

**SUMMER TRAINING PROJECT REPORT**

ORDINANCE PARACHUTE FACTORY

(DEPARTMENT OF DEFENCE PRODUCTION)

MINISTRY OF DEFENCE

NAPIER ROAD KANPUR-208004

TOPIC- MANUFACTURING OF PARACHUTES

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**UNDER THE GUIDANCE OF SUBMITTED BY**

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**JWM P6 SECTION BTECH II YEAR**

**OPF, KANPUR UPTTI KANPUR**

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* **Shri HRIDAY LAL**
* **Shri PRAVEEN CHANDRA**
* **Shri GAREEB DAS**

***INTRODUCTION OF THE FACTORY:***

Ordnance Parachute Factory is one of the 41 manufacturing units working under Ordnance Factory Board (OFB) Kolkata, Ministry of Defence Production, Government of India.

The 41 Ordnance Factories operating in India catering with the varied defence needs are as under:

1. Ammunition Factory Khadki (AFK)
2. Cordite Factory Aruvankadu (CFA)
3. Engine Factory Avadi (EFA)
4. Field Gun Factory Kanpur (FGK)
5. Gun Carriage Factory (GCF)
6. Grey Iron Foundry (GIF)
7. Gun and Shell Factory (GSF)
8. Heavy Alloy Penetrator Project (HAPP)
9. High Explosive Factory (HEF)
10. Heavy Vehicle Factory (HVF)
11. Machine Tool Prototype Factory (MPF)
12. Metal and Steel Factory (MSF)
13. Ordnance Clothing Factory Avadi (OCFAV)
14. Ordnance Cable Factory Chandigarh (OCFC)
15. Ordnance Clothing Factory Shahjahanpur (OCFS)

16) Ordnance Equipment Factory Kanpur (OEFC) 17) Ordnance Equipment Factory Hazratpur (OEFHZ)

18) Ordnance Factory Ambernath (OFA)

1. Ordnance Factory Ambajhari (OFAJ)
2. Ordnance Factory Bhandara (OFBA)
3. Ordnance Factory Bhusawal (OFBH)
4. Ordnance Factory Bolangir (OFBOL)
5. Ordnance Factory Kanpur (OFC)
6. Ordnance Factory Chandrapur (OFCH)
7. Ordnance Factory Dumdum (OFDC)
8. Ordnance Factory Dehu Road (OFDR)
9. Ordnance Factory Dehradun (OFDUN)
10. Ordnance Factory Itarsi (OFI)
11. Ordnance Factory Khamaria (OFK)
12. Ordnance Factory Katni (OFKAT)
13. Ordnance Factory Muradnagar (OFM)
14. Ordnance Factory Project Nalanda (OFN)
15. Ordnance Factory Project Korwa (OFPKR)
16. Ordnance Factory Project Medak (OFPM)
17. Ordnance Factory Tiruchirapalli (OFT)
18. Ordnance Factory Varagaon (OFV)
19. Opto Electronics Factory (OLF)
20. Ordnance Parachute Factory (OPF)
21. Rifle Factory Ishapore (RFI)
22. Small Arms Factory (SAF)
23. Vehicle Factory Jabalpur (VFJ)

**BRIEF HISTORY OF THE FACTORY:**

Ordnance Parachute Factory was established in the year 1941 at Kanpur (UP), India. It started as a repair unit of Man Carrying Parachutes and thereafter commenced and established production of Supply Drop Parachutes and Military Uniforms in 1962. In 1970 production of personnel parachutes i.e. PTR-M and PTR-R was established. In 1971 production of floats for KM Bridge and inflatable boats was also established.

***VISION OF THE FACTORY:***

* To equip Armed Forces with modern Defence and Battle Field Equipment.
* To continuously modernize production facilities.
* To train and motivate personnel.
* To equip ourselves with technologies through acquisition, synergy and in-house R&D.
* To continuously improve quality.
* To achieve highest level of customer satisfaction.
* To increase customer base in defence, non-defence and export markets and establish global presence.

