GasGrab™ Project

Postural Loading (Handler) Whilst Manually Lifting and Lowering a Gas Cylinder

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1. INTRODUCTION

1.1 Background

Large, 230mm diameter pressurised gas cylinders, commonly used in the welding/fabrication industry, are routinely lifted onto a platform using the bear hug method of lifting. The cylinders, which weigh approximately 99kg when full, need to be vertically lifted a height of about 150mm. The sizeable weight together with this method of lifting can cause a considerable amount of physical strain on the handler leaving them at risk of injury, particularly to the lower back.

1.2 Product Development

In response to the need to reduce the level of physical risk from this activity, the GasGrab™ lifting device was devised and patented
Since the production of the original prototype, the GasGrab™ has been modified and improved, however there is as yet no scientific evidence to support its proof of concept.

The GasGrab™ is a lightweight device, made from die-cast aluminium that is placed around the body of the cylinder by the handler before lifting. Since the original idea was conceived, the GasGrab™ is now manufactured in a number of different sizes so that it can be used with a range of cylinders.

The 230mm diameter GasGrab™ (figure 1) uses a scissor action style to grip the cylinder in order to provide handles that can be used to lift the cylinder with. The 140mm diameter GasGrab™ (figure 1) used in the licensing trade and in restaurants is placed over the cylinder and grips it as the cylinder starts to tip as it is being lifted. This provides a single handle giving the handler a free hand.

Figure 1 GasGrab™ Device

230mm GasGrab™

140mm GasGrab™

1.3 Project Aims

The desired effect of the GasGrab™ is to reduce the level of physical risk involved when lifting and lowering a gas cylinder. The main aim of this project was to demonstrate and evaluate any health benefits that may be gained through using the

230mm and 140mm diameter GasGrab™ devices. In order to do this, a small study that measured the level of perceived exertion, discomfort and physical risk (particularly to the lower back), when manually lifting pressurised gas cylinders, was undertaken.

Alongside any demonstrable health benefits, it is hoped that the results of this project can be used to aid any further developments of the product, enhance the proof of concept, and ultimately lead to increased sales and productivity.

2. METHOD

2.1 Protocol Development

The original directive for both sizes was to evaluate the level of physical risk involved when using a non-mechanical manual lift compared to a lift using the GasGrab™. The feasibility of lifting/carrying two 140mm cylinders (one in each hand), using GasGrabs™ was also to be looked at.

Due to the considerable weight of the 230mm cylinder, risk assessments using the Health and Safety Executive's (HSE) Manual Handling Assessment Chart (MAC) were carried out (see figures 2 - 4 on p.4 & 5). Following this it was concluded that the risk of injury was too high to justify including a non-mechanical lift in the 230mm cylinder study. It was subsequently decided that the level of physical risk from an individual lift with the GasGrab™ device would be compared to that with a team lift. A brief explanation of the MAC results can be found in appendix 1.

2.2 Overview of Study Protocol

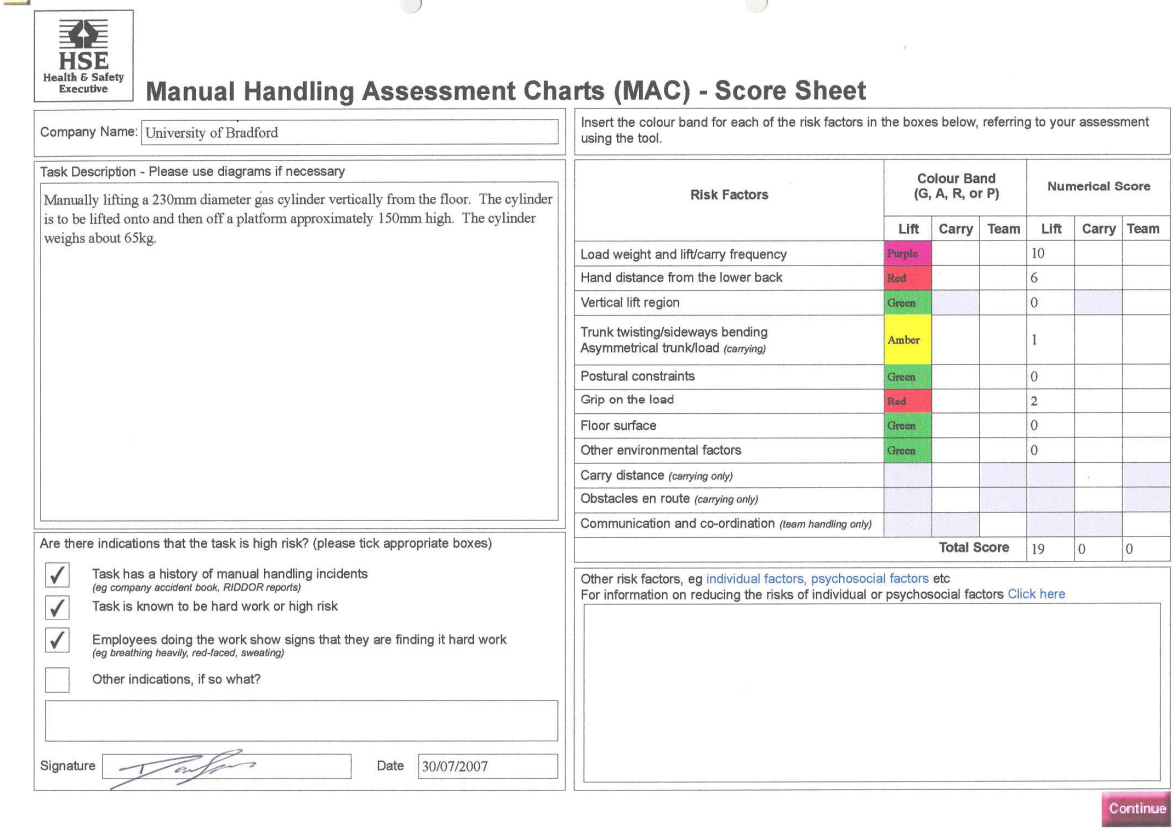
Following a number of amendments the definitive version of the study protocol was produced, the full version of which can be found in appendix 2. Included in this is the technique used for the 230mm team lift. All participants used their right hand during the team lift.

The study took place at the University of Bradford, within the school of engineering, design and technology, with a cohort of 16 adults, all of whom are in regular receipt of manual handling training. Before entering the study all participants were given a copy of the handler information leaflet to read (appendix 4), and all gave informed consent (appendix 5). The study was conducted in the following three stages:

Stage 1:	A 140mm cylinder lifted with and without the 140mm diameter GasGrab™
Stage 2:	Two 140mm cylinders and two 140mm GasGrabs™ (one in each hand)
Stage 3:	A 230mm cylinder and the 230mm diameter GasGrab™

HSE Manual Handling Assessment Charts (230mm cylinder)

Figure 2 Non-mechanical lift



HSE Health & Safety Executive

Manual Handling Assessment Charts (MAC) - Score Sheet

Company Name: University of Bradford

Task Description - Please use diagrams if necessary

Manually lifting a 230mm diameter gas cylinder vertically from the floor. The cylinder is to be lifted onto and then off a platform approximately 150mm high. The cylinder weighs about 65kg.

Are there indications that the task is high risk? (please tick appropriate boxes)

- ☑ Task has a history of manual handling incidents *(eg company accident book, RIDDOR reports)*
- ☑ Task is known to be hard work or high risk
- ☑ Employees doing the work show signs that they are finding it hard work *(eg breathing heavily, red-faced, sweating)*
- ☐ Other indications, if so what?

