

Date: 17/07/2023

“Design, Development and Manufacturing of suspension system for Air Defence Gun.”

BACK GROUND


Gun Carriage Factory (GCF) Jabalpur is a premier weapon production unit of Advanced Weapons and Equipment India Limited (AWEIL), working under the Ministry of Defence, Govt. of India. Currently GCF is producing medium & large caliber weapons. GCF is developing Air Defence (AD) Gun for Indian Army. In this regards, GCF need to develop special suspension system for Air Defence Gun. The need of such suspension arises due to the requirement of a special feature of the suspension system.

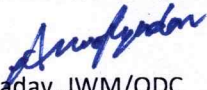
Suspension system should act as a hydraulic cylinder for bringing the gun on the ground during firing and lifting the gun up (and maintaining certain ground clearance) and act as suspension system during travelling.

OBJECTIVE

Following are the objectives of this design, development and manufacturing of suspension system:

1. To conduct a preliminary study and formulating a primary design of suspension system.
2. Design suspension system with following features:
 - a. The suspension system should be such that it enables the gun to rest on the ground (off-wheel) during firing and there should be no load on tyres.
 - b. During travelling, gun should raise above the ground (on-wheel) to maintain a certain ground clearance suitable for on road and off-road travelling.
 - c. There should be quick change from off-wheel to on-wheel and vice a versa.
3. Create a digital twin of suspension system.
4. Manufacture one prototype for functionality test and dynamic life cycle test at firms developed test rigs.
5. Manufacture and supply two set of suspension system.
6. Prepare production documents for mass production.
7. To install and test the newly designed suspension on the AD Guns available in GCF for actual on road and off road trials.
8. Supply of full technology, manufacturing drawings, operating manuals, part catalogue, animation videos, QAP etc. to GCF.


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Pre-Qualification Criterion

1. Firms which are working in the field of hydraulic system or suspension system design and manufacturing for at least 10 Years is eligible to quote.
2. Firm should have successfully completed design and manufacturing projects of any of following type or similar with reputed OEMs:
 - a. Hydraulic system for artillery gun, earthmovers, aircraft, machine tools, armored vehicles etc.
 - b. Suspension system for vehicles.
 - c. Design and manufacturing of hydraulic assemblies involved dynamic forces and motions.
 - d. Vendor must present documentary proofs showing experience in design, development & delivery of such systems. Case studies and results should be given in the technical bid for assessment.
3. Firm should be an Indian Registered Company with minimum average turnover of 3 Crores in last 3 Years.
4. Firm will provide satisfactory work completion certificates of at least 04 such project. These projects must have been completed after 1st April 2017.
5. For designing part of the project, firm should have its own licensed CADD software and competent manpower or firm should have collaboration with other firms for designing.
6. For analysis part of the project, either firm should have authorized licensed software for CAE (that should broadly include CFD, FEM, Electromagnetics, Multi-body dynamics, PCB/Controller Design) or firm should have collaboration with other firms for analysis.
7. Designers to be deployed for computer based design software (3D, 2D) should have diploma/bachelor degree in mechanical engineering and minimum 3-year experience in the field of Computer Aided Product Design (If necessary GCF will ask for the details of such manpower employed by the firm or its design partner).
8. Designers to be deployed for Computer Aided Engineering should have bachelor degree in mechanical engineering with minimum 5-year experience (If necessary GCF will ask for the details of such manpower employed by the firm or its design partner).
9. Firm or its partners should have authorized licensed software for word processing, document creation, typing and editing of technical manuals, charts, part catalogue etc.
10. Firm should have its own in-house full manufacturing facilities for hydraulic systems. Including Deep hole boring machines, bore super finishing machines, cylindrical grinding machines, CNC turning machines, CNC machining centers, dust proof room for assembly etc. Heat treatment can be outsourced to the collaborators.
11. Firms which have collaboration with other firms for design and analysis part of the project should have its own basic design software for in-house R&E.
12. Capacity assessment of the firms will be done to ascertain the capability of design, development and manufacturing of suspension system.