**PRODUCT OF THE FACTORY:**

### **PARACHUTE ITEMS:**

* Man Carrying Parachutes
* Seat Ejection/Pilot Parachutes.
* Supply Drop Parachutes.
* Aerial Delivery Systems.
* Ammunition Drop Parachutes.
* Brake Parachutes for A/C.
* Illuminating Ammunition Parachutes.
* Aero sport Parachutes.
* Recovery System Parachutes.

### **CLOTHING ITEMS:**

* Parade/Combat Uniforms
* High Altitude Clothing/Winter Clothing
* Protective Warfare Clothing – NBC Suits

### **KNITTED ITEMS:**

* Socks Wool OG
* Socks Wool Hay Khaki
* Socks Wool and Cotton 50:50 (under development)

**RUBBERIZED ITEMS:**

* Float for K.M. Bridge
* Inflatable Boats
* Splint Inflateble

**FEATURES OF THE FACTORY:**

* Air conditioned state of the art Para cutting and manufacturing shops.
* Computerized single needle high speed industrial sewing machine with auto thread trimming.
* Computerized button stitching and button hole stitching machines.
* Computerized socks knitting machines to produce improved quality of woollen socks.
* Well-equipped garment manufacturing shops.
* Having NABL accredited testing lab to carry out the testing of raw materials as per specification.
* CAD system for auto designing, pattern making of parachutes and clothing items.
* Fabric inspection machines.
* Two needle and four needle zigzag machines and heavy duty industrial sewing machines.
* Automatic shirt pressing and trousers finishing plant.
* Interlining fusing machine.
* Many other useful equipment/supports for mass production of various products.
* Dedicated factory for parachute production.
* All types of parachute manufactured. Highly skilled labour force.

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**PARACHUTE INTRODUCTION**

A parachute is a device used to slow the movement of a person or object as it falls or moves through the air. Used primarily for safe descent from high altitudes (e.g., a spacecraft reentering the atmosphere, a person or object dropped from an airplane), parachutes can also be used in horizontal configurations to slow objects like race cars that have finished their runs.There are two basic types of parachutes. One is a dome canopy made of fabric in a shape that ranges from a hemisphere to a cone; the canopy traps air inside its envelope, creating a region of high pressure that retards movement in the direction opposite the entering air flow. The other is a rectangular parafoil, or ram-air canopy, consisting of a series of tubular cells; commonly used by sport jumpers, the parafoil acts as a wing, allowing the jumper to "fly" toward a target. Either type of parachute weighs less than 15 lb (7 kg) and costs from $1,200-$ 1,500.

In addition to the fabric canopy, a parachute designed to be used by a person must be equipped with a harness that is worn by the user. Attached to the harness is a container that holds the canopy; often this is a back-pack, but it can also extend low enough for the user to sit on it. There is an actuation device that opens the container and releases the canopy for use; one of the most common actuation devices is a ripcord. When the container is opened, a small pilot chute about 3 ft (1 m) in diameter is pulled out, either by a spring mechanism or by hand. This pilot chute, in turn, pulls the main canopy from the container. Some type of deployment device, such as a fabric sleeve, is used to slow the opening of the canopy so that the suspension lines will have time to straighten. A gradual opening of the canopy also reduces the shock to the equipment and the user that a more sudden opening would cause.

**History**

There is some evidence that rigid, umbrella-like parachutes were used for entertainment in China as early as the twelfth century, allowing people to jump from high places and float to the ground. The first recorded design for a parachute was drawn by Leonardo da Vinci in 1495. It consisted of a pyramid-shaped, linen canopy held open by a square, wooden frame. It was proposed as an escape device to allow people to jump from a burning building, but there is no evidence that it was ever tested.

Parachute development really began in the eighteenth century. In 1783 Louis-Sebastien Lenormand, a French physicist, jumped from a tree while holding two parasols. Two years later, J. P. Blanchard, another Frenchman, used silk to make the first parachute that was not held open by a rigid frame. There is some evidence that he used the device to jump from a hot air balloon.