Signature Date 30/07/2007

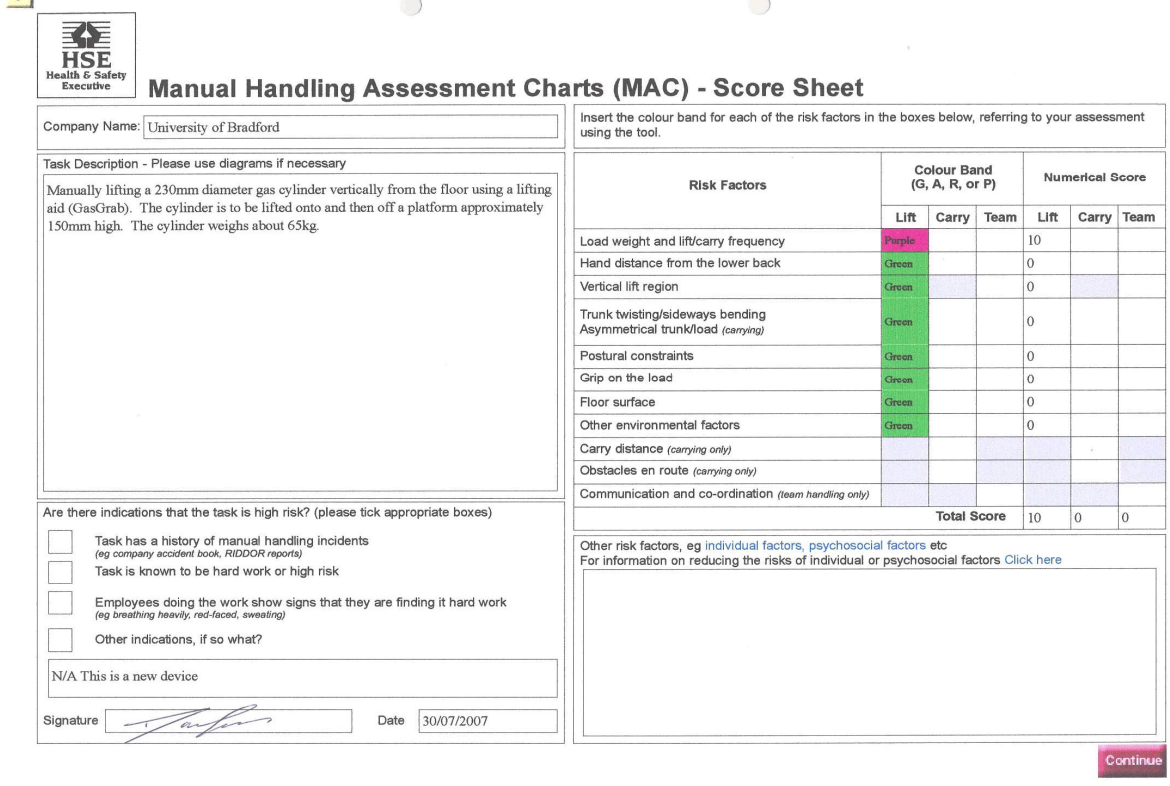
Insert the colour band for each of the risk factors in the boxes below, referring to your assessment using the tool.

Risk Factors	Colour Band (G, A, R, or P)			Numerical Score		
	Lift	Carry	Team	Lift	Carry	Team
Load weight and lift/carry frequency	Purple			10		
Hand distance from the lower back	Red			6		
Vertical lift region	Green			0		
Trunk twisting/sideways bending Asymmetrical trunk/load *(carrying)*	Amber			1		
Postural constraints	Green			0		
Grip on the load	Red			2		
Floor surface	Green			0		
Other environmental factors	Green			0		
Carry distance *(carrying only)*						
Obstacles en route *(carrying only)*						
Communication and co-ordination *(team handling only)*						
			Total Score	19	0	0

Other risk factors, eg individual factors, psychosocial factors etc
For information on reducing the risks of individual or psychosocial factors Click here

Continue

Figure 3 Individual lift using GasGrab™



HSE Health & Safety Executive

Manual Handling Assessment Charts (MAC) - Score Sheet

Company Name: University of Bradford

Task Description - Please use diagrams if necessary

Manually lifting a 230mm diameter gas cylinder vertically from the floor using a lifting aid (GasGrab). The cylinder is to be lifted onto and then off a platform approximately 150mm high. The cylinder weighs about 65kg.

Are there indications that the task is high risk? (please tick appropriate boxes)

- ☐ Task has a history of manual handling incidents *(eg company accident book, RIDDOR reports)*
- ☐ Task is known to be hard work or high risk
- ☐ Employees doing the work show signs that they are finding it hard work *(eg breathing heavily, red-faced, sweating)*
- ☐ Other indications, if so what?

N/A This is a new device

Signature Date 30/07/2007

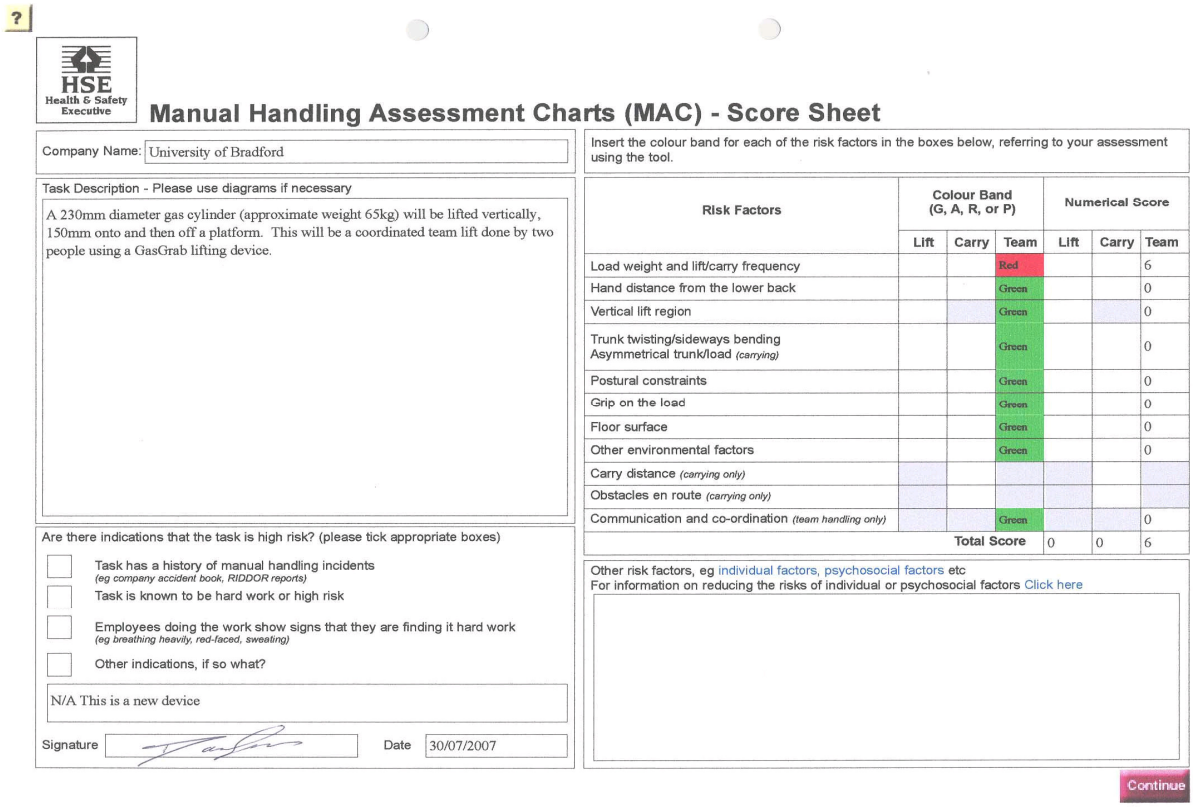
Insert the colour band for each of the risk factors in the boxes below, referring to your assessment using the tool.

Risk Factors	Colour Band (G, A, R, or P)			Numerical Score		
	Lift	Carry	Team	Lift	Carry	Team
Load weight and lift/carry frequency	Purple			10		
Hand distance from the lower back	Green			0		
Vertical lift region	Green			0		
Trunk twisting/sideways bending Asymmetrical trunk/load *(carrying)*	Green			0		
Postural constraints	Green			0		
Grip on the load	Green			0		
Floor surface	Green			0		
Other environmental factors	Green			0		
Carry distance *(carrying only)*						
Obstacles en route *(carrying only)*						
Communication and co-ordination *(team handling only)*						
			Total Score	10	0	0

Other risk factors, eg individual factors, psychosocial factors etc
For information on reducing the risks of individual or psychosocial factors Click here

Continue

Figure 4 Team lift (2 person) using GasGrab™



HSE Health & Safety Executive

Manual Handling Assessment Charts (MAC) - Score Sheet

Company Name: University of Bradford

Task Description - Please use diagrams if necessary

A 230mm diameter gas cylinder (approximate weight 65kg) will be lifted vertically, 150mm onto and then off a platform. This will be a coordinated team lift done by two people using a GasGrab lifting device.

