

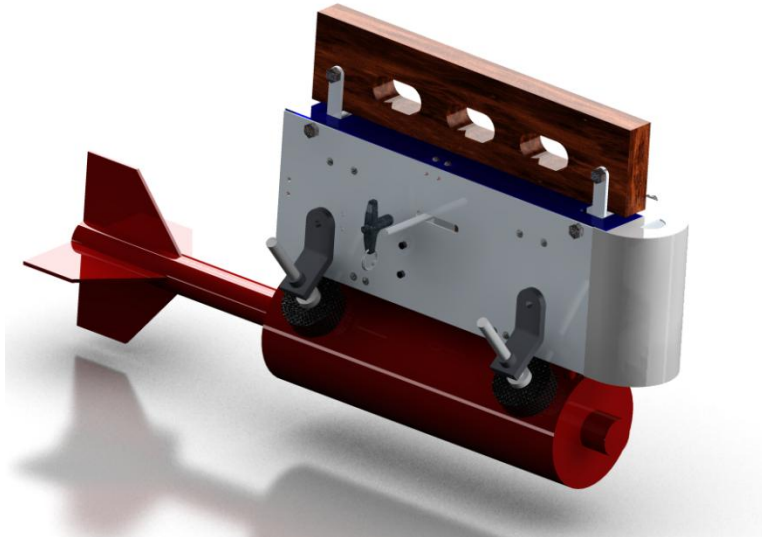
# Miniature Bomb Rack Unit

**Operations Manual - April 2012**

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## Contents

Introduction.....	3
Pneumatics Diagram .....	6
Firing Diagram.....	7
Assembly Instructions.....	8
Operational Procedure .....	11
Safety .....	12

## Introduction

The Bomb Rack Unit, BRU, is used to hold and release a payload at a specified time. The BRU has been designed to be used with the Tigershark UAV. This requires the system to be five pounds, carry a ten pound payload, and withstand 1G landing shock and 2G lateral load. The BRU is also required to eject the payload at four feet per second to ensure a safe ejection.

To simplify the design of our system, the design process was broken into four main parts:

1. Hook Release
2. Mechanical Safety
3. Ejection System
4. Sway Brace

For the Hook Release of the BRU, it was found that the best design was a horizontal sliding hook. To keep the system light weight, the Ejection System was then coupled into the hook as a 30° ramp. This ramp is in constant contact with a piston that ejects the payload as the hooks are opened. The Hook and Ejector are forced open by a pneumatic air cylinder. When given a blast of air, the piston in the cylinder pushes the hooks open along a bearing track.

For the Mechanical Safety, a lightweight servomotor was used to rotate a T-shaped stop block in front of the hook when desired to put the BRU in a safe position. The stop block works by filling the gap between the hook and wall of the BRU, thus rendering the hook immovable. The purpose of the Sway Brace is to secure the payload during maneuvers. This keeps the BRU from getting damaged by the payload. The four Sway Braces used for this system have swiveling feet that allow the type of payload to be changed. The Sway Brace is also able to move in or out, making the system useable for different types of payload diameters.

This system when used in conjunction with each other safely carries and releases a payload from the UAV. Safety of the personal is then succeeded with the use of the BRU, and ensures an efficient way to carry out the mission.