There is extensive evidence that Andre Jacques Garnerin made numerous parachute jumps from hot air balloons, beginning in 1797. His first jump, in Paris, was from an altitude of at least 2,000 ft (600 m). In 1802, he jumped from an altitude of 8,000 ft (2,400 m); he rode in a basket attached to a wooden pole that extended downward from the apex (top) of the canopy, which was made of either silk or canvas. The parachute assembly weighed about 100 lb (45 kg). During the descent, the canopy oscillated so wildly that Garnerin became airsick. In fact, he was once quoted as saying that he "usually experienced [painful vomiting] for several hours after a descent in a parachute." In 1804, French scientist Joseph Lelandes introduced the apex vent—a circular hole in the center of the canopy—and thus eliminated the troublesome oscillations.

Americans became involved in parachute development in 1901 when Charles Broadwick designed a parachute pack that was laced together with a cord. When the parachutist jumped, a line connecting the cord with the aircraft caused the cord to break, opening the pack and pulling out the parachute. In 1912, Captain Albert Berry of the U.S. Army accomplished the first parachute jump from a moving airplane. Parachutes did not become standard equipment for American military pilots until after World War I (German pilots used them during the final year of that war).

Parachutes were widely used during World War II, not only as life-saving devices for pilots, but also for troop deployment. In 1944, an American named Frank Derry patented a design that placed slots in the outer edge of the canopy to make a parachute steerable.

The world record for the highest parachute jump was set in 1960. Joe Kittinger, a test pilot for the U.S. Air Force's Project Excelsior ascended in a balloon to an altitude of 102,800 ft (31 km) and jumped. Using only a 6ft (1.8 m) parachute to keep him in a stable, vertical position, he experienced essentially free fall for four minutes and 38 seconds, reaching a speed of 714 mph (1,150 km/h). At an altitude of 17,500 ft (5.3 km), his 28-ft (8.5-m) parachute opened. In all, his fall lasted nearly 14 minutes.

**Raw Materials**

Parachute canopies were first made of canvas. Silk proved to be more practical because it was thin, lightweight, strong, easy to pack, fire resistant, and springy. During World War II, the United States was unable to import silk from Japan, and parachute manufacturers began using nylon fabric. The material turned out to be superior to silk because it was more elastic, more resistant to mildew, and less expensive. Other fabrics, such as Dacron and Kevlar, have recently been used for parachute canopies, but nylon remains the most popular material. More specifically, parachutes are made of "ripstop" nylon that is woven with a double or extra-thick thread at regular intervals, creating a pattern of small squares. This structure keeps small tears from spreading.

Other fabric components such as reinforcing tape, harness straps, and suspension lines are also made of nylon. Metal connectors are made of forged steel that is plated with cadmium to prevent rusting. Ripcords are made from stainless steel cable.

One parachute manufacturing plant lists its monthly materials use as exceeding 400,000 sq yd (330,000 m 2 ) of fabric, 500,000 yd (455 km) of tape and webbing, 2.3 million yd (2,000 km) of cord, and 3,000 lb (1,400 kg) of thread.

**Design**

A dome canopy may consist of a flat circle of fabric, or it may have a conical or parabolic shape that will not lie flat when spread out. It has a vent hole at the apex to allow some air to flow through the open canopy. Some designs also have a few mesh panels near the outer edge of the canopy to aid in steering the descent. Some designs use continuous suspension lines that run across the entire span of the canopy and extend to the harness on each end. Others—as described in "The Manufacturing Process"—use segments of suspension lines that are attached only to the outer edge of the canopy (and across the apex vent).

**Manufacturing Process**

**Assembling**

* Ripstop nylon cloth is spread on a long table and cut according to pattern pieces. The cutting may be done by a computer-guided mechanism or by a person using a round-bladed electric knife.
* Four trapezoidal panels are sewn together to form a wedge-shaped "gore" about 13 ft (3.96 m) long. A two-needle industrial sewing machine stitches two parallel rows, maintaining consistent separation between A typical dome canopy parachute.
* To provide sufficient strength and enclose the raw fabric edges, a "French fell" seam is used; an attachment on the sewing machine folds the cloth edges as a highly skilled operator feeds the material through it. Depending on the parachute's specific design, a few of the gore sections may be sewn using mesh rather than ripstop nylon fabric for the largest panel.
* A number of gores (typically 24) are sewn together, side by side, to form a circular canopy. The seams are sewn in the same manner as in Step 2.
* Every panel and every seam is carefully inspected on a lighted inspection table to make certain that the seams are correctly folded and sewn and that there are no flaws in the cloth. If any weaving defects, sewn-in pleats, or an incorrect number of stitches per inch is found, the canopy is rejected. The problems are recorded on an inspection sheet, and they must be repaired before additional work is done.

