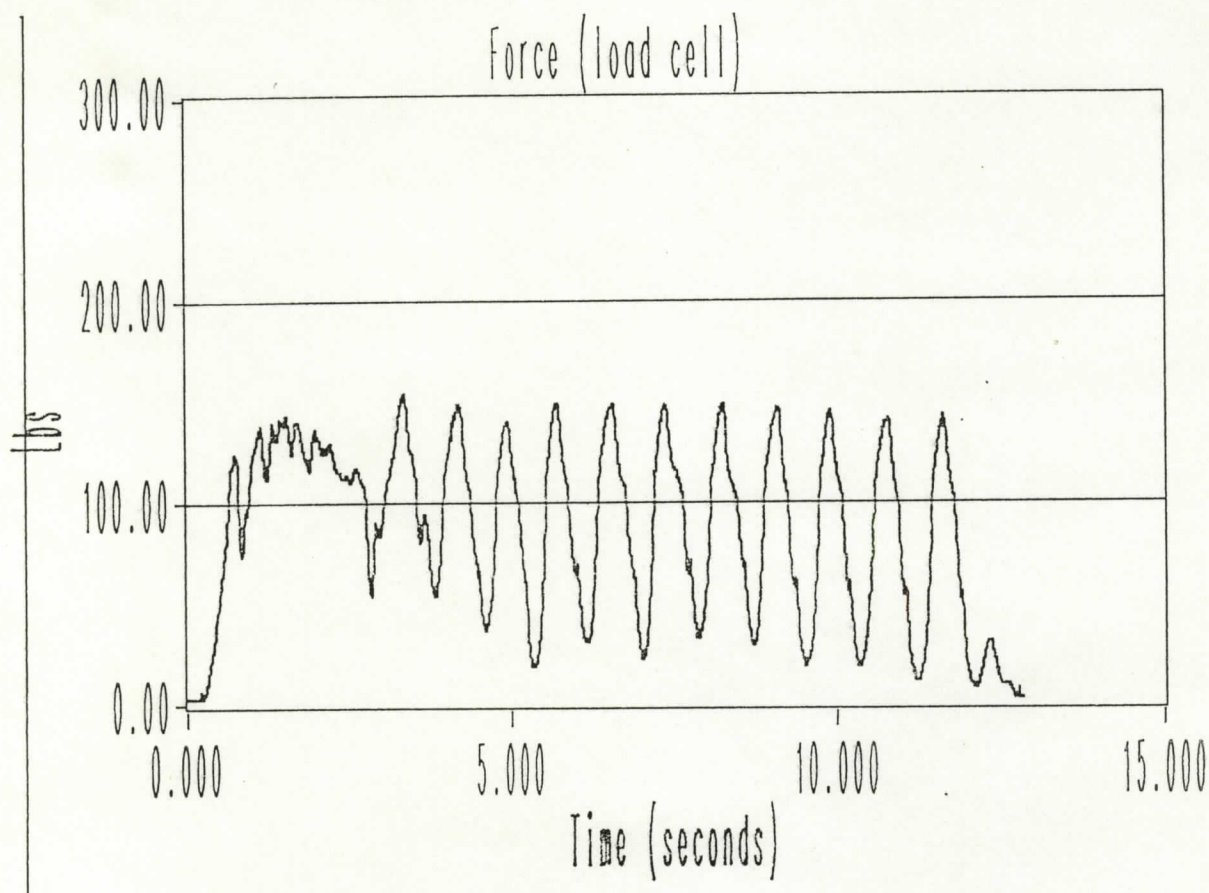
BAR DIPS

MAX FORCE = 154

SUBJECT 4

Mark
Bowman

KC-135 Isotonic Data Display

PARABOLA ~~140~~

38

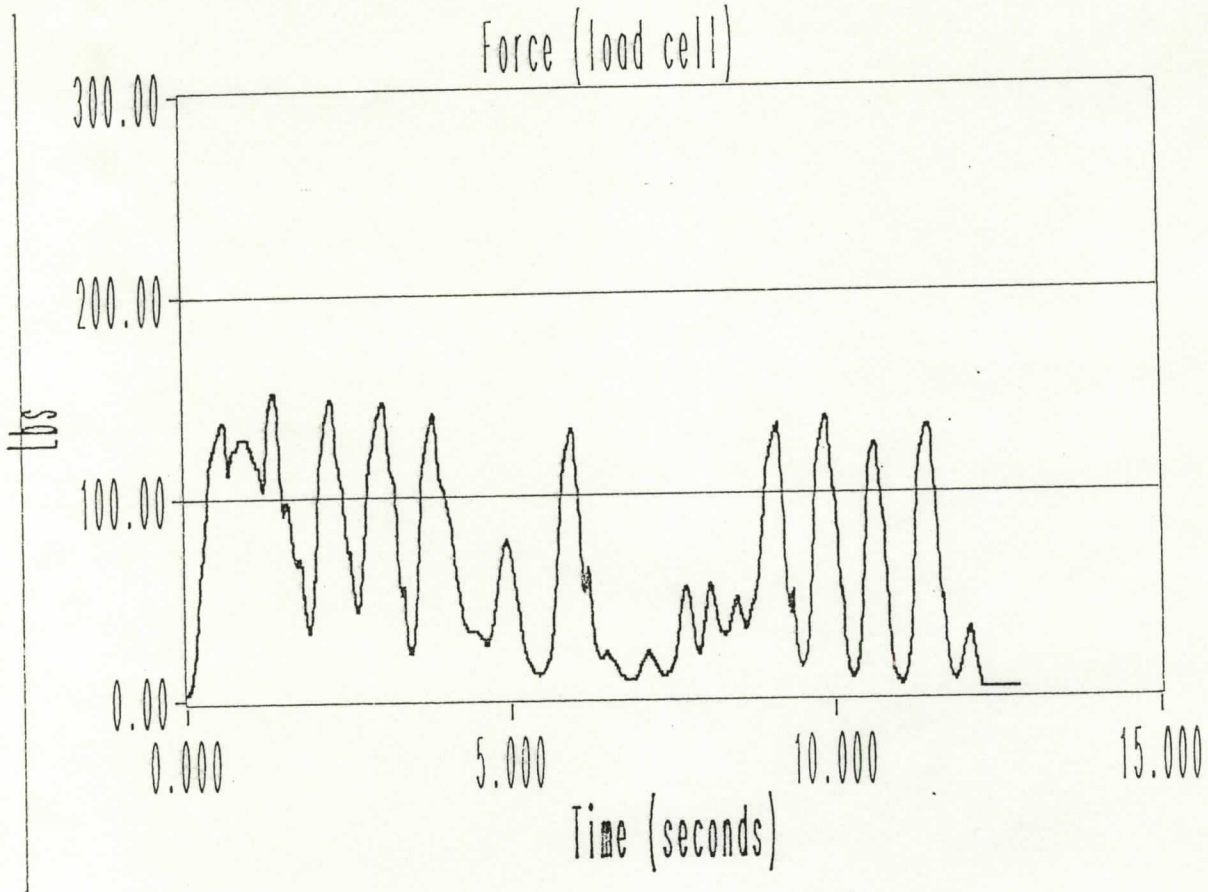
BAR DIPS

MAX FORCE = 154

SUBJECT 4

Mark
Bowman

KC-135 Isotonic Data Display