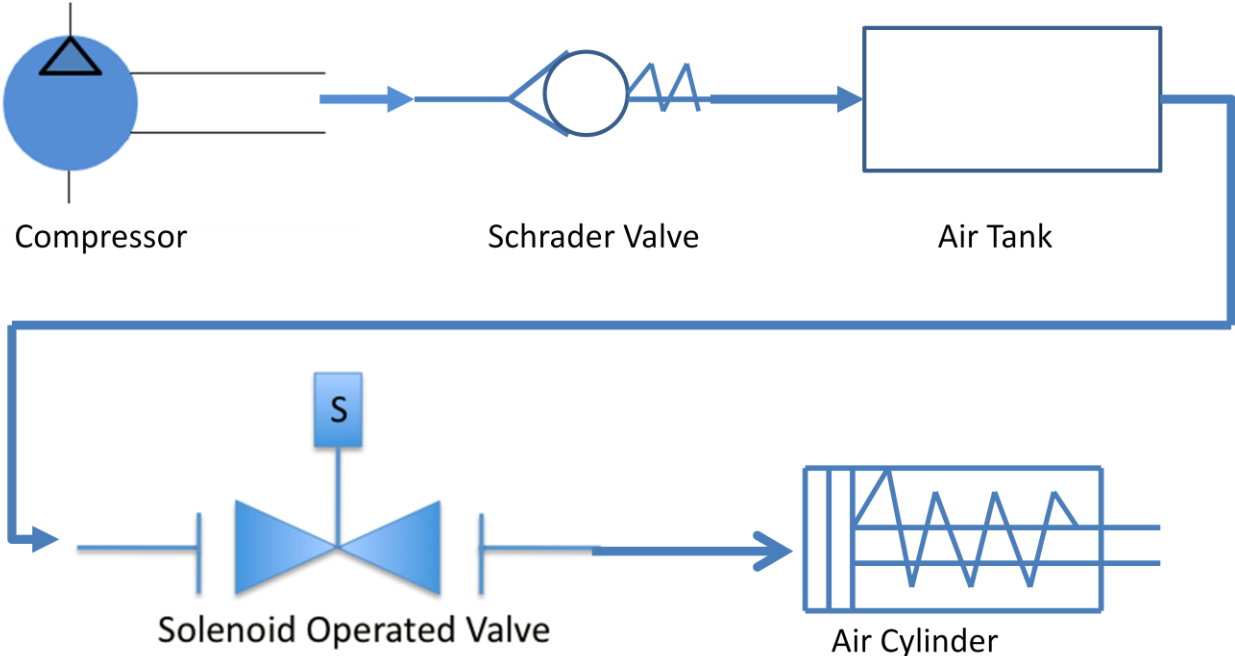
## Bill of Materials

Part #	Part Name	Vender	Vender Part Number	Unit Cost	Quantity	Total
1	BRU_casing_angle	Custom			10	
2	Leveling Foot	McMaster	2531k61	\$7.30	4	\$29.20
3	Swaybrace	Custom			4	
4	3/8-16 Nut	Lowe's		\$0.08	4	\$0.32
5	Schrader Valve	McMaster	8063K38	\$4.43	1	\$4.43
6	Air Tank	Clippard	AVT-24-4	\$16.82	1	\$16.82
7	BRU_casing_back	Custom			1	
8	BRU_casing_side2	Custom			1	
9	BRU_casing_side	Custom			1	
10	Solenoid Valve	Cylval	SA31NC	\$40.80	1	\$40.80
11	Cylinder_mount	Custom			1	
12	Servo_bracket	Custom			1	
13	Servo	Futaba	FUTM0513	\$124.98	1	\$124.98
14	Stop_block	Custom			1	
15	Guide_roller	Grainger	1ZGT7	\$48.25	4	\$193.00
16	Guide_roller_block	Custom			4	
17	Guide_rail	Custom			3	
18	Exploded View 1					
19	Ejector_bushing	McMaster	6377K114	\$20.27	2	\$40.54
20	Ejector_mount	Custom			1	
21	Ejector_piston	Custom			1	
22	Hook_bar	Custom			1	
23	Air Cylinder	McMaster	6498K211	\$33.42	1	\$33.42
24	BRU_casing_front	Custom			1	
25	Guide_top_angle	Custom			2	
26	Limit Switch	McMaster	7090K37	\$7.91	1	\$7.91
27	Exploded View 2					
28	Exploded View 3					
29	Pylon					
30	BRU_casing_top	Custom			1	
31	Spacer_outer	Custom			4	
32	Spacer_inner	Custom			2	
33	Pylon_tab	Custom			4	
34	Exploded View 4					
35	Nose Cone	Custom			1	
36	Payload					
	6-32x1/2	Grainger	1MU14 (100ct.)	\$2.29	1	\$2.29
	6-32x1.5	McMaster	91251A157 (100ct.)	\$6.98	1	\$6.98
	6-32 lock nut	Grainger	3HDT6 (100ct.)	\$2.83	1	\$2.83

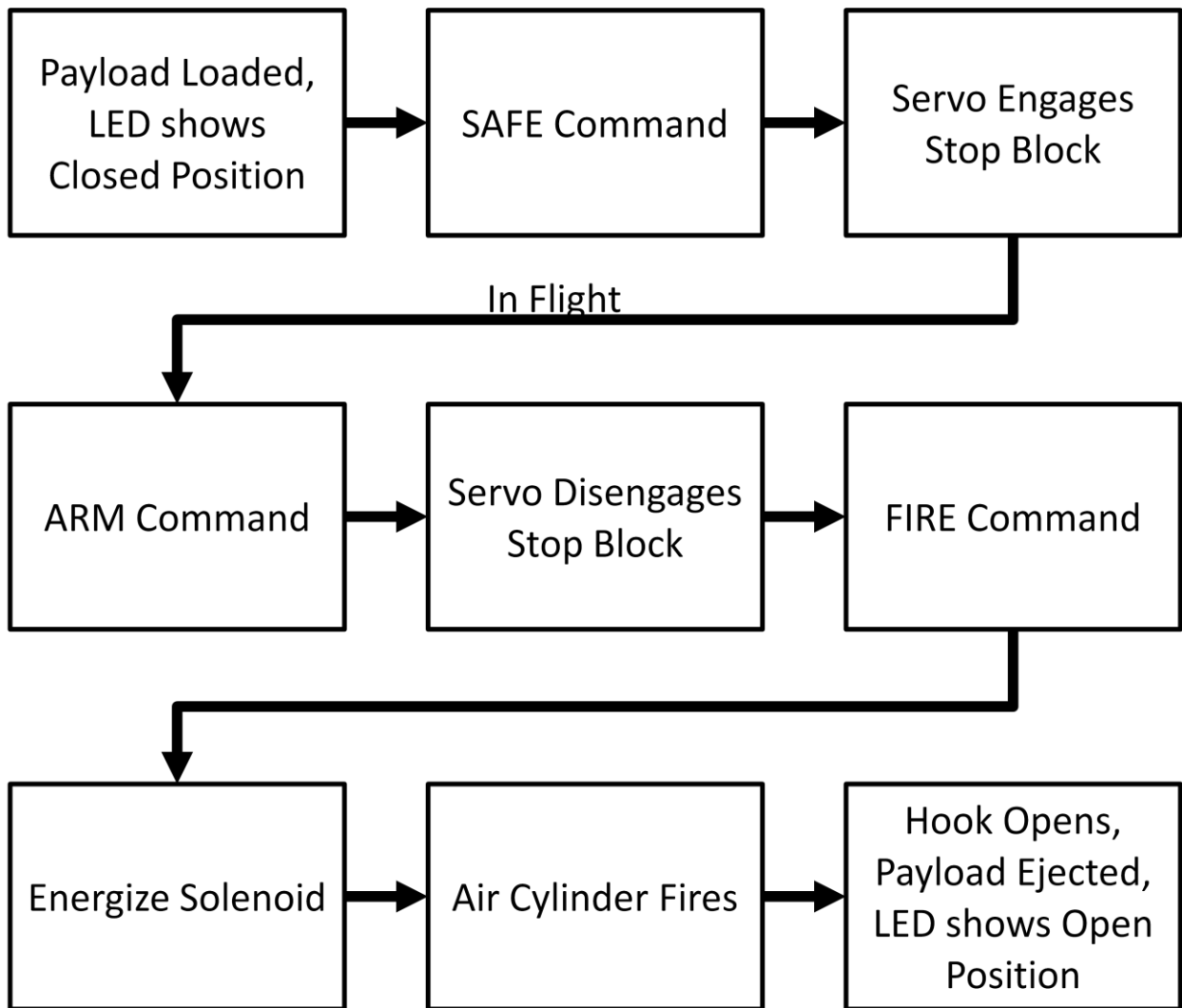
1/4-20 nuts & bolts	Home Depot	0.5" (4), 1.5" (2), 3.5" (2)			\$9.19	
male connector	omega	OM-AIR-C24250418-5PK	\$5.50	2	\$11.00	
air hose	omega	TYUTH95-1418-50-TRBL	\$21.00	1	\$21.00	
90deg elbow	omega	OM-AIR-C24470418-5PK	\$8.25	1	\$8.25	
Raw Materials	onlinemetals	See Table Below			\$102.54	
*Note: Part numbers refer to exploded view drawings only Use Part Name to refer to custom part drawings					<b>Total</b>	<b>\$655.50</b>