A. French fell seam. B. Needle hem. C. V-tab. D. Outside view of stitched v-tab.

A. French fell seam. B. Needle hem. C. V-tab. D. Outside view of stitched v-tab.

**Finishing**

* A tape the same width as the original seam is sewn on top of each radial seam using two more rows of stitching. This tape strengthens the canopy.
* The top of each gore is a few inches (several centimeters) wide; after the gores are sewn together, their tops form a small open circle (the vent) at the center of the canopy. To reinforce the vent and to keep the cloth from fraying, the fabric is rolled around a piece of webbing and sewn with a four-needle sewing machine, which stitches four parallel rows at once.
* The bottom of each gore is 2-3 ft (0.5-1 m) wide. Sewn together, these edges form the outer edge (the skirt) of the canopy. This edge is finished in the same manner as the vent, as in Step 6.
* A short piece of reinforcing tape is sewn to the skirt at each radial tape. It is folded into a "V" pointing outward from the canopy. A specialized automatic sewing machine, designed for this specific operation, is used to sew precisely the same number of stitches in exactly the same pattern every time.
* One end of a 20 ft (6 m) long suspension line is threaded through each V-shaped tab, which will distribute the load from the line to a section of the skirt hem. Using a special zigzag pattern that is both strong and elastic, the suspension cord is sewn to the canopy's hem tape and to the canopy seam for a length of 4-10 in (10-25 cm).
* After the 24 suspension lines are sewn to the canopy, 12 1 ft (30 cm) long apex lines are similarly sewn to the central vent. One end of each line is stitched into a V-tab, then the line crosses the vent to the opposite seam where the other end is stitched into a V-tab.

**Rigging**

* The canopy is attached to the harness by tying the suspension lines to steel connector links on the harness. The lines must not be twisted or tangled if the parachute is to function properly. Attaching the lines to their correct sequential positions on the connecting links of the harness and making certain that the lines are straight is called rigging the parachute. The line end may be knotted at the harness link, or the end may be threaded back inside the line like a "Chinese fingertrap."
* To keep the attaching knot or fingertrap from untying, the end of each suspension

A. Two half hitches. B. Clove and half hitch. C. Braided suspension line.

A. Two half hitches. B. Clove and half hitch. C. Braided suspension line.

line is zigzag stitched to the main section of the line.

* Every assembly operation, every seam, even every stitch is reviewed for completion and correctness. When the parachute is approved, it is marked with a serial number, the date of manufacture, and a final inspection stamp.
* A parachute rigger licensed by the Federal Aviation Administration (FAA) assembles the component parts (e.g., canopy, suspension lines, pilot chute) and carefully folds and arranges them in the pack, securing it with the appropriate activation device such as a ripcord.

**Quality Control**

The quality control systems used by parachute manufacturers must meet the requirements for civil and/or military aviation equipment established by the federal government, under the supervision of the FAA. In addition to the lighted inspection tables mentioned, other types of testing equipment include tensile test machines (to measure strength of fabric and seams while being pulled), Parameters (to test the amount of air that can pass through the fabric), and basic measuring devices (e.g., to count stitches per inch).