Are there indications that the task is high risk? (please tick appropriate boxes)

- Task has a history of manual handling incidents *(eg company accident book, RIDDOR reports)*
- Task is known to be hard work or high risk
- Employees doing the work show signs that they are finding it hard work *(eg breathing heavily, red-faced, sweating)*
- Other indications, if so what?

N/A This is a new device

Signature Date 30/07/2007

Insert the colour band for each of the risk factors in the boxes below, referring to your assessment using the tool.

Risk Factors	Colour Band (G, A, R, or P)			Numerical Score		
	Lift	Carry	Team	Lift	Carry	Team
Load weight and lift/carry frequency			Red			6
Hand distance from the lower back			Green			0
Vertical lift region			Green			0
Trunk twisting/sideways bending Asymmetrical trunk/load *(carrying)*			Green			0
Postural constraints			Green			0
Grip on the load			Green			0
Floor surface			Green			0
Other environmental factors			Green			0
Carry distance *(carrying only)*						
Obstacles en route *(carrying only)*						
Communication and co-ordination *(team handling only)*			Green			0
			Total Score	0	0	6

Other risk factors, eg individual factors, psychosocial factors etc
For information on reducing the risks of individual or psychosocial factors Click here

Continue

3. DATA COLLECTION

Laboratories and workshops permission to work/risk assessments, (copies of which can be found in appendix 5), were completed and authorised prior to the collection of any data.

3.1 Demographical and Anthropometrical

Basic demographic and anthropometrical data (i.e. age, gender, height and arm span) was collected from each participant and can be found in appendix 6.

3.2 Subjective Data

It was decided that subjective data, relating to the preferences, thoughts and opinion of the participant, would be collected alongside objective data sets. This was done through the use of a numeric rating scale questionnaire that was filled after each part of the study, and an open section for general comments. The questions were related to overall level of exertion, body part discomfort and how easy the GasGrab™ device was to use.

3.2 Rapid Entire Body Assessment

Objective data for the 140mm GasGrab™ was collected by using the Rapid Entire Body Assessment (REBA) tool. This ergonomic assessment tool was considered by the researcher to be the most appropriate for this study as it includes a variable that enables the grip to be evaluated. Photographs were taken of the subjects during

each stage of the “lift” (i.e. lift, hold/carry and lower), and these were evaluated at a later date using the REBA assessment criteria.

3.3 Electromyography and Electrogoniometry

Objective data for the 230mm study was collected using electronic methods. Electromyography (EMG) was used to measure the electrical activity of the superficial muscles in the lower back, and electrogoniometry was used to measure the degree of flexion/extension and lateral flexion that the lower back was subjected to during the procedure. Electromyography readings were evaluated separately for each stage (i.e. at rest, prepare to lift, lift and lower).

4. RESULTS

Data was not collected from participants 11 and 15 in the 230mm cylinder study, as they were unable to perform an individual lift, however they did participate in the team lift.

Statistical analysis was done electronically using Stata software. A combination of repeated measures and linear regression analysis was used, and a p value of 0.05 or less was considered to be statistically significant (appendices 9 and 10).

4.1 Objective Data

<u>140mm Cylinder</u>
All REBA scores that fell into the high or very high risk category for the non-mechanical lift/carry of one cylinder were lowered when using the GasGrab™. In the majority of cases the level of risk remained medium or low when proceeding to lift/carry two cylinders with the GasGrab™. The full table of results can be seen in figure 5 on p.7.

The overall mean REBA value for the non-mechanical lift/carry (Part A) was 8.7. This was reduced to 4.4 in Part B and 4.7 in Part C of the study, both of which are statistically lower values ($p<0.001$). There was no statistically significant difference between Parts B (one cylinder and GasGrab™) and C (two cylinders) ($p=0.39$).

Figure 5 **Rapid Entire Body Assessment Scores – 140mm cylinder(s)**

	LIFT			CARRY			LOWER		
	1	2	3	1	2	3	1	2	3
A1	10	10	10	3	4	8	11	10	12
B1	6	7	4	3	4	7	4	5	6
C1	6	8	4	4	4	3	6	6	6
A2	11	11	11	7	7	5	11	11	11
B2	6	4	5	2	4	4	7	6	7
C2	6	4	6	4	2	2	4	7	7
A3	11	12	11	4	4	4	10	10	11
B3	6	3	6	2	4	3	3	6	6
C3	3	6	6	2	2	2	4	4	4
A4	11	11	11	6	5	6	11	11	11
B4	4	4	4	2	2	2	4	4	3
C4	4	4	4	2	2	2	7	7	4
A5	10	10	10	5	5	5	9	9	9
B5	7	7	4	3	3	3	7	5	4
C5	8	8	8	2	4	4	5	8	7
A6	9	10	10	5	5	7	9	10	9
B6	4	6	4	3	4	3	6	6	4
C6	6	7	6	3	3	3	7	7	7
A7	12	11	12	3	3	3	12	11	12
B7	4	3	3	4	6	6	4	4	4
C7	4	4	6	2	2	2	7	4	4
A8	10	11	11	6	6	4	11	11	10
B8	4	6	4	2	2	4	6	7	4
C8	6	6	6	4	3	3	7	5	5

Key – Subjects 1 - 8

A – One cylinder without GasGrab™
B – One cylinder with GasGrab™
C – Two cylinders with two GasGrabs™ (one in each hand)

REBA Action Levels

Action Level	REBA Score	Risk Level	Action (including further assessment)	
0	1	Negligible	None necessary	
1	2 – 3	Low	May be necessary	
2	4 – 7	Medium	Necessary	
3	8 – 10	High	Necessary soon	
4	11 – 15	Very High	Necessary now	

230mm Cylinder

As discussed previously, the level of physical risk when performing a non-mechanical lift was considered too high for it to be used in this study. The results therefore, are based on a comparison between an individual lift and a team lift with the GasGrab™.

There were no statistically significant differences between the individual or team lifts for EMG readings on the left side of the lower back ($p=0.624$). There was, however a large difference in readings on the right side where the mean reading was 0.05mV for Part D and 0.01mV for Part E, which is a statistically significant difference ($p<0.001$). This indicates that the left side of the lower back is working harder during the team lift.

The maximum degree of flexion is statistically significantly lower during the team lift ($p=0.018$) and the maximum degree of lateral flexion is statistically significantly higher during the team lift ($p=0.002$). EMG graphs can be viewed in appendix 8.

4.2 Subjective Data

A bar chart illustrating the mean values from the questionnaires can be found in figure 6 on p. 9, and the full table of results and participant's comments can be found in appendices 7a and 7b.

There were no statistically significant differences for height, age, arm span or level of discomfort, in either the 140mm or 230mm study.

140mm Cylinder

The overall level of exertion and level of discomfort in the legs was considerably reduced when using the GasGrab™ to lift/carry one cylinder. Compared to the non-mechanical lift/carry however, participants reported a slight increase in the level of discomfort felt in the upper limbs, and unilaterally in the back, when using the GasGrab™.

There was an overall reduction in the level of discomfort in the upper and lower back when two cylinders were lifted/carried using the GasGrabs™, when compared to one. The overall level of exertion, and level of discomfort in the legs was greater in this part of the study, however this is to be expected due to the extra weigh being lifted/carried.

When lifting two cylinders, four out of the eight participants found that there was a tendency for the cylinders to slip when being placed back onto the ground. This was however observed by the researcher to become less of a problem with practice in most cases.

