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Technical Requirements for

Providing Engineering Services for Airframe Design and Analysis of DBMRH

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LIST OF ABBREVIATIONS

Notations	Definition
AC	Air Condition / Air Conditioner
AFCS	Advanced Flight Control System
APU	Auxiliary Power Unit
ASIST	Aircraft Ship Integrated Secure and Traverse System
ATA	Air Transport Association
AUW	All Up Weight
BOM	Bill of Material
C.G.	Centre of Gravity
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CDR	Critical Design Review
CEMILAC	Centre for Military Airworthiness & Certification
cgm	Computer Graphics Metafile
CS	Certification Specifications
DAL	Drawing Applicability List
DEFSTAN	Defence Standard
DFEM	Detailed Finite Element Model
DFMA	Design for Manufacturing and Assembly
DRDO	Defence Research & Development Organisation
DRN	Drawing Release Note
EBOM	Engineering Bill of Material
EMRU	Electro Mechanical Release Unit
EO	Electro Optical
F&DT	Fatigue and Damage Tolerance
FAR	Federal Aviation Regulation
FCS	Flight Control System
FE	Finite Element
FEA	Finite Element Analysis
FEM	Finite Element Modeling
FTR	First Time Right
FWD	Forward
GFEM	General Finite Element Model
GTV	Ground Test Vehicle
H/C	Helicopter
HAL	Hindustan Aeronautics Limited
IGB	Intermediate Gear Box
I/B	Inboard

Notations	Definition
IR	Infra-Red
IT	Information Technology
LAN	Local Area Network
LRU	Line Replaceable Unit
MBD	Model Based Dimensioning
MGB	Main Gear Box
MIL-STD	Military Standard
MS	Material Schedule
NAL	National Aerospace Laboratory
NC	Non - conformance
O/B	Outboard
PC	Personal Computer
PDP	Preliminary Design Phase
PDR	Preliminary Design Review
PLM	Product Lifecycle Management
PTMC	Project Technical Monitoring Committee
PSU	Public Sector Unit
RCS	Radar Cross Section
RFQ	Request For Quotation
RWR&DC	Rotary Wing Research and Design Centre
SOM	Strength of Material
SOP	Standard Of Preparation
TDS	Tail Drive Shaft
TGB	Tail Gear Box
USB	Universal Serial Bus

1 Introduction

Hindustan Aeronautics Limited (HAL), Bangalore is a Premier Aeronautical Industry in India engaged in design, development & production of Aircrafts, Helicopters and other aerospace products. At present the Rotary Wing Research and Design Centre (RWRDC), a Design Centre of HAL has undertaken a prestigious program of Design and Development of Deck Based Multi Role Helicopter (DBMRH) of 12.5-ton weight class.

The Deck Based Multi Role Helicopter (DBMRH) is envisaged to meet Qualitative Requirements of Indian Navy. This Helicopter will have significant improvements in performance over the existing contemporary Multi Role Medium lift helicopters with many features specially designed for Indian conditions.

Towards meeting the time frame of DBMRH development and to utilize the indigenous expertise, the activities related to detail design and analysis of Airframe is proposed through private participation within India. HAL seeks response from prospective Engineering Service Providers meeting these technical requirements. The fundamental working principle of this private participation is to utilize the technical capabilities / competencies available within India.

2 Scope of work for Detail Design and Analysis of Airframe

The Engineering Service Provider (Design Partner) to take up the Airframe design definitions from Preliminary Design Phase for detail design, which comprises of metallic and composite components. As part of this work package, the Engineering Service Provider has to carry out following activities:

- Creation of manufacturable detailed part definitions (3D)
- Incorporating Model Based Dimensioning in CAD Models
- Creation of System Models
- Mapping the requirements to CAD geometry
- Establishing the trace links to verification and validation requests
- Part & Assembly drawings within budgeted weight

- Preliminary and Detailed sizing of components
- Finite Element Modeling (FEM)
- Finite Element Analysis (FEA)
- Weight optimization
- Preparation of Stress analysis reports
- FE/stress analysis support for ground testing
- Preparation of Test orders and Synthesis reports
- Creation of Dedicated Detailed FE Models (DFEM) for airframe modules & a dedicated full airframe FE model for dynamic analysis with FE input reports
- Incorporate changes during the support period of prototype building

The anticipated work involved is approximately 10000 drawings with its supporting documents including Layouts, Modelling, Analysis etc during Design phase and 40% of design phase effort during Engineering change management phase. It is to be noted that, the detail design and analysis phase is evolutionary and iterative in nature. The total number of drawings cannot be certainly and/or reliably known at the beginning. The service provider shall estimate the number of drawings and effort involved independently. Refer ANNEXURE -I for overall dimensions and Three view diagram of DBMRH.

2.1 General Description of DBMRH Airframe

Advanced technology, processes, materials and manufacturing techniques have been envisaged in the design and development of DBMRH airframe to achieve lightweight with sufficient strength & stiffness. Flexibility is the key features infused in the basic design of DBMRH. The airframe has to be built as modular concept facilitating ease of Assembly and Maintenance. Tail Boom should have the provisions for folding to meet the stowage dimensions which is constrained by the ship hangar dimensions.

DBMRH will be having three variants for catering the requirement of Indian Navy. They are Warfare (W), Special Operations (S) and Airborne Early Warning (A). The Airframe of helicopter should be designed to meet civil airspace requirements also.

Though the primary structural members are same for all the variants, separate set of drawings will be there for catering the roles specific to different variants at Top levels and at leaf nodes.

The DBMRH airframe consists of Five main sections: 1) Front Fuselage 2) Center Fuselage 3) Tail Boom and empennage 4) Weapon Suspension System 5) Cowlings& Firewalls.

The approximate no of LRUs estimated will be in an order of around 250 nos. and distributed throughout the Airframe.

2.1.1 Front Fuselage of DBMRH

The Cockpit accommodates two or three crew members with maximum crash protection and provides good all-around visibility. Normal entry and exit to cockpit is through door provided between cabin and cockpit whereas emergency exit to be achieved by jettisonable doors placed on each side of cockpit. However, provisions to be kept during design stage itself for converting the emergency exit to regular hinged door for pilot entry at a later stage. It should absorb loads imposed by the Nose landing gear. Flight controls, avionics etc. are also located in and around the cockpit region. Provisions for installing Pilot and Co-pilot Seats in side-by-side configuration to be provided in the cockpit floor board. Front Fuselage Structure consists of Beams and frames with either sheet metal or machined construction. Cockpit floor to be made removable for accessibility. Bird hit tolerance and transparencies to be provided for wind shield. The anticipated work involved is approximately 1800 drawings for this module and its supporting documents.

Front Fuselage should have structural provisions as follows:

- Lower flight control systems.
- Nose landing gear attachments.
- Wheel Brake system LRUs, Nose Wheel lock cable & Parking Brake cable attachments
- Removable Armour Panels.
- Harmonization Bracket attachment at Y0
- Crashworthy crew seats etc.

- Accommodating a third crew and seat to be provided in the passage area between cockpit and cabin.
- Accommodating cockpit instruments such as Instrument panel, Overhead panels, Console panels, etc
- Fitment of Air conditioning system.
- Emergency Floatation Gear (EFG)
- Radar & EO system with cooling arrangements.

Besides above several other LRUs to be located inside cockpit for which support provisions should be made. Details of LRUs will be defined during a detail design phase. Noise levels should conform to DEFSTAN 00-970 Volume 2 and vibration levels should conform to ISO 2631-1 & ISO 2631-5 standards.

The cockpit geometry/instruments and controls arrangement should afford optimum work sharing between the crew. The DBMRH should incorporate HOCAC (hands on cyclic and collective) concept to the extent possible.

Structure should have provisions for installation of adjustable crew seats.

The cockpit structure is proposed to be made with Combination of Metals, Acrylics and composites, which provide good strength, stiffness and optimum cross section to have better visibility.

The bottom structure of front fuselage consists of Beams and frames with sheet metal construction. The wind shield and other transparencies to be made up of acrylic sheets.

2.1.2 Centre Fuselage of DBMRH

The middle section of the fuselage i.e., Centre Fuselage contains the cabin for troop/passenger/cargo compartment and fuel. It should absorb loads imposed by the main rotor and Main landing gear. The centre fuselage is the main load bearing element of the fuselage structure, which carries the payload, fuel and support Transmission system, Control system elements and Engine System.

The centre fuselage accommodates the Main Landing Gear and interfaces for Weapon Suspension System, other weapons, Slithering boom, Rescue hoist etc. The floors are to be made individually removable for accessibility. The cabin is to be

provided with two sliding doors, one on each side. The sliding doors are required to be flushed with outside surface which gives a better aerodynamic surface, thus reducing drag. Minimum 4 windows are to be provided on each side with jettisonable configuration for emergency exit. Hard points have to be provided for jacking, towing, mooring, landing gear, Weapon Stub Wing, EFG, Engine mounts, Bracketry for Engine lifting crane attachment, MGB, MGB oil cooler, TDS Bearings and other attachments.

The rear side of fuselage contains a hydraulically operated Ramp, Tail Boom connection and Equipment bays on the inner sides of the fuselage. The Ramp and ramp door allows the loading of cargo.

The engine floor provides attachment for two different engine configurations which matures during development of the program. The hot section around the engine is to be constructed using Titanium alloy to meet the fire resistance requirements of DEFSTAN / FAR-29 amdt. 59 /CS-29 and other applicable standards.

For DBMRH, cabin dimensions should be at least 5.5m x 2.0m x 1.6m (Length x width x height) and it should be able to accommodate 36 troops. External Cargo hook should have a maximum underslung load carrying capacity of 3500 Kg. Bottom structure of DBMRH should have provisions for attaching Ship Deck Landing mechanisms, Sonar and Sonobuoys systems and Airborne Early warning Radar.

Centre Fuselage section of DBMRH will be having 3 different configurations for accommodating the 3 variants (Warfare, Special Operations and Aerial Early Warning). Even though the major load carrying members and construction methodologies are same for all the three variants, separate set of drawings should be there for three variants at Top levels and at leaf nodes.

Hard points to be provided for installation of

- Transmission System
- Powerplant (Changes in mounting location of Engine in airframe to be accommodated at any point during development phase based on Engine selection).
- Flight control systems.
- Main landing gear attachments.

- Provisions for mounting of Weapon Suspension System
- Provisions for mounting Emergency floatation Gear (EFG)
- Provisions for wheel Brake system LRUs.
- Jacking points and mooring points.
- Provisions for Removable Armour Panels
- Provision for weapons installation inside the cabin
- Cargo hook for attaching external payloads
- Provisions for mounting Slithering and Rescue hoist
- Provisions for installation of Seat, Safety and Medical support systems
- Provisions for Tail Boom Attachment
- Doors, removable Access panels/covers, Floor boards, Removable armour panel to be interchangeable by design.
- Provision for integrating ASIST
- Provision for mounting AVCS actuator in fuselage.

Apart from above, several other LRUs to be located inside fuselage for which support brackets and panels provisions on structure should be made.

The anticipated work involved is approximately 5300 drawings for this module and its supporting documents.

2.1.3 Tail Boom and Empennage of DBMRH

The Tail boom supports the tail gearbox, Intermediate gear box, tail drive shafts, assembly segments and the horizontal stabilizer with the vertical fin. Outside the tail boom the tail rotor drive system is to be housed. The Tail boom is to be mounted to Centre fuselage by bolted joint for supporting the modular build concept and transportation purpose. The horizontal stabilizer with the vertical fin provides helicopter directional stability and reduces the yaw control travel during flight.

Advanced technology has to be used in the design of DBMRH airframe to achieve a well-balanced metal/composite construction, which complies with the requirements of DEFSTAN 00-970 / FAR-29 amdt. 59/CS-29and other applicable standards.

Tail boom for DBMRH should have folding mechanism (either manual of automatic) for meeting the stowage requirements from Indian Navy. In DBMRH, Horizontal

Stabilizer will be positioned only on one side of Tail boom for ease of folding and meeting the stowage dimension as per customer requirements.

The tail boom of DBMRH will be in two segments, one is stationary which is attached to the main fuselage of the helicopter and the other one is movable segment. Both segments of tail boom will be constructed by means of frames, stringers, stiffeners and skin/sandwich shell.

The anticipated work involved is approximately 1000 drawings for this module and its supporting documents.

Tail Boom and Empennage should have the following design features / requirements.

- The frames should be designed robustly considering the optimum strength, stiffness & budgeted weight.
- Stiffness of the Tail Boom should be designed with consideration of the capabilities of bearings, Flexible couplings of the tail drive shaft segments. It is important because the tail boom deflects dynamically (Judder due to vibration and change in flight regimes) in flight and also deflects during landing.
- The optimum weight distribution of tail boom will facilitate the C.G to be in the desired forward position of the Helicopter.
- The usage Loads and Vibration spectrum to be considered in association with User/HAL to predict the life of the Tail boom structure.
- The design and ergonomics of the tail boom should follow the respective standards.
- Provision for having Winglets on Horizontal Stabilizer to be considered if required.
- Provision for Armour Panels mounting brackets.
- Design may consider accommodating the concept of having actuator operated Stabilator (Horizontal stabilizer) if required.
- Design of tail boom should consider absorption of impact load due to inadvertent landing by providing suitable provision at the tail boom end.
- The tail boom design should not affect the entry and exit of vehicle through rear cargo door.
- Length of Tail boom is based on Anti Torque requirement.

- Positioning of Horizontal Stabilizer.
- Selection of Control Surfaces Based on Aerodynamics Requirements.
- Transportability Requirements.
- Provision for Cut-out based on Accessibility/ Maintainability Requirements.
- Hard Points for Maintenance Requirements
- Tail bumper Attachments

2.1.4 Weapon Suspension System of DBMRH

Weapon Suspension system (4 type of attachment Assembly like Wing/Truss) is used to carry, release and jettison an array of weapons on DBMRH. The roles of Helicopter are categorized as below:

i) Anti-submarine Role (Torpedo and Depth Charge)
ii) Anti-Surface role (Anti-Ship Missile)
iii) Special Operations (Rocket and Gun Pod)

The Weapon wing/truss can be attached at the different locations of Helicopter structure based on requirements and feasible configuration. Each weapon Wing/Truss attachment has 01 Nos of weapon stations/stores (01 each on both side of the Helicopter). It is attached to Helicopter by Hard points/Attachment Lugs provided on