<b>Raw Materials</b>				
	<b>Material</b>	<b>Size</b>	<b>Vendor</b>	<b>Price</b>
<b>Angle</b>	Al6061	2x2x.125-12in	onlinemetals	\$3.28
	Al6063	2x2x.0625<12in	onlinemetals	\$3.98
		.75x.75x.0625-24in	onlinemetals	\$2.81
		1x1x.0625<12in	onlinemetals	\$1.64
<b>Flat Bar</b>	Al6061	.25x5-24in	onlinemetals	\$15.17
		.125x4-12in	onlinemetals	\$3.16
<b>Plate</b>	Al6061	12x24x.0625 in	onlinemetals	\$14.90
	Acetal	12x12x.5 in	onlinemetals	\$40.78
	Polycarb	24x24x0.06in	onlinemetals	\$11.00
<b>Round</b>	Acetal	.375x24in	onlinemetals	\$3.48
	Steel 1018	.5x<12in	onlinemetals	\$2.34
<b>Total</b>				<b>\$102.54</b>

**Pneumatics Diagram**



## Firing Diagram



## Assembly Instructions

Follow these instructions to properly assemble the BRU.

Refer to Explode- Part 1

1. Machine all custom parts
  - a. Part drawings available in main design report.
2. Weld BRU\_casing\_side2 to BRU\_casing\_back as seen in figure 1
3. Attach Cylinder\_mount
4. Rivet angle brackets

Should look like Figure 1

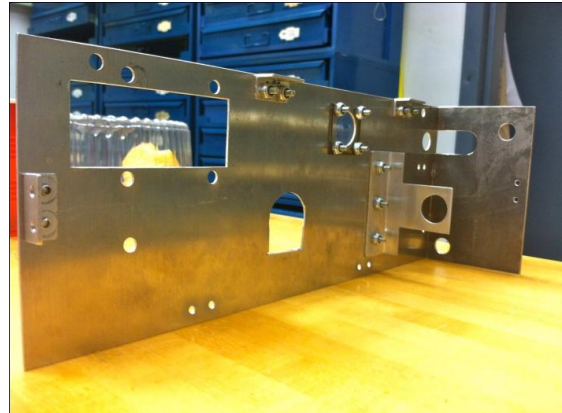


Figure 1

5. Attach BRU\_casing\_bot using 6-32x1/2
6. Join Guide\_roller to Guide\_roller\_blocks and mount along with Guide\_rail

Should look like Figure 2

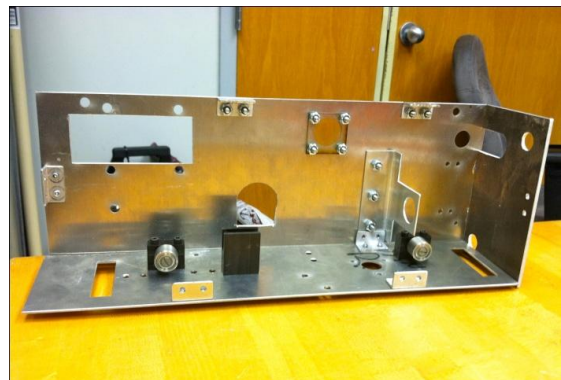


Figure 2

7. Mount connectors to pneumatics
  - a. Schrader valve and male connector onto Air Tank
  - b. Two male connectors on Solenoid Valve
  - c. 90° elbow to Air Cylinder
8. Connect Stop\_block to Servo
  - a. Use two 4-40x1/2 screws
  - b. Mount to Servo\_bracket
  - c. Attach to BRU
9. Mount Air Tank using heavy duty Zip-Ties
10. Mount Solenoid Valve
11. Assemble Ejector\_mount