230mm Cylinder

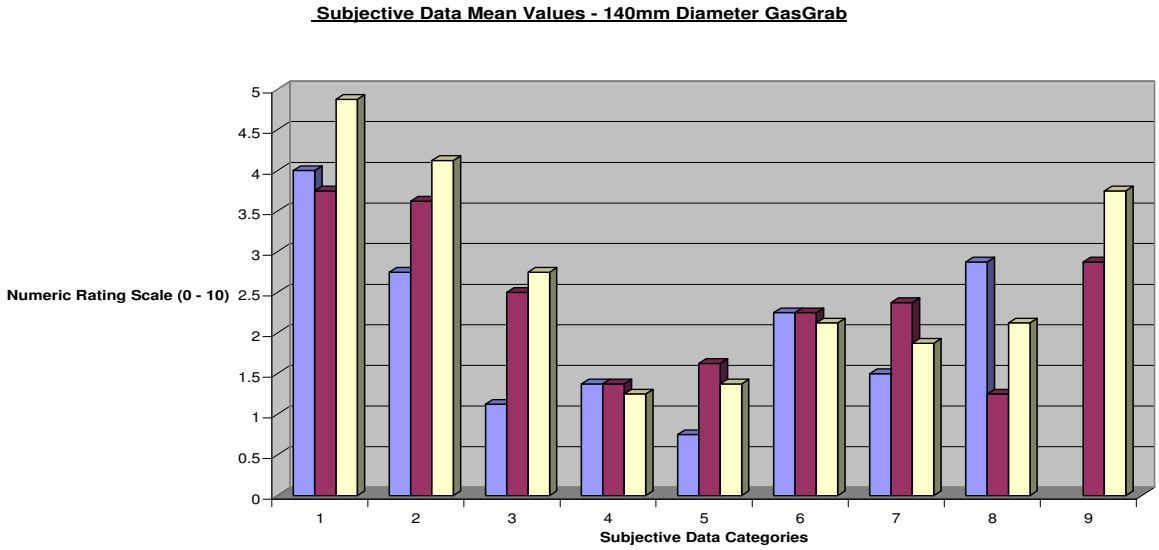
The overall level of exertion and general body discomfort (in all categories), was considerable reduced with the team lift when compared to the individual lift.

All participants felt that the GasGrab™ was a good idea and aided lifting the 230mm cylinder. It team lift was generally felt to be more favourable.

The level of perceived exertion was statistically significantly lower for the team lift ($p=0.04$).

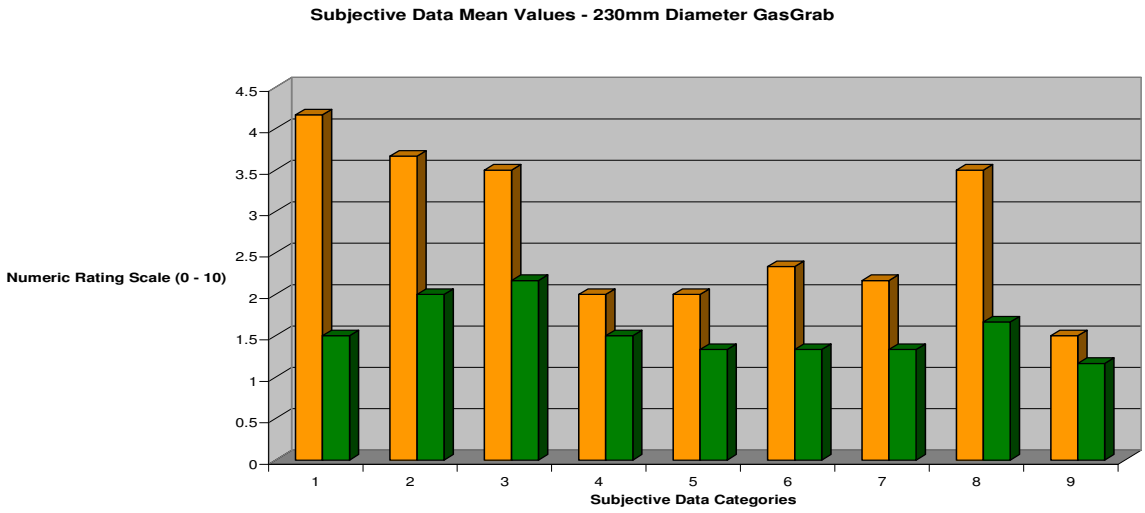
Figure 6 **Mean Values from the Subjective Data Questionnaires**

140mm Cylinder



	Part A – 1 cylinder without GasGrab™
	Part B – 1 cylinder with GasGrab™
	Part C – 2 cylinders with GasGrabs™

230mm Cylinder



	Part D – Individual lift with GasGrab™
	Part E – Team lift with GasGrab™

Subjective Data Categories

1 – Overall Level of Exertion
2 – Level of Discomfort felt in Arms & Hands
3 – Level of Discomfort felt in Shoulders
4 – Level of Discomfort felt in Upper Back (Central)
5 – Level of Discomfort felt in Upper Back (Unilateral)
6 – Level of Discomfort felt in Lower Back (Central)
7 – Level of Discomfort felt in Lower Back (Unilateral
8 – Level of Discomfort felt in Legs
9 – How easy the GasGrab™ was to use

5. Conclusions

5.1 140mm GasGrab™

The results indicate that the level of physical risk when lifting/handling a gas cylinder could be significantly reduced by using a GasGrab™, and the risk remains reduced when lifting/carrying two cylinders.

5.2 230mm GasGrab™

Using the HSE documentation, the level of risk is theoretically reduced when performing the task with the GasGrab™, however this was not tested objectively in this study as the level of risk to the participants was deemed to be too high.

Participants found the task to be significantly easier and less exerting when using a team lift.

6. Limitations of Study

It must be noted that none of the participants used in the study had any experience of lifting or moving gas cylinders, and the cylinders used in this study were empty.

A larger sample size is required to increase the statistical power of any future studies.

The author wishes to acknowledge the following for their help with this project:

- Mr Jonathan D. Philby, Business Development Manager, School of Engineering, Design and Technology
- Mrs Sue E. Barton, Risk Management Facilitator & Educator, School of Health Studies
- Mr Andrew J. Scally, Senior Lecturer, School of Health Studies

HSE Manual Handling Risk Assessment - 230mm Cylinder **Appendix 1**

Introduction

A manual handling risk assessment was carried out on 30/07/07 to determine the level of risk associated with manually lifting a 230mm gas cylinder (approx. weight 65kg). This was done using the Health and Safety Executive's Manual Handling Assessment Chart (MAC), which allows the level of risk to be ascertained for each risk factor.

The assessment was then repeated for the same task but using the GasGrab™.

Results

The results have been summarised in a table on the following page

Manual Lift

The numerical score for manually lifting the cylinder was 19 (out of a possible total of 30), and from this the following four areas were identified as requiring attention in terms of reducing the risk to the operative.

1. Load weight (10/10) – very high level of risk, particularly if lifted by one person.
2. Hand distance from lower back (6/6) – High level of risk requiring prompt action.
3. Trunk twisting or sideways bending (1/2) – Medium level of risk that needs to be closely examined.
4. Grip on the load (2/2) – Poor and requires attention.

GasGrab™ Lift

The numerical score for lifting the same cylinder, under the same conditions using the GasGrab™ was 10. With the exception of the load weight, which could not be changed, the risk was reduced for all the other areas identified as requiring attention in the manual lift.

Conclusion

It was concluded that the risk of injury was too high to justify including a manual lift of the 230mm cylinder in the study, and therefore only a GasGrab™ lift will be evaluated. Although the risk is reduced by using the GasGrab™, participants will be made fully aware of the very high risk that remains due the weight of the cylinder before being asked to take part.

The task was re-assessed using the GasGrab™ and a two-person team lift. The level of risk from the load weight was reduced from a very high level of risk to a high level of risk. It was therefore decided to include this as part of the study and make a comparison between the individual and the team lift.

Table of MAC Results - 230mm Cylinder Appendix 1ctd.

Risk Factors	Manual Lift	GasGrab™ Lift
Load Weight (Approx. 65kg)	A very high level of risk that may represent a serious risk of injury, especially when the load is lifted by one person.	Remains a very high level of risk when the lift is undertaken by one person.
Hand Distance from Lower Back	A high level of risk due to the arms being away from the body and trunk being bent slightly forwards in order to grasp the cylinder	Reduced to a low level of risk as the arms are brought closer to the body and the trunk can remain upright.
Vertical Lift Region	This is a low risk as the hands remain above the height of the knees and below the height of the elbows.	Remains low risk.
Trunk Twisting and/or Sideways Bending	A small amount of either twisting or side bending of the trunk gives this a medium level of risk.	The GasGrab™ should eliminate the need for side bending or twisting, therefore reducing this to a low risk.
Postural Constraints	The movement of the operative is unhindered in the laboratory setting, and therefore this carries a low risk of injury.	Remains low risk.
Grip on the Load	This is classified as being poor as the cylinder is difficult to hold.	The GasGrab™ provides the operative with handles, enabling them to grip the cylinder. This re-classifies the grip as being good.
Floor Surface	The floor in the university laboratory is dry, clean and in good condition, therefore the risk associated with this is low.	Remains low risk.
Other Environmental Factors	There are no environmental risk factors present in the laboratory setting and therefore the risk from this is low.	Remains low risk.