**NYLONS USED IN OPF KANPUR**

* Cordage Nylon 345-N(used for bomb parachute 51mm)
* Tape Nylon 26mm U/D BS 1000 kg(used for MIG. 21)
* Cordage Nylon 250Kg Red(use for para sail parachute)
* Webbing Nylon 44mm 1815 Kg(use for harness of man drop parachute)
* Tape nylon 44mm OG BS 1000(use for man drop parachute)
* FABRIC Cotton 375gm
* Nylon 66
* Duck Cotton 475gm OG
* Nylon 48
* Fabric cotton 310 gm
* Nylon 37gm

**PARACHUTES IN OPF**

**Man carrying parachutes**

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***Parachute Tactical Assault- Main (PTA-M)***

PTA-M is a low level personnel main parachute to be used by the parachutist for a predetermined jump. The parachute is highly drag efficient, stable having quick opening feature has air scoops and anti-inversion netting facilitating easy opening of the canopy.

**Technical Sheet**

 Rate of Descent : 5.45 m/s

 Canopy Diameter : 8 meter

 Dropping Load : 150 kgs

 Dropping Height : 600 ft AGL to 15000 ft AMSL

 Basic Material : Fabric Nylon Light Weight 37 gm. Rip stop weave Olive Darb Shade.

 Design of Canopy : Flat circular

 Life of Parachute : 10 years or 100 live descents whichever is earlier.

***Parachute Tactical Assault- Reserve (PTA-R)***

PTA-R is a low level personnel reserve parachute to used by the parachutist when the main PTA-M parachute fails to open or otherwise malfunctions. The parachute is highly drag efficient, stable and quick opening.

**Technical Sheet**

 Rate of Descent : 7.5 m/s

 Canopy Diameter : 7.0 meter

 Dropping Load : 130 kgs

 Dropping Height : 400 ft AGL to 15000 ft AGL

 Design of Canopy : Parabolic with pinched appearance at the skirt.

 Life of Parachute : 13 years / Single operation

***Parachute Paratroop Type- Main (PTR-M)***

Parachute paratroop type PTR-M is a personnel main parachute to be used by the parachutist for the predetermined jump from a minimum height of 457 m having the rate of descent varying from 4.5 to 5.8 m per second depending on air velocity, atmospheric pressure and altitude.

**Technical Sheet**

Rate of Descent : 4.5 to 5.8 m/s

 Canopy Diameter : 10.67 meter

 Dropping Load : 160 kgs

 Dropping Height : 457 to 3656 m

 Basic Material : Fabric Nylon Light Weight 37 gm. Rip stop weave Olive Darb Shade.

 Design of Canopy : Parabolic with pinched appearance at the skirt.

 Life of Parachute : 15 years or 100 live descents whichever is earlier.

***Parachute Paratroop Type- Reserve (PTR-R)***

Parachute paratroop type PTR-R is a personnel reserve parachute to be used by the parachutist for the predetermined jump from a minimum height of 457 m when the main parachute i.e. PTR-M fails to open.

**Technical Sheet**

 Canopy Diameter : 7.5 meter

 No. of Rigginh Lines : 24

 Design of Canopy : Parabolic with pinched appearance at the skirt.

 Life of Parachute : 15 years / Single operation

**High Altitude Parachute (HAP)**

High Altitude Parachute has been designed and developed for use in high altitude dropping zones upto 20,000 ft ASL and for training jumps at plains from high speed AN-12 Aircraft

**Technical Sheet**

 Rate of Descent : 2.4 to 3.3 m/s

 Canopy Diameter : 10.67 meter

 No. of Rigging Lines : 30

 Altitude : 500m AGL

 Release Speed : upto 320 kmph

 Basic Material : Fabric Nylon Low porosity 52 gm Rip Stop Weave Olive Darb Shade.

 Design of Canopy : Flat circular

 Life of Parachute : 15 years or 100 live descents whichever is earlier.

***Combat Free Fall Parachute***

***(Ram Air 9 Cell Para)***

Ram Air parachute is a highly steerable & gliding free fall parachute for clandestine and deep penetration into enemy territory. The parachute in a 9-cell configuration has been developed for use by Army, Air Force and adventure wings. The parachute is fully maneuverable & provides pinpoint landing. The canopy is in rectangular-shape with aerofoil design. The parachute consists of two layers of almost nil porosity fabric with intervening aerofoil shaped ribs making cells. During development air rams through the opening of cells and canopy is deployed in the shape of wing surface to provide lift.