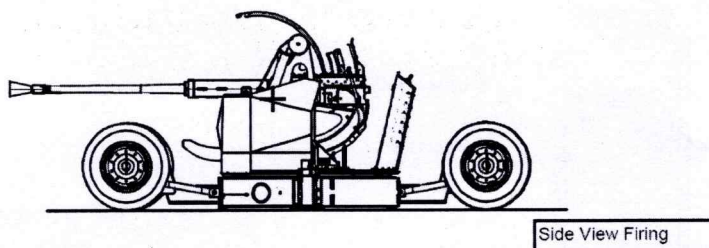
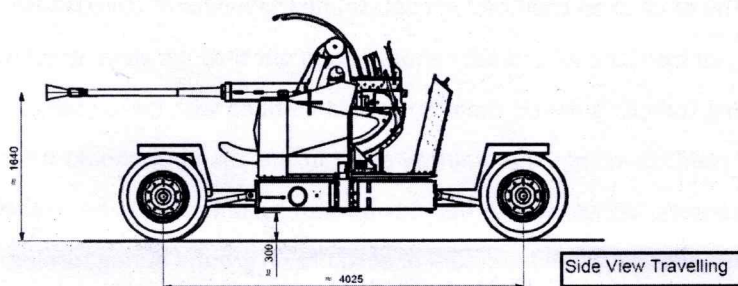
PROBLEM STATEMENT

There is a need to design the special suspension system for Air Defence Gun due to following requirement:

Stability: Air defence gun is highly accurate gun which neutralizes air target at speed 500m/sec and at a distance of 4000m. To engage the target at such speed and distance the gun should be stable and rigid which is achieved by resting the gun platform on ground (off-wheel) and pegged with ground. During this position gun should not be supported by suspension system and/or wheels.

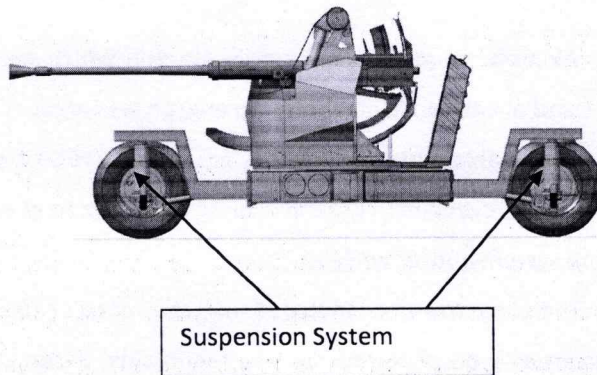
Mobility: The gun is towed on metalled road at a speed of 70 km/hr. and off road condition 15 km/hr. in all type of terrain such as mountains, deserts, river beds etc. for this gun should be on-wheels with good suspension and ground clearance.

Due to this high stability and mobility requirement the suspension system should have raising and lowering capabilities as gun has to change its position from on-wheel to off-wheel (zero ground clearance to good ground clearance) and vice versa regularly as shown in picture.



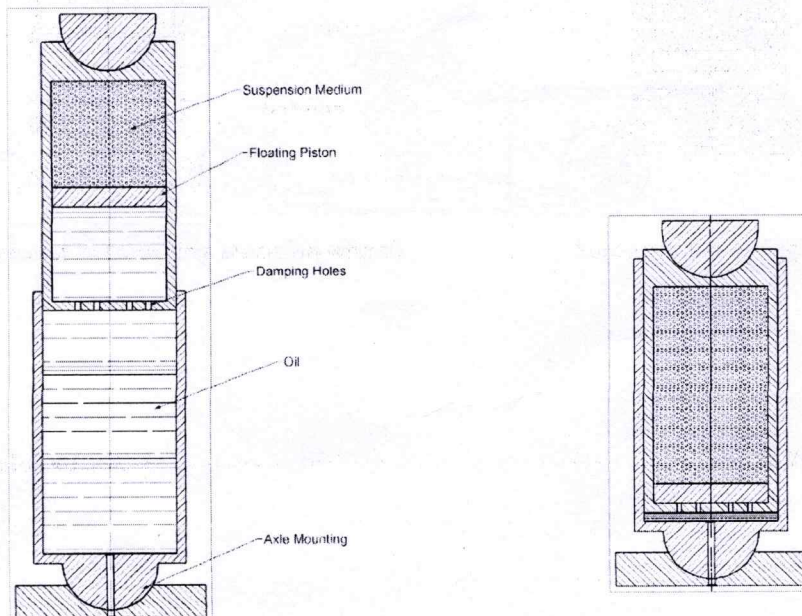
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CONCEPT*

The suspension system can be hydro-pneumatic or hydro-spring type with oil damping as shown in figure. Compressed nitrogen gas or mechanical spring will act as a suspension medium. Oil will work as a hydraulic cylinder to bring gun on-wheel and off-wheel. Oil will also act as damping media of suspension during travelling. Quantity of oil in oil chamber will determine the height of chassis form the ground. When gun is in firing mode, oil from the oil chamber should drain out through valve which will bring the chassis on the ground. During travelling the oil chamber should be filled with oil to maintain certain ride height for on-road and off road travelling. The quantity of oil in the chamber should be automatically controlled through smart sensors, pump, valves etc. Suspension system should be capable of maintaining load balance between sides and ground pressure of each tire on ground during turning, uneven ground etc. for less tyre wear and good ride quality.