GasGrab™ Study Protocol — Appendix 2

INTRODUCTION

It is proposed to undertake a small study at the University of Bradford, within the school of engineering, design and technology, to determine the level of perceived exertion, discomfort and physical risk (particularly to the lower back), when manually lifting pressurised gas cylinders both with and without the use of a lifting aid.

The lifting aid that will be used is the GasGrab™, which is a light-weight aluminium casted device that grips the cylinder and provides a handle(s) that can be used to lift the cylinder with. It is currently manufactured in two sizes (230mm and 140mm), and these will be independently evaluated in the study.

A cohort of eight adults will take part in the study, which will be conducted in three stages. It is proposed that Parts A, B and C will be conducted during the same session, with sufficient rest breaks in between to minimise the risk of fatigue. Parts D and E will be conducted on a different day, also with sufficient rest breaks in between.

Stage 1:	A 140mm cylinder lifted with and without the 140mm diameter GasGrab™
Stage 2:	Two 140mm cylinders and two 140mm GasGrabs™ (one in each hand)
Stage 3:	A 230mm cylinder and the 230mm diameter GasGrab™

Informed consent will be obtained from the participants before they are entered into the study. On entry into the study, basic demographic and anthropometrical data (age, gender, knowledge of safe handling of gas cylinders, height and arm span) will be collected for each participant.

METHOD

It is proposed that the procedure is repeated three times for each part. The participants will be given the opportunity to have a practice lift, enabling them to familiarise themselves with the correct lifting technique and use of the equipment.

STAGE 1

It is proposed that stage 1 of the study will be conducted in two parts.

Part A: This will involve the participant manually lifting, briefly holding, and lowering the cylinder, following suitable and sufficient manual handling education, without using the GasGrab™.

Part B: The same cylinder will be lifted and lowered by the participant using the GasGrab™, after they have received some tuition, and a demonstration, on the correct use of the device.

STAGE 2

Due to the impracticality of lifting two cylinders without lifting aids, it is proposed that stage 2 will consist of only one part.

Part C: The participant will lift and lower two 140mm gas cylinders using two 140mm GasGrabs™, one in each hand.

Lifting Procedure (Stages 1 and 2)

The cylinder(s) will be positioned, lifted and lowered vertically for Parts A, B and C.

It is proposed that the following protocol will be adopted for each part;

1. "STAND" Baseline readings of the participant's normal posture
2. "TAKE HOLD" Taking hold of the cylinder(s) but no lift
3. "LIFT" The cylinder(s) is/are lifted with a short hold (approx 2 secs to allow the appropriate information to be gathered)
4. "LOWER" The cylinder(s) is/are lowered into the original starting position

STAGE 3

The completion of a Health and Safety Executive (HSE) manual handling assessment chart identified the lifting of the 230mm cylinder, without a lifting aid, as having a very high level of risk. As this was reduced with the GasGrab™ it is proposed that stage 3 will be conducted in two parts, both with the GasGrab™. Part D will be an individual lift and Part E will involve of a team lift, and the level of physical risk for each will be compared:

Part D: The cylinder will be lifted and lowered by the participant using the GasGrab™, after they have received some tuition, and a demonstration, on the correct use of the device.

Part E: The cylinder will be lifted and lowered by two participants (handlers) using the GasGrab™. Tuition and a demonstration of the lifting technique to be used will be given before starting the study.

Lifting Procedure (Stage 3)

It is proposed that the following protocol will be adopted for each part;

1. "STAND" Baseline readings of the participant's normal posture
2. "TAKE HOLD" Taking hold of the cylinder but no lift
3. "LIFT" The cylinder is lifted approx. 150mm onto a platform
4. "LOWER" The cylinder is lifted and lowered back onto the floor

Team Lifting Technique (Part E – two handlers)

The following technique was developed following a short practice session, involving a manual-handling advisor, prior to the start of the study.

The two handlers will stand either side of the cylinder, facing in opposite directions, and slightly angled walk stance with soft knees and elbows will be used. Each handler will use one hand to lift the cylinder, using the GasGrab™ handle, and the free hand can be used to steady the cylinder.

DATA COLLECTION

The level of exertion and discomfort, as perceived by the participants, will be assessed after each lift using a self-report questionnaire. This will be done for Parts A, B and C of the study.

Parts A, B and C
Participants will be photographed during both stages of the procedure (if applicable), enabling the manual handling risk to be assessed using the Rapid Entire Body Assessment (REBA) tool.

Parts D and E
The participants will undergo the following physiological tests during the procedure:

- Electromyography will be used to accurately measure the behaviour of the superficial muscles in the back.
- Electrogoniometry will be used to accurately measure the angle of the back (specifically flexion/extension and lateral flexion).

The data produced will measure the physiological differences, and therefore determine the level of physical risk, when manually lifting gas cylinders with and without using the GasGrab™ lifting aid. The level of perceived exertion reported by the participants will also be determined both with and without the GasGrab™.

Postural loading (handler) whilst manually lifting and lowering a gas cylinder

A collaboration between the
UNIVERSITY OF BRADFORD
SCHOOL OF ENGINEERING DESIGN & TECHNOLOGY, SCHOOL OF HEALTH STUDIES

'HANDLER' INFORMATION LEAFLET

THIS COPY IS YOURS TO KEEP

PRINCIPAL INVESTIGATOR: Dawn Groves
ACADEMIC SUPERVISORS: Sue Barton (School of Health Studies)
Jonathan Philby (School of Engineering, Design & Technology)

INVITATION

'You are being invited to take part in the evaluation of physical risk whilst performing the task of manually lifting, and lowering a gas cylinder(s)'. Before you decide whether you are happy to take part it is important for you to understand why the evaluation is being done and what it will involve.
Please take time to read the following information, carefully, and discuss it with others if you wish. Please ask us if there is anything that is not clear or if you would like any more information. Take time to decide whether or not you wish to take part. Thank you for reading this.'

PURPOSE OF THE STUDY

The purpose of the study is to measure the physical risk involved in performing the task of lifting and lowering a gas cylinder. It is hoped that this will inform the development of a mechanical device (GasGrab™) aimed at increasing effectiveness and efficiency, and decreasing the level of physical risk to the handler.
Physical activity of the handler (you) will be measured using a self-report questionnaire plus electromyography and electrogoniometry [230mm cylinder] / the Rapid Entire Body Assessment (REBA) tool [140mm cylinder(s)]. The REBA assessment will require you to be photographed whilst performing the task.
The information collected will enable further development of the mechanical device, which we hope will lead to its manufacture.

WHY YOU HAVE BEEN CHOSEN

You have been selected because you have professional experience of the handling of objects.

DO I HAVE TO TAKE PART?

It is entirely up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep, and be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect you in any way.

WHAT WILL HAPPEN IF I DO DECIDE TO TAKE PART?

Measurements will be taken with regard to the activity in your lumbar spine whilst performing the

task of lifting, and lowering the gas cylinder(s). You will be shown the equipment, and the 'set-up' procedure will be explained to you fully. Selected, personal and anthropometrical date will be recorded. This will remain anonymous and confidential.

ARE THERE ANY DISADVANTAGES OR RISKS?

There are not expected to be any.

WHAT ARE THE BENEFITS?

The objective data collected on the physical risks (specifically to the low back) involved in the handling of the gas cylinder(s) will be analysed statistically. From this information, it is also hoped that the risk of handling related injury, to the 'gas cylinder handler', will be reduced.
It is hoped that the information gathered from this study will inform future education, as well as the development of the mechanical device.

WHAT IF SOMETHING GOES WRONG?

'If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for a legal action, but you may have to pay for it. Regardless of this, if you wish to complain, or have any concerns about any aspect of the way you have been approached or treated during the course of this study, the normal complaints mechanisms should be available to you.'

WILL MY TAKING PART BE CONFIDENTIAL?

All information that is collected about you during the course of the study will be kept strictly confidential. Information will be used for education purposes and to inform the development of the mechanical device. Any information about you that leaves the University will have all identification removed.