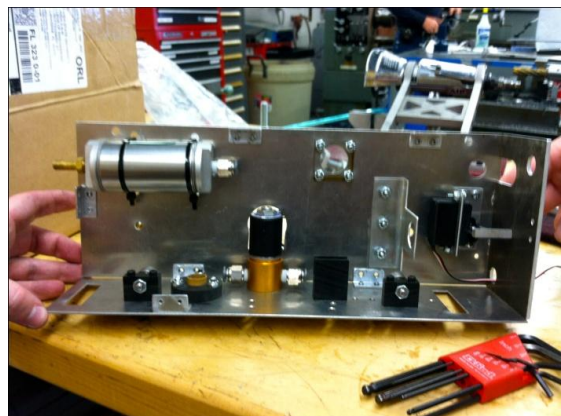


Figure 3



- a. First place two Ejector\_bushings opposite each other
  - b. Mount onto BRU
12. Attach BRU\_casing\_side to angle bracket under Air Tank
13. Attach Sway braces

Should now look like Figure 3

Refer to Explode-Part 2

14. Attach air hoses
  - a. First travels from the Air Tank around right bearing block, around the Ejector\_mount and into the left connector on the solenoid
  - b. The Second travels from the right connector on the solenoid around the Guide\_rail and will be inserted into the elbow connector at a later time
  - c. Secure air hose with Zip-ties

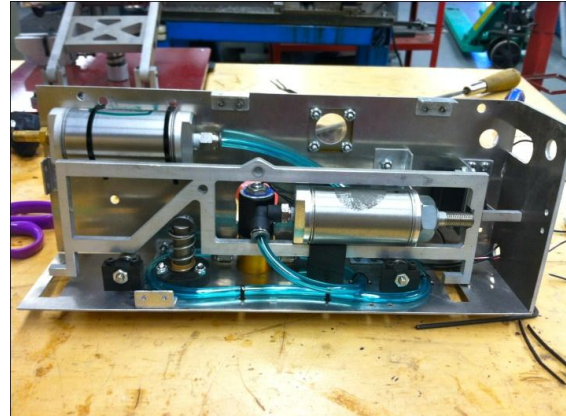


Figure 4

15. Insert Ejector\_piston and Spring into the bushings
16. Position Hook\_bar so that it rests inside the Guide\_rail and on top of the roller bearings
17. Insert Air Cylinder, secure with attached nut
  - a. Should be positioned in the center of the Hook\_bar with the piston shaft fitting into notch on the hook
  - b. Attach air hose

BRU should look like Figure 4

Refer to Explode- Part 3

18. Assemble Guide\_top\_angle
  - a. Mount Guide\_roller\_block and Guide\_rail
  - b. Attach to BRU\_casing\_front
19. Attach Limit Switch

- a. Connect wires
  - i. Green (top)
  - ii. Red (middle)
  - iii. Black (bottom)

20. Bolt on Sway braces

Continue to Explode-Part 4

21. Combine components

- a. Drop down
- b. Ensure Hook\_bar sits within Guide\_rail
- c. Screw on bottom first
- d. Screw down angle brackets located at front and back of BRU
- e. Run all wires through BRU front

22. Attach handle

- a. Use ¼-20x3.5 bolt through slot into the upper hole on the Hook\_bar
- b. Should contact the limit switch when hook in closed position

Conclude assembly with Explode-Part 5

23. Attach mounting tabs

- a. Use ¼-20x3.5 bolts
- b. Slide onto bolt in order: Spacer\_outer, Mounting\_tab, Spacer\_inner, Mounting\_tab, Spacer\_outer
- c. Make sure tabs point vertically

24. BRU\_casing\_top fully encloses BRU

BRU is now ready to be attached to Pylon. Assembly is complete.

## Operational Procedure

Operation of the Bomb Rack Unit starts with attaching it to the aircraft. The mounting tabs which protrude vertically from the BRU bolt onto the Pylon which is located under the wing of the aircraft. Make sure the nose cone faces forward, toward the nose of the aircraft. Once secure, connect the MIL-spec connector, located at top of nose cone, to the aircraft's corresponding connector.

Next, the payload is loaded. First, ensure the mechanical stop is not in SAFE mode. Look through inspection hole to do this. Pull the handle toward the nose cone to open the hooks. Raise payload through holes located in the bottom of the BRU. Push handle forward to close hooks, make sure the payload is secured. Insert the Remove Before Flight (RBF) pin to prevent the payload from ejecting prematurely. Switch the mechanical stop into SAFE mode, inspect that the stop block is flush with the hook.