Suspension in Travelling Mode (on wheel)

Suspension in Firing Mode (off-wheel)

***This concept is for understanding purpose only, designed system can be completely different than this concept. Designers are free to design any other arrangements meeting the project requirement. The system should be essentially hydropneumatic or hydro-spring type.**


SCOPE OF WORK


GCF desires to engage reputed vendor to undertake ab-initio design, development and manufacturing of hydro-pneumatic suspension system with following scope of work:

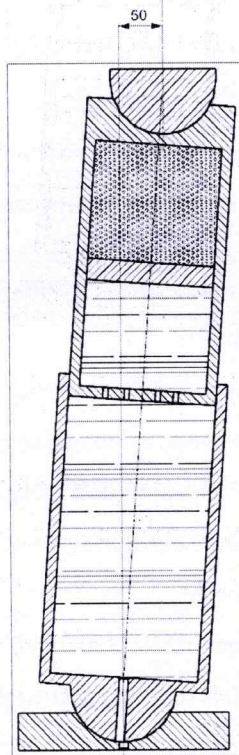
1. Design, development, manufacturing, life cycle test and supply two sets of suspension system with following specification:
 - a. Ground Clearance during travelling: 300 Nominal but not less than 270mm.
 - b. Change time between on-wheel to off-wheel and vice a versa: 5 min. (maximum)
 - c. Gross weight of equipment: 8000kg.
 - d. Weight over the suspension system: 7000kg. maximum (approx. 2000 kg maximum on each suspension column)
 - e. Towing speed on metalled road: 70 km/hr.
 - f. Road irregularities (bumps, obstructions under tyre) at metalled road: Standard Indian road conditions.
 - g. Towing Speed off road condition 15 km/hr.
 - h. Road irregularities (bumps, obstruction under tyre) during off road conditions: 200mm height.
 - i. Total height of suspension column in travelling position should not be more than 700mm.
2. Supplied suspension system should be completely assembled and ready to fit on the gun chassis.

One set of fully assembled suspension system should include:

- a. Four suspension column, one each for each wheel.
- b. Pump with motor for fluid charging and discharging.
- c. Valve system for fluid charging and discharging.
- d. Position sensors to maintain ride height and ride level.
- e. Safety Interlock for unintended lowering of Suspension.
- f. Sump and filters for storing and cleaning fluid.
- g. Pipe lines, connectors, seals require for mounting suspension system on Gun.
- h. Suspension system stress free fittings between axle and chassis.
- i. During up and down movements of chassis there will be relative motion between chassis and axle in all three axis. To compensate this there should be some allowable offset between two mounting points (chassis and axle). Allowable offset should be at least 50mm. as shown in the figure.


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- j. Operation should be digitally/electrically controlled by a switch. With emergency manual provision.
 - k. All operation should be automatically controlled through logics and inter-locking. There should only one electrical switch for operator with two options: FIRING MODE and TRAVELLING MODE. Electric switch will be in GCF scope.
 - l. All electrical/electronic wire harnesses required for suspension system functioning. (Power input wire harness and Electric switch will be in GCF Scope).
 - m. All hardware items, rubber bushings, dampers etc. required for functioning and mounting suspension on gun etc.
3. Change from on-wheel to off-wheel and vice versa should be powered and operated through button/switch by operator.
 4. Hand operated valve and hand operated pump for emergency situation (without power) to change from on-wheel to off-wheel and vice versa.
 5. All parts design should be optimized through strength analysis.
 6. Firm will do durability optimization of the component and assemblies. Predicted life of components, sub-assemblies etc. should be defined in terms of time span (self-life) or kilometers of travelling or both. This should be validated through life cycle test after manufacturing one system.
 7. Design should be reliable, ruggedized and MIL grade standard. It should be able to perform in dusty, rainy etc. conditions.