WHAT WILL HAPPEN TO THE INFORMATION COLLECTED?

All information collected will be used to further develop the mechanical device – GasGrab™,

FUNDING FOR THIS STUDY

This study has been supported by the University of Bradford Summer Experience programme, part of the Knowledge Transfer Partnership.

STUDY REVIEW

This study has been reviewed by mentors at the School of Engineering, Design and Technology, and the School of Health Studies.

Many thanks for taking part in this study. Your involvement will be invaluable to us
If you require any further information, please do not hesitate to contact us:-

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Appendix 6

Demographic and Anthropometrical Data of Participants

140mm Cylinder(s)

Handler ID Number	Study Number	Gender	Age	Height (cm)	Arm Span (cm)
1	A1/B1/C1	F	56	153	145
2	A2/B2/C2	F	44	165	156
3	A3/B3/C3	M	35	176	181
4	A4/B4/C4	F	49	165	157
5	A5/B5/C5	F	30	172	173
6	A6/B6/C6	F	42	160	157
7	A7/B8/C7	M	34	176	176
8	A8/B8/C8	F	32	155	146

230mm Cylinder

Handler ID Number	Study Number	Gender	Age	Height (cm)	Arm Span (cm)
9	D9/E9	M	49	179	174
10	D10/E10	M	55	184	189
11	*D11/E11*	*M*	*55*	*148*	*150*
12	D12/E12	M	55	170	172
13	D13/E13	M	58	173	171
14	D14/E14	M	55	169	169
15	*D15/E15*	*M*	*63*	*167*	*162*
16	D16/E16	M	24	185	182

Appendix 7a

Subjective Questionnaire Data

STAGE 1 (one cylinder)

Part A – without GasGrab™

Handler Identification No.	1	2	3	4	5	6	7	8		Mean
Level of Exertion	3	2	3	2	6	6	5	5		4.000
Discomfort Level										
Arms & Hands	2	0	3	0	3	6	5	3		2.750
Shoulders	1	0	1	0	2	1	3	1		1.125
Upper Back (central)	1	1	1	0	2	0	5	1		1.375
Upper Back (unilateral)	1	0	1	0	2	0	0	2		0.750
Lower Back (central)	1	0	2	0	3	6	2	4		2.250
Lower Back (unilateral)	1	0	2	0	3	0	2	4		1.500
Legs	4	1	3	1	3	2	3	6		2.875

Part B – with GasGrab™

Handler Identification No.	1	2	3	4	5	6	7	8		Mean
Level of Exertion	2	3	2	1	1	8	7	6		3.750
Discomfort Level										
Arms & Hands	3	2	2	0	1	6	7	8		3.625
Shoulders	3	2	1	0	1	1	7	5		2.500
Upper Back (central)	1	2	1	0	0	0	2	5		1.375
Upper Back (unilateral)	1	0	1	0	0	0	7	4		1.625
Lower Back (central)	1	0	2	0	1	6	0	8		2.250
Lower Back (unilateral)	1	0	2	0	1	0	7	8		2.375
Legs	1	0	1	0	2	0	1	5		1.250
Ease of use of GasGrab™	1	3	1	2	1	5	2	8		2.875

STAGE 2 (two cylinders)

Part C – two cylinders with GasGrabs™

Handler Identification No.	1	2	3	4	5	6	7	8		Mean
Level of Exertion	3	4	3	3	4	7	8	7		4.875
Discomfort Level										
Arms & Hands	2	2	2	1	3	8	8	7		4.125
Shoulders	3	3	2	1	2	1	4	6		2.750
Upper Back (central)	2	0	1	0	1	0	1	5		1.250
Upper Back (unilateral)	2	0	1	0	1	0	2	5		1.375
Lower Back (central)	1	0	2	0	2	2	2	8		2.125
Lower Back (unilateral)	1	2	2	0	1	0	1	8		1.875
Legs	2	0	2	1	3	0	2	7		2.125
Ease of use of GasGrab™	3	5	2	3	2	5	2	8		3.750

STAGE 3 (230mm GasGrab™)

Part D – individual lift with GasGrab™

Handler Identification No.	9	10	11	12	13	14	15	16		Mean
Level of Exertion	5	8		5	1	3		3		4.1667
Discomfort Level										
Arms & Hands	5	7		5	1	2		2		3.667
Shoulders	5	6		5	1	2		2		3.500
Upper Back (central)	5	5		0	1	0		1		2.000
Upper Back (unilateral)	5	5		0	1	0		1		2.000
Lower Back (central)	5	5		0	1	0		3		2.333
Lower Back (unilateral)	5	5		0	1	0		2		2.167
Legs	6	7		5	1	2		0		3.500
Ease of use of GasGrab™	1	1		5	1	0		1		1.500

Part E – team lift with GasGrab™

Handler Identification No.	9	10	11	12	13	14	15	16		Mean
Level of Exertion	2	4		1	1	0		1		1.500
Discomfort Level										
Arms & Hands	3	3		3	1	1		1		2.000
Shoulders	3	4		3	1	1		1		2.167
Upper Back (central)	2	4		0	1	1		1		1.500
Upper Back (unilateral)	2	4		0	1	0		1		1.333
Lower Back (central)	3	4		0	1	0		0		1.333
Lower Back (unilateral)	3	4		0	1	0		0		1.333
Legs	3	3		3	1	0		0		1.667
Ease of use of GasGrab™	1	1		3	1	0		1		1.167

Comparison of Means

Handler Identification No.	PART A	PART B		PART C		PART D	PART E
Level of Exertion	4.000	3.750		4.875		4.1667	1.500
Discomfort Level							
Arms & Hands	2.750	3.625		4.125		3.667	2.000
Shoulders	1.125	2.500		2.750		3.500	2.167
Upper Back (central)	1.375	1.375		1.250		2.000	1.500
Upper Back (unilateral)	0.750	1.625		1.375		2.000	1.333
Lower Back (central)	2.250	2.250		2.125		2.333	1.333
Lower Back (unilateral)	1.500	2.375		1.875		2.167	1.333
Legs	2.875	1.250		2.125		3.500	1.667
Ease of use of GasGrab™		2.875		3.750		1.500	1.167

Appendix 7b

Subjective Comments from Participants and Researcher's Observations

140mm Study (Parts A, B & C)

Handler ID Number	Comment(s)
1	• "Single GasGrab would start to pull on one side *if held for longer*" • "GasGrab device became easier to use with practice" • Cylinders slipped on floor when being put down – required help (2 cylinders)
2	• "Felt unstable with a single GasGrab" – better with 2 • "Felt uncomfortable when trying to put the cylinders down onto the floor as they were slipping" (2 cylinders)
3	• "Would prefer to carry cylinder in 2 arms, with the GasGrab, *if walking over uneven ground*"
4	• Cylinders slipped when being put back down onto the floor – required help (2 cylinders)
5	No comments/observations made
6	• "Low back pain came on after Part A" (i.e. 1 cylinder without GasGrab) • Needed to "throw cylinders forwards" to stop them slipping when being put back down (2 cylinders)
7	• Participant was "fatigued" at the time of assessment • "Handles on GasGrab are large and may cause slip or loss of grip over a *prolonged* period"
8	• "Carrying only 1 cylinder (with GasGrab) puts a lot of strain on the arms and neck"

230mm Study (Parts D & E)

Handler ID Number	Comment(s)
9	• "Much easier when lifting with someone else"
10	No comments/observations made
11	• Attempted to, but failed to lift cylinder as an individual. Able to complete team lift
12	• "Very good idea, easy to use with or without someone else" • Cylinder tipped when lifting/lowering with partner - probably due to large difference in height
13	• "Excellent idea – very easy to use. Better with two."
14	• "Good idea – easy to use, especially with two people""
15	• Attempted to, but failed to lift cylinder as an individual. Able to complete team lift
16	No comments/observations made

EMG Graphs (230mm cylinder)

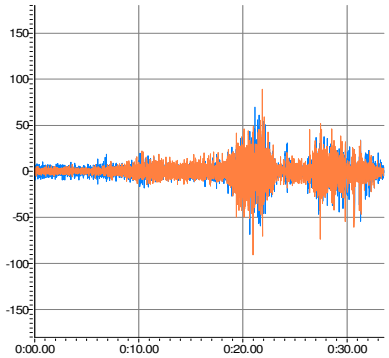
Appendix 8

Key

D = Individual Lift
E = Team Lift (all participants used the right hand for the team lift)