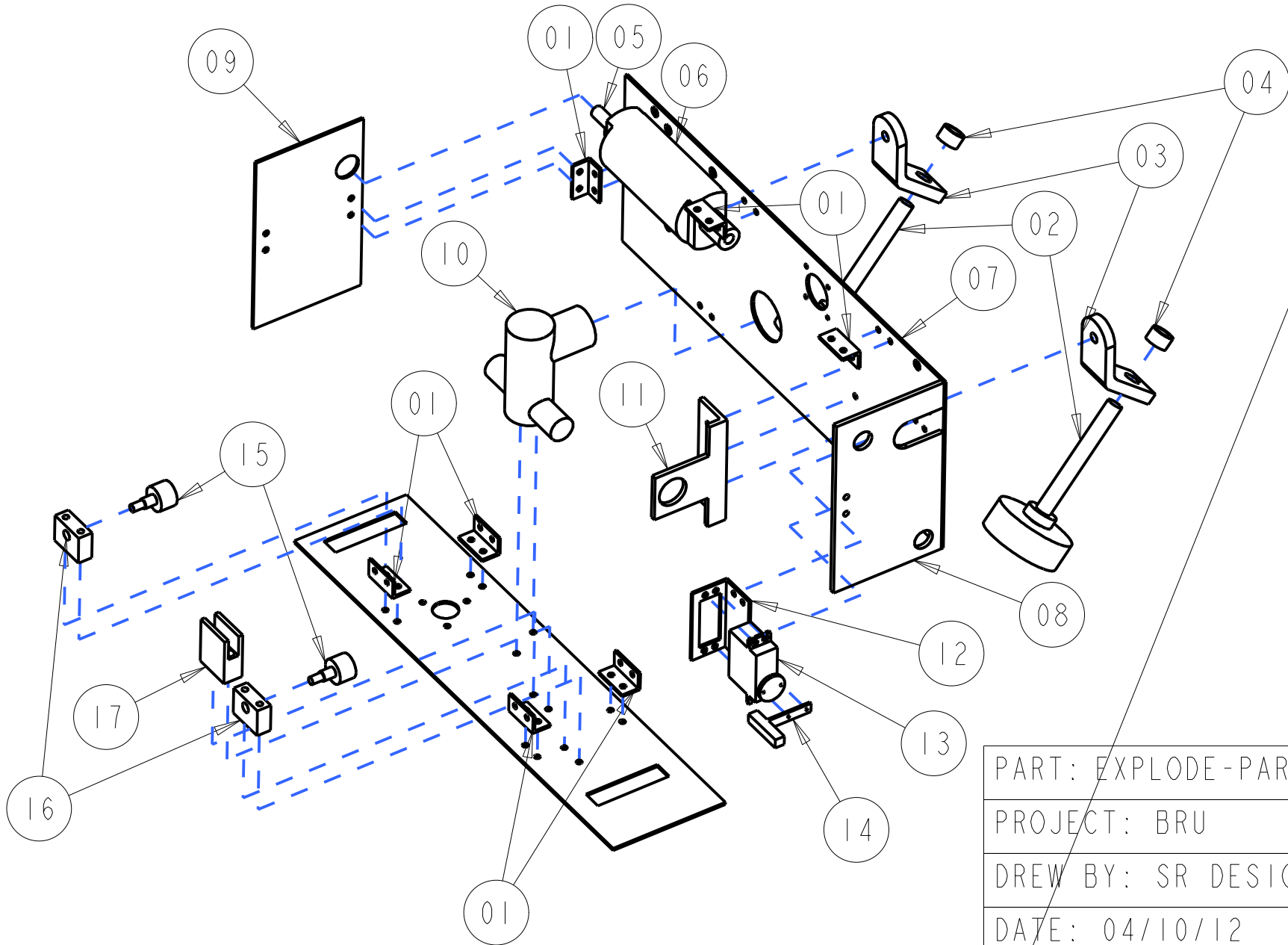
Now tighten the swaybraces down onto the sides of the payload. Adjustment of the swivel foot pad angle may be needed to get the best contact. Ensure that the swaybraces are not loose and that the payload is restricted from all movement.

To pressurize the system, compressed air is added through the Schrader valve located in the back of the BRU. Pressurize the system to between 90-110 psi. Use a gauge periodically while filling to check the pressure, do not overfill. Immediately prior to takeoff, remove the RBF pin. The BRU is now ready for flight.