PARABOLA ~~44~~
39

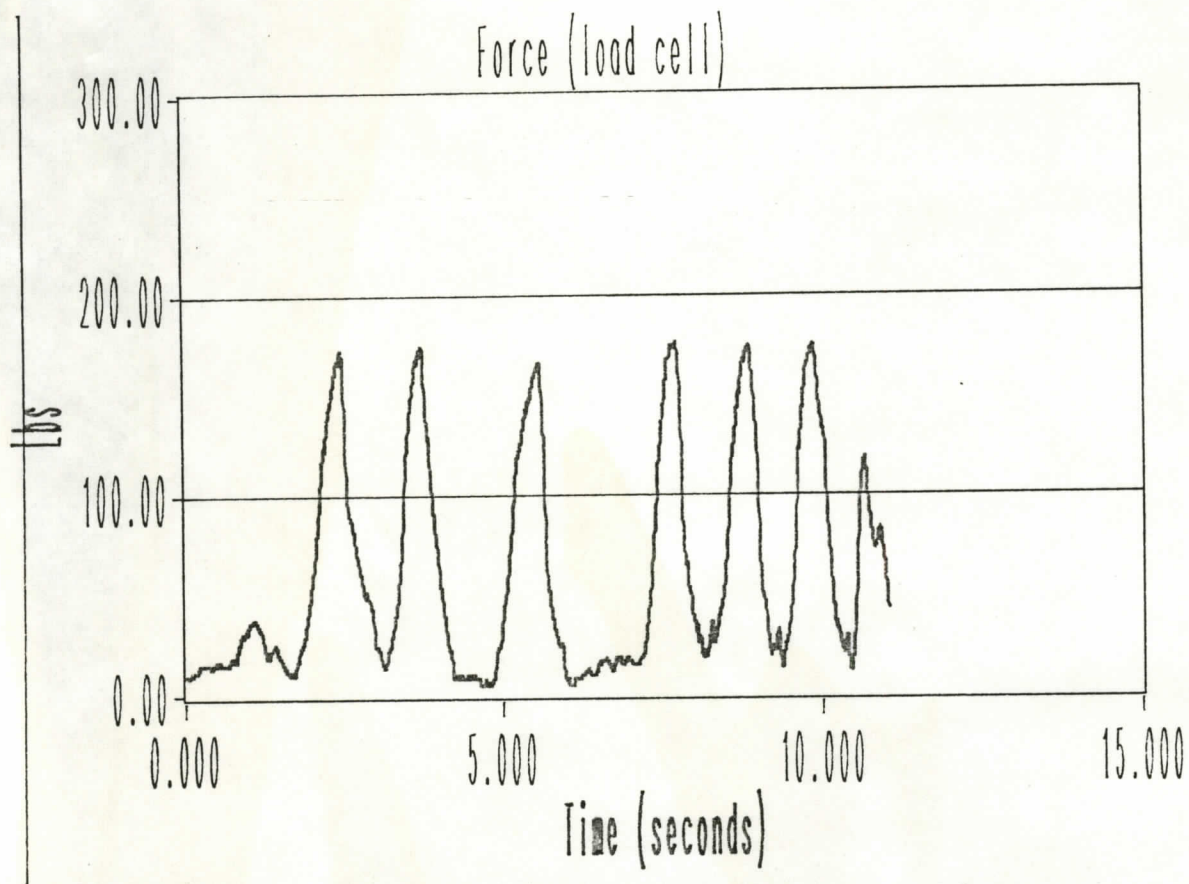
BAR DIPS

MAX FORCE = 153

SUBJECT 4

Mark
Bowman

KC-135 Isotonic Data Display



PARABOLA #9
40

~~BAR DIPS~~
dead
lifts

MAX FORCE = 177

SUBJECT 4

John
Kiowski

not filmed