= Right Side
= Left Side

9D1



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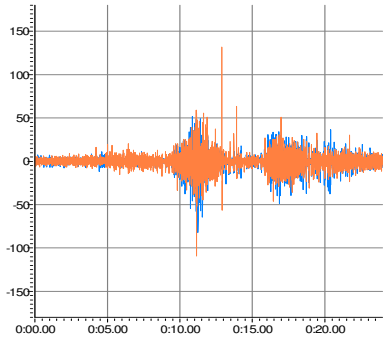

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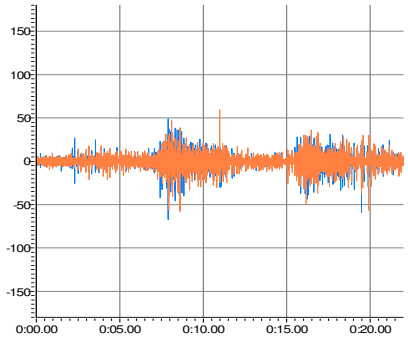

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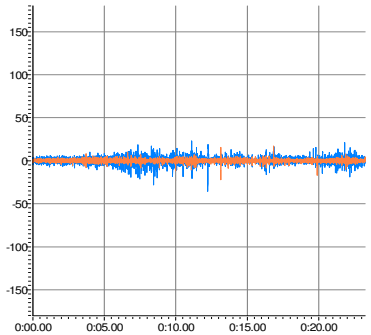

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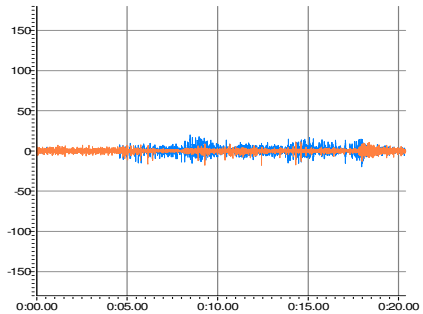

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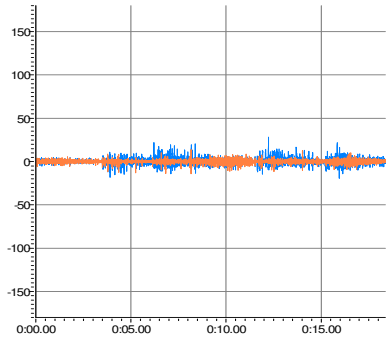

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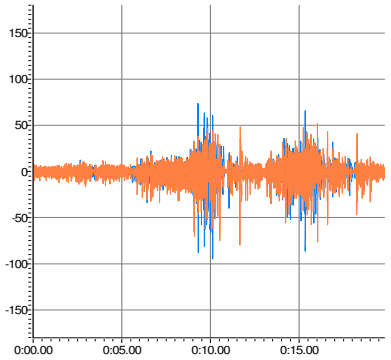

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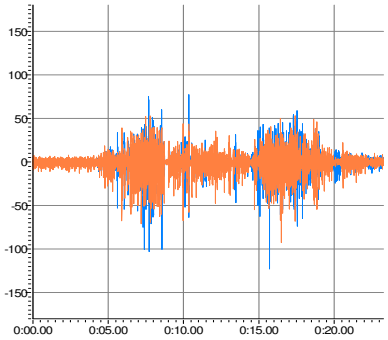

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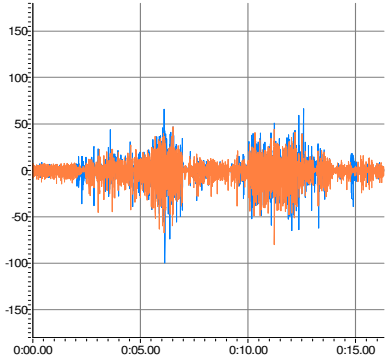

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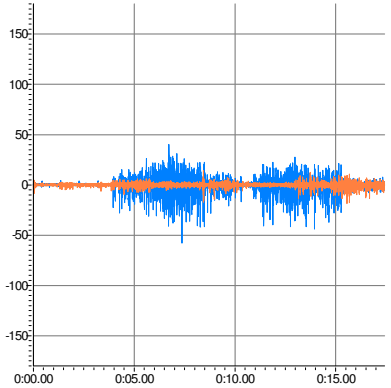

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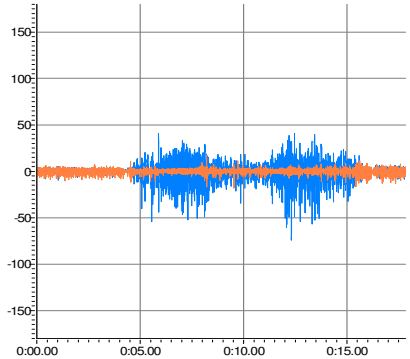

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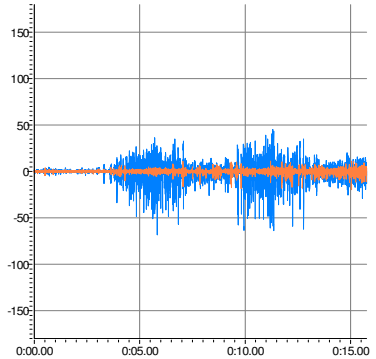

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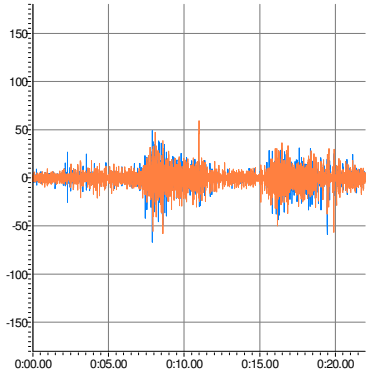

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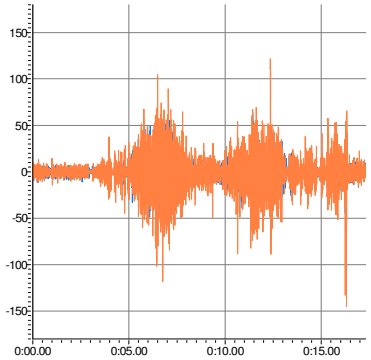

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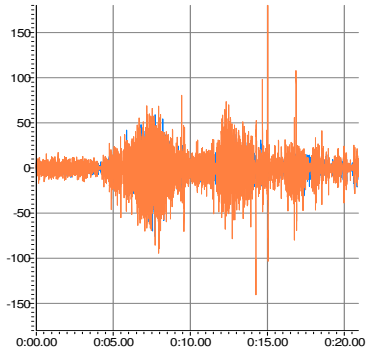

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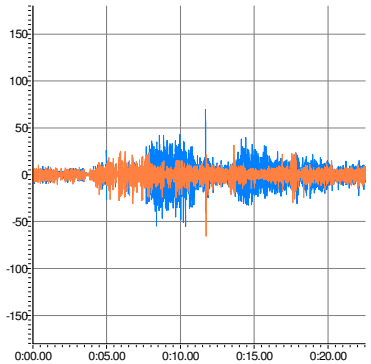

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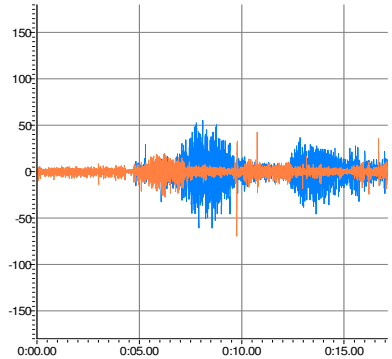

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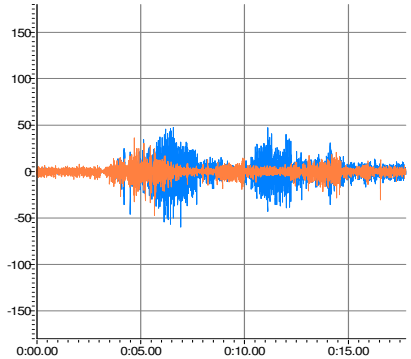