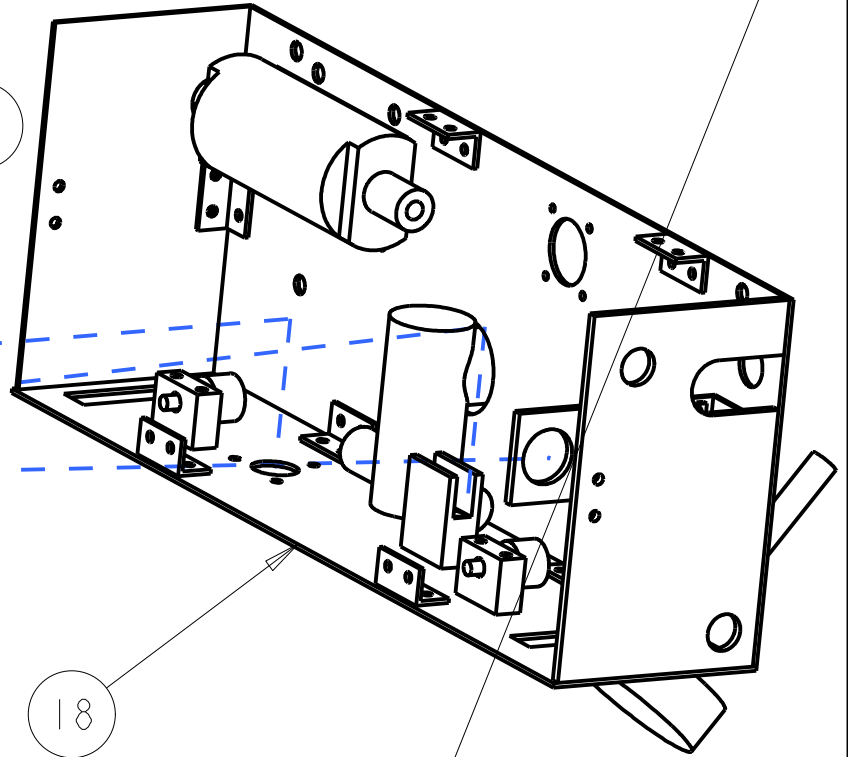
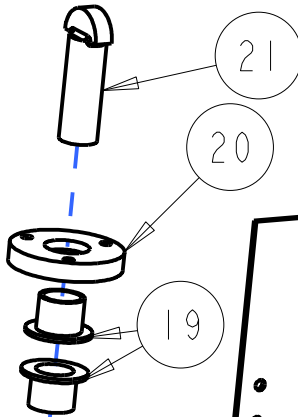
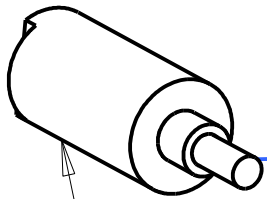
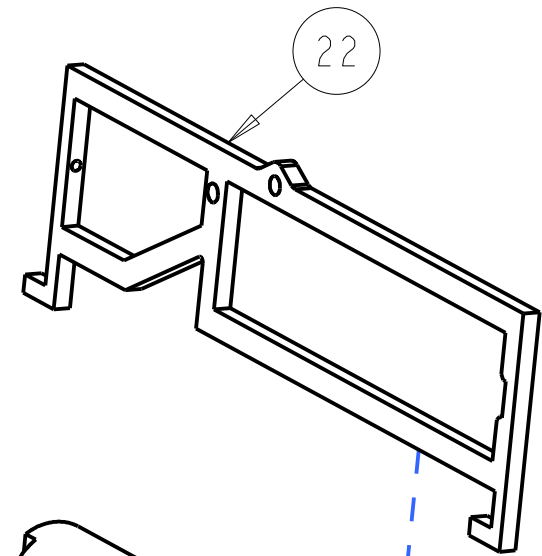
When in flight, to disengage the mechanical safety, select the ARM command. This will use the servo to lower the stop block out of the path of the hook so that the payload can be released. When over target, select the FIRE command. This energizes the solenoid valve which will fire the air cylinder. The hooks will then open and the payload will be ejected. When back on the ground, the remaining air in the system can be purged by pressing in the Schrader valve. The BRU is now ready to load the next payload.

## **Safety**

For this design there were no environmental concerns with the construction of the BRU. However, safety is a big factor in the design of this system, especially since there is a possibility of people's lives being at stake. The biggest concern lies with the safety system of the BRU, this being the system that stops the payload from being released unintentionally. The system was designed with appropriate safety factors; however adhering to typical safety practices is a must. During test firing, operators must take safety precautions as a heavy object (the payload) will be falling at a high rate of speed. Injury could occur if someone is in the path of the falling object.