8. For make to order components materials suggested for manufacturing should be from Indian standard (IS) and where ever Indian Standard not existing other international standard like BS, ISO, EN, ASTM can be suggested.
9. Ambient working temperature for the system is -25 deg. to +50 deg. Altitude is up to 5000m in high altitude area.
10. Supply of CAD Models, motion study, manufacturing drawing.
11. Supply of production documents (2D drawings, bill of materials, process schedule, quality assurance plan etc.) for mass production. All documents should be in GCF format.
12. Preparation and supply of maintenance documents, ISPL, parts catalogue, animation videos etc.
13. Initially one prototype suspension system to be manufactured for life cycle testing in order to validate the design before finalization of the design for manufacturing two set of suspension system. The components of this suspension system should be kept for study purpose at firm's premise and need not to be supplied to GCF.
14. Manufacturing and supply of two set of suspension system as per digitally validated design and life cycle test.
15. Firm to remain involved during GCF trials of the system any gaps or faults should be improved by the firm.
16. Any Spare require for trouble free operation during trials should be provided by firm free of cost.
17. GCF is having Siemens Nx 1980 software hence all supplied cad data, the exchange format should be compatible to this software.
18. Power requirement of suspension system should be defined.
19. EMI / EMC: The suspension system in its own cell should be EMI / EMC hardened as per MIL STD 464C at system level and as per MIL STD 461E or better at sub system level.
20. Environmental Tests: As per relevant portion of JSS 55555.
21. Installation of the suspension system on the Gun.

DELIVERABLES

1. Design data of suspension system of Air Defence Gun as per scope of work.
2. Complete CAD models along with design calculations, analysis models & validation data.
3. Complete 2D engineering drawings of the designed suspension system for mass production.
4. Manufacturing and Life cycle test of one suspension system. This will be property of the supplier and need not be dispatched to GCF.
5. Manufacturing of two sets of suspension system and functional demonstration before delivery.
6. Supply of two sets of suspension system.
7. Following Documents of suspension system should be provided in editable digital format.
 - a. Maintenance manuals.
 - b. Operator manual describing functioning, operation.

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- c. Part catalogue with exploded isometric views of assemblies.
 - d. List of spares with quantities require for 100nos of suspension system for 2-years of trouble free operation. Price list of all spares should be given with MOQ if any.
2. Animation video of suspension system working.
 3. Fitment and functional trials of the system on gun.
 4. Transfer of technology for mass manufacturing of suspension system.
 5. 2D drawings should contains detailed dimensioning, GD&T, tolerances, material, heat treatment requirement etc.
 6. Firm's experts should be available on its own expenses during towing trials of the gun on road and off road by GCF in Jabalpur.

DELIVERY AND PAYMENT SCHEDULE

Payment will be made based on the delivery milestone achieved, as follows:

S. No.	Milestone	Delivery Schedule	Payment Schedule
1.	<ol style="list-style-type: none"> 1. Readiness of the design of suspension system. 2. Handover of CAD models along with design calculations, analysis models & validation data and 2D engineering drawings to GCF. 3. Demonstration of digital twin of the suspension system. 4. Handover of animation video of the actual designed system. 	D+5 months	20% (After completion of this milestone)
2.	<ol style="list-style-type: none"> 1. Manufacturing one suspension system and its life cycle test at supplier premises. 2. No physical delivery of components involved at this milestone 	D+7 Months	10% (After completion of this milestone)
3.	<ol style="list-style-type: none"> 1. Manufacturing, functional demonstration and supply of two sets of suspension system. 2. Supply of manuals/documents, part catalogue etc. in digital format. 	D+10 Months	30% (After completion of this milestone)
4.	<ol style="list-style-type: none"> 1. Assembly and fitment of suspension system on two Guns. 2. Functional Demonstration of both suspension systems on the gun. (static trials, functional trials, road trials, firing trials). 3. Towing, road trials of the suspension system by GCF. 	D+12 Months	10% (After completion

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			of this milestone)
5.	1. Transfer of technology for mass production.	D+14 Months	30% (After completion of this milestone)

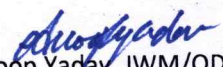
D: Order placement date.

OTHER TERMS & CONDITIONS

1. All deliverable generated under this assignment will become property and IPR of GCF.
2. Complete confidentiality shall be maintained by Vendor during and after the project.
3. Design and delivered system should not bound by any third party IPR regulations.
4. The design evolved during this exercise and under this project should not be used for any other organizations for next 10 years.
5. In compliance to Government of India Preference to Make in India Order-2017, minimum local content should be 70%.



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