**Technical Sheet**

 Span : 8.84 meter

 Opening Time : 3-4 seconds

 Altitude of Opening : 300 m to 10,500 m

 Deployment Speed (Max) : 77 m/sec (150 knots)

 Suspended Mass : 150 kgs (max)

 Forward Speed : 40 kmph

 Turn Rate : 10 - 12 sec for a turn of 360 deg

 Lift of Drag ratio : 3.3 : 1.0

 Aspect ratio : 2.6 : 1.0

 Surface Area : 34.28 Sq.m

 Rigging Lines : Cordage Polyester heat set BS=318Kg

 Basic Material : Fabric Nylon Rip Stop weave low porosity 42 gm/m2

 Design of Canopy : Flat circular

 Life of Parachute : 15.

**CARGO PARACHUTES**

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**Supply Drop Parachute**

This Parachute is used for dropping supplies and loads ranging from 135 to 160 kgs. From Aircraft flying at 305 m height with a speed of 120 to 150 knots.

**Technical Sheet**

 Dia of skirt : 8.5 meter

 Load dropping capacity : 135 to 160 kgs

 Basic Material : Cotton Fabric for SD parachute scoured 91.4 cm width.

 Design of Canopy : Flat fully rigged

**Heavy Drop Parachute**

Heavy Drop system AN-32 is a platform system. The system is for dropping Jeeps & heavy vehicles. Load is attached with platform and vehicle is dropped with platform. In the system initially auxiliaries and then main parachutes open.

**Technical Sheet**

 Area of Canopy : 350 sqm

 No. of Rigging Line : 120

 Basic Material : Fabric Nylon 32 gm. U/D

 Design of Canopy : Flat circular

**BREAK PARACHUTES**

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**Break Parachute for MiG-21 Aircraft**

The brake parachute is used on MiG-21 aircrafts as a brake in addition to the main mechanical brakes during emergency landing or on short wet runway. This brake parachute system ensures required reduction of landing run at speed not exceeding 180 kmph when system is released. Recommended aircraft speed at which the parachute should be jettisoned at the end of decelerating run - 30 knots.

**Technical Sheet**

 Across Measurement of canopy : 5.45 meter

 No. of rigging lines : 28

 Normal Landing Speed : 180 kmph (72.2 m/s)

 Emergency Landing Speed : 290 kmph (83.3 m/s)

 Basic Material : Fabric Nylon 109 gm Undyed

 Design of Canopy : Canopy Unicross Design

 Life of Parachute : 10 years or 40 streamings whichever is earlier. In case of Parachute operated at speed above 290 Kmph the same cannot be used again for further streaming.

***Parachute for Illuminating Ammunition***

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Primarily used for illuminating ammunitions and Mortar bomb 81 mm. This parachute is used to decelerate and to stabilise the speed of bombs and for a quick illumination of target area. These parachutes can also be used to provide complete battle field illumination.

**Technical Sheet**

Variant 1

 Canopy Diameter : 1.10 meter

 Design of Canopy : Flat Circular

 No. of Rigging Lines : 8

 Basic Material : Fabric Nylon 37g Light weight Olive Drab.

Variant 2

 Canopy Diameter : 1.15 meter

 Design of Canopy : Unicross

 No. of Rigging Lines : 12

 Basic Material : Fabric Nylon 37g Light weight Olive Drab

P6 SECTION IN OPF KANPUR

I have been allotted P6 section to work under the guidance of Mr Praveen Chandra(JWM) .This section consists of 10 GANGS and each gang consist of 16-17 members so in total there are approximately 175-180 members working inside this section being allotted by their respective work. Nylon fabrics are cutted down in the P2 section and faults of the fabric is watched by the light emitting square table by passing the fabric over it. Different types of sewing machines are been used to stitch the different panels of the parachute fabric.

**TYPES OF SEWING MACHINES:**

* Single needle sewing machine
* Double needle sewing machine
* Four needle sewing machine
* Zig zag sewing machine
* Heavy duty sewing machine
* Mini duty sewing machine
* Basting sewing machine