PART: EXPLODE-PART 1	
PROJECT: BRU	
DREW BY: SR DESIGN 3	
DATE: 04/10/12	
PART #:	
REV: 0	SHT: 1 OF 1



PART: EXPLODE-PART 2

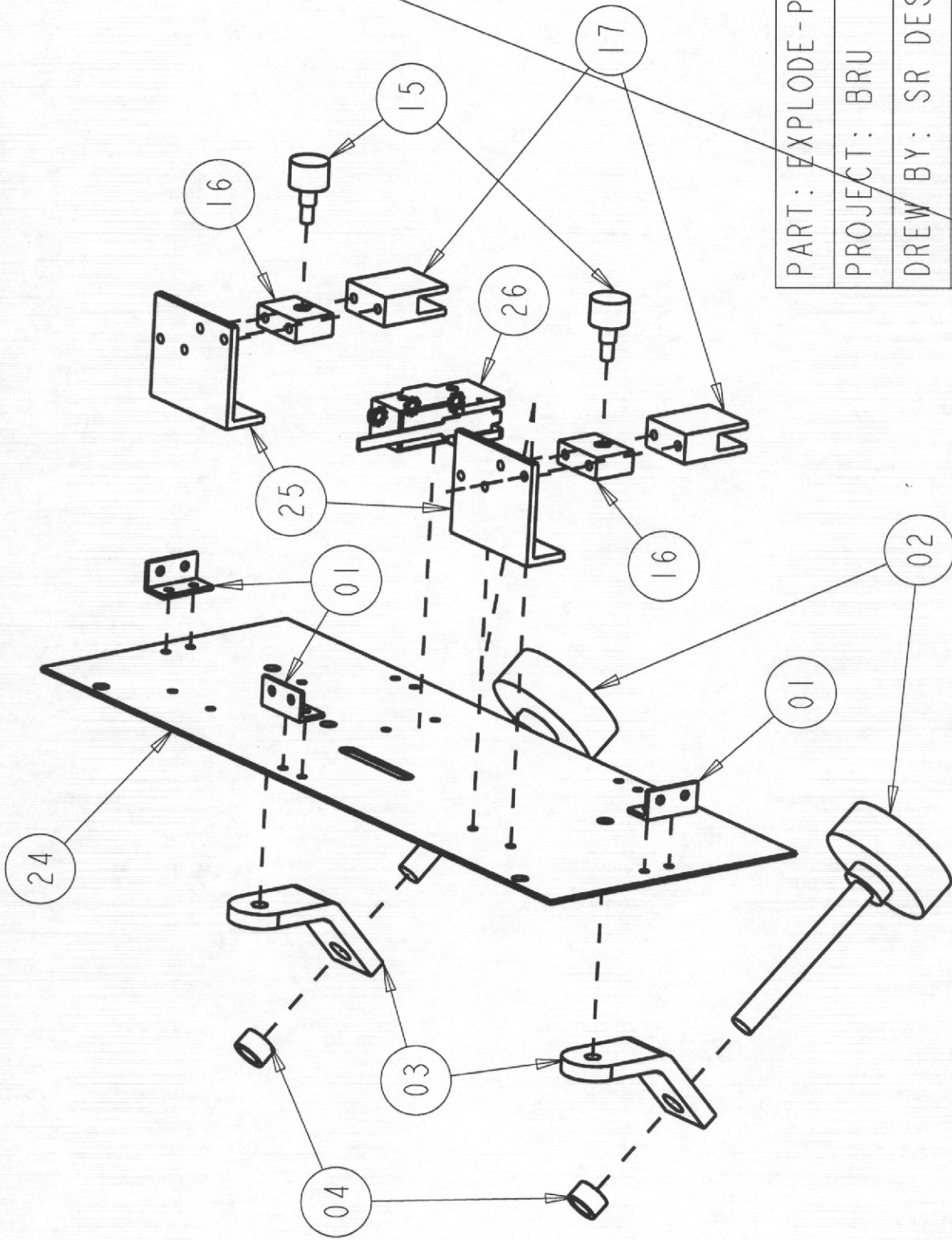
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DREW BY: SR DESIGN 3

DATE: 04/10/12

PART #:

REV: 0 SHT: 1 OF 1



PART: EXPLODE-PART 3

PROJECT: BRU

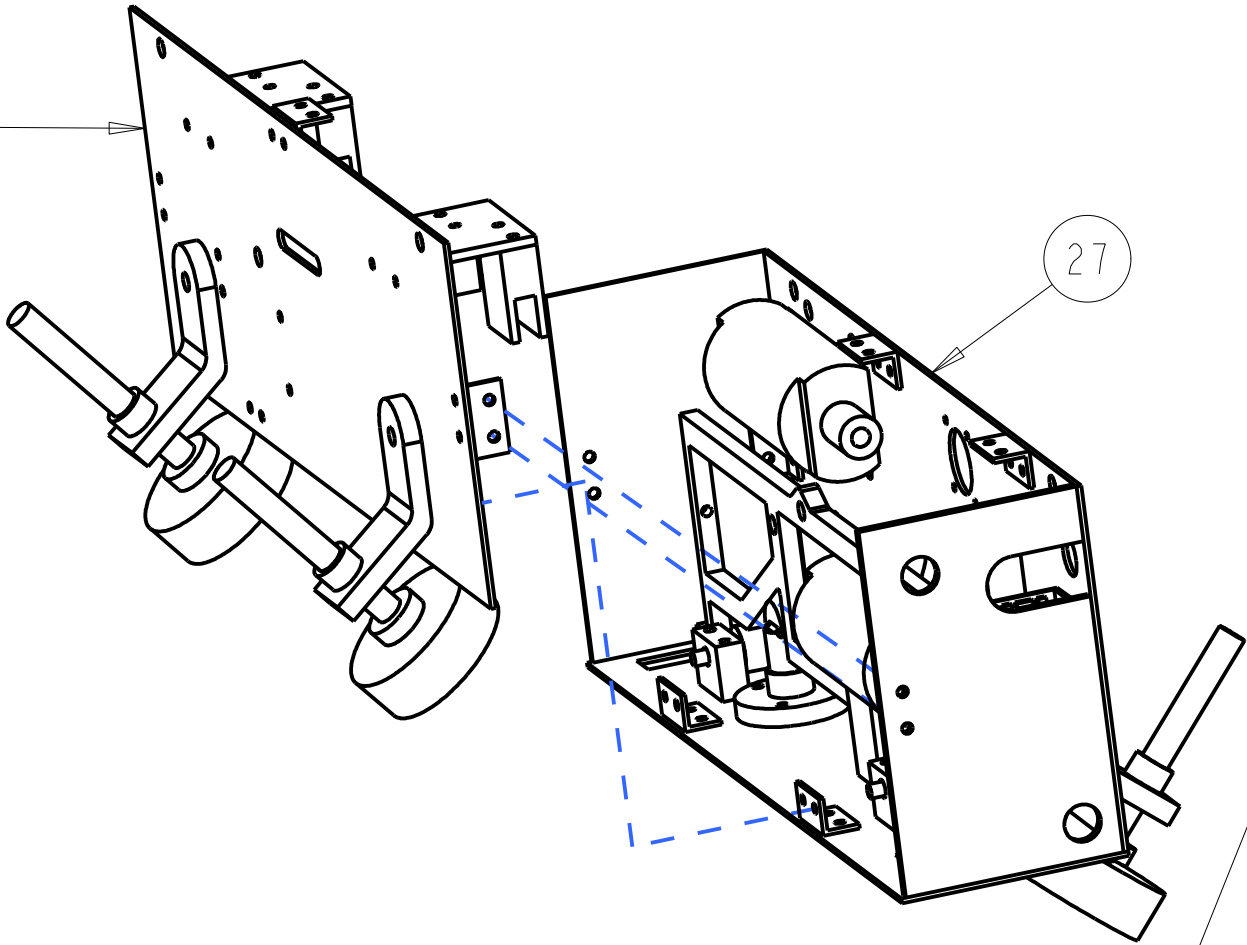
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PART #:

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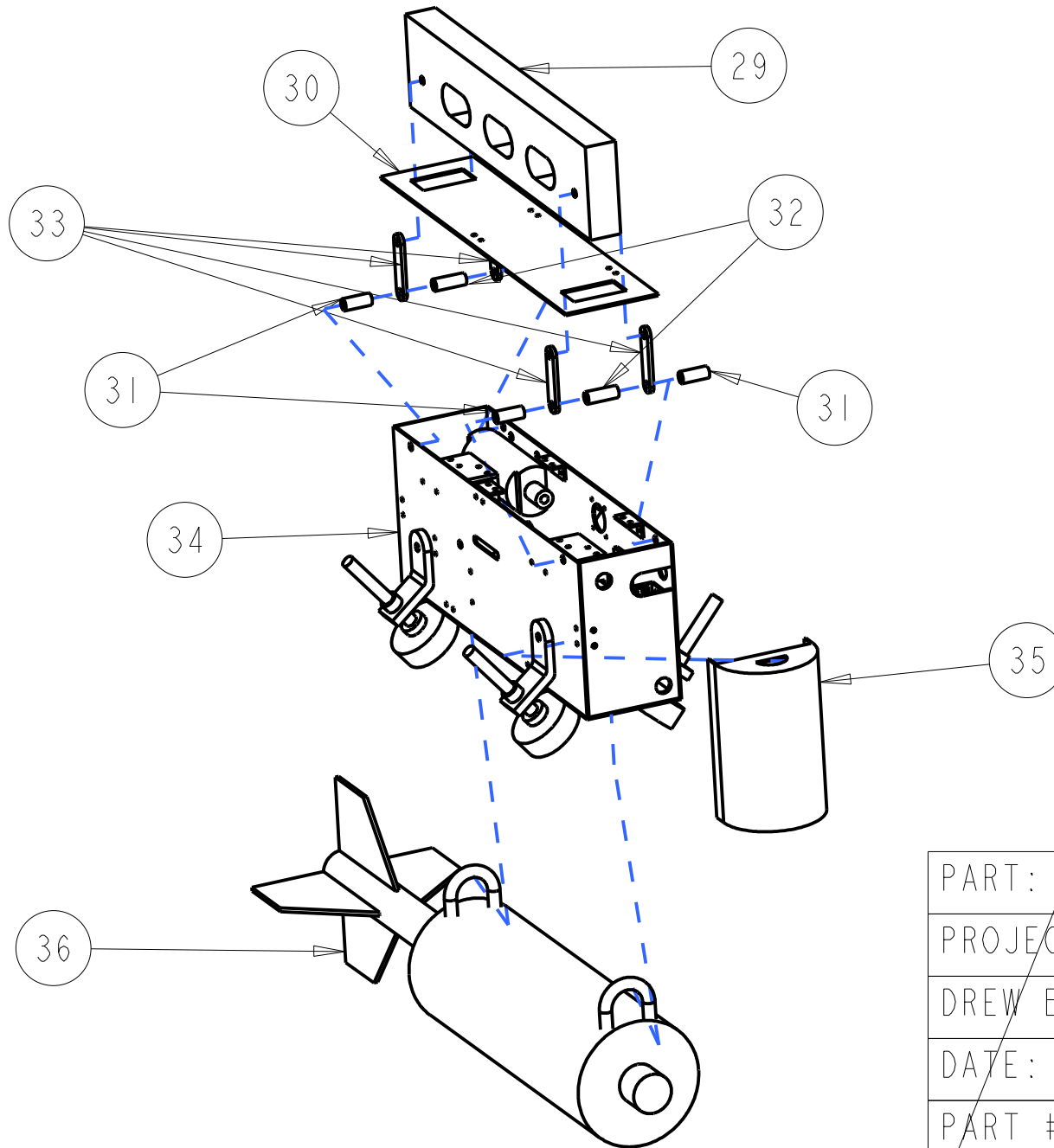
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PART: EXPLODE-PART 4	
PROJECT: BRU	
DREW BY: SR DESIGN 3	
DATE: 04/10/12	
PART #:	
REV: 0	SHT: 1 OF 1





PART: EXPLODE-PART 5	
PROJECT: BRU	
DREW BY: SR DESIGN	
DATE: 04/10/12	
PART #:	
REV: 0	SHT: 1 OF 1