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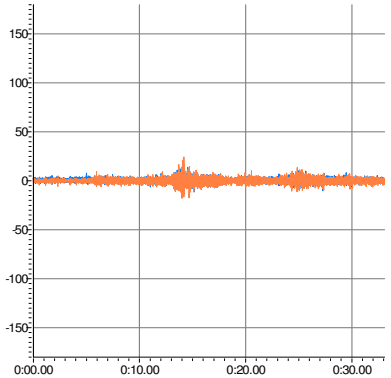

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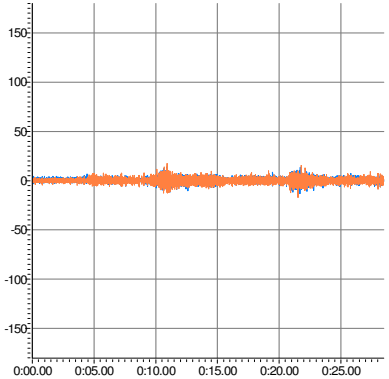

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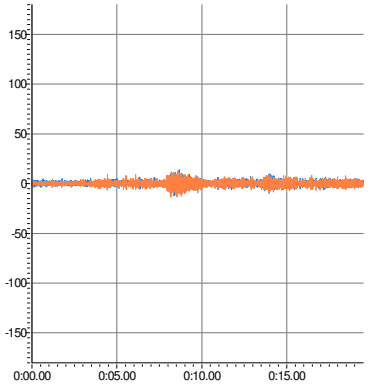

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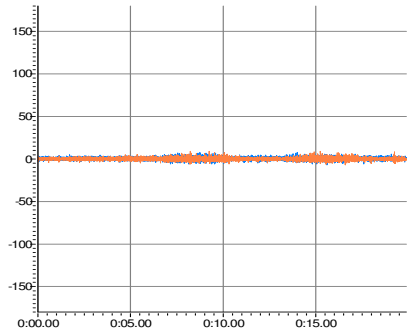

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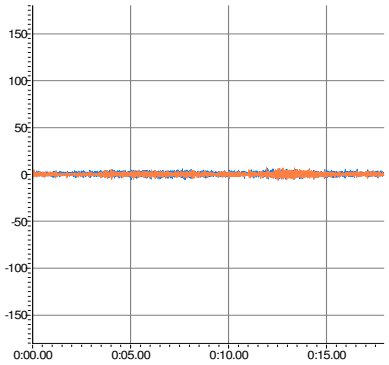

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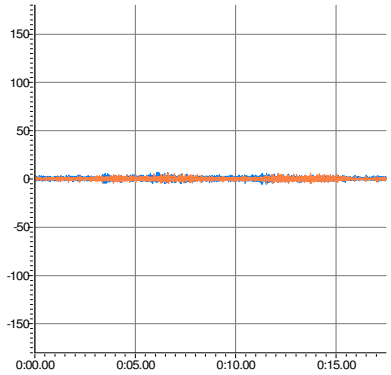

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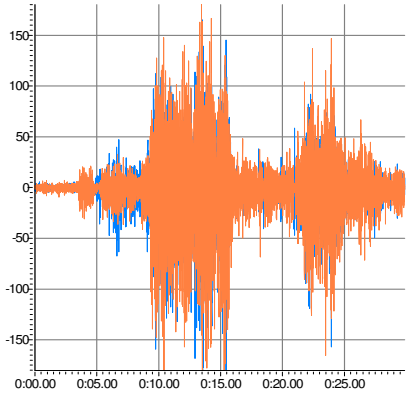

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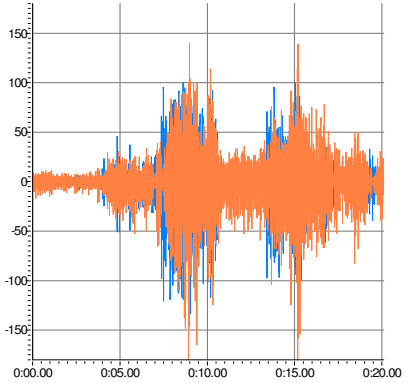

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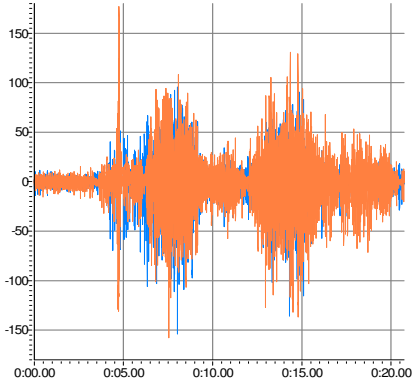

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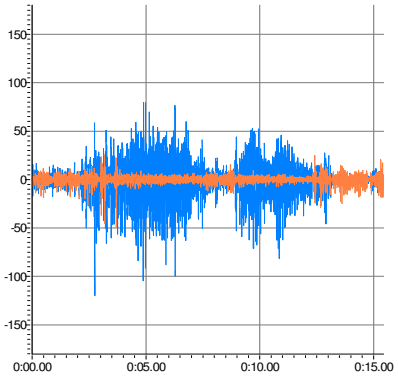

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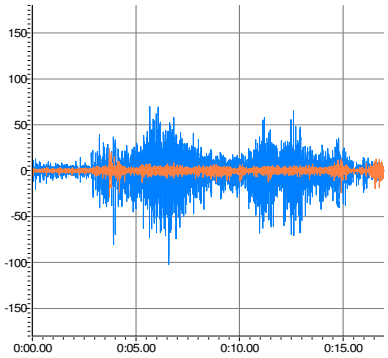

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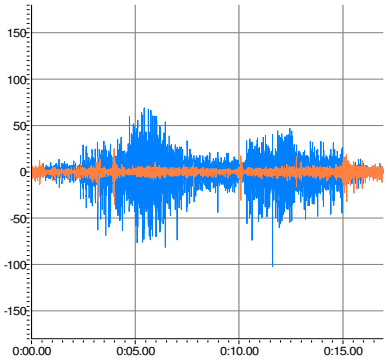

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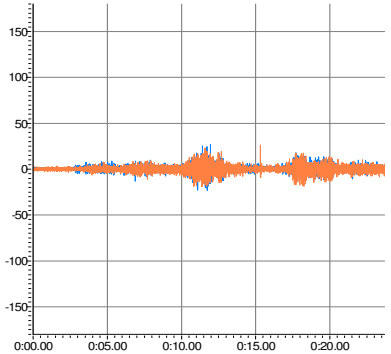

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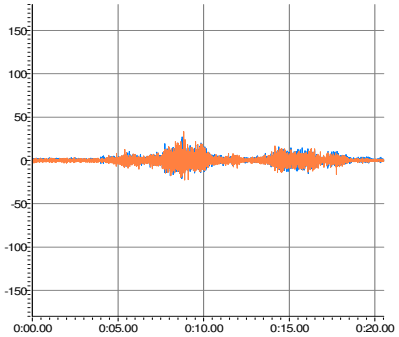

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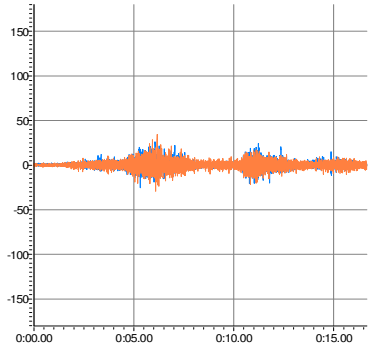

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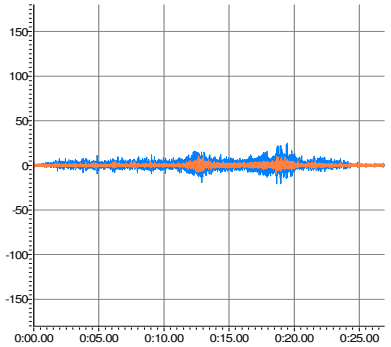
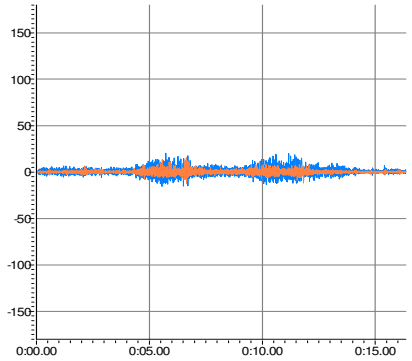


16E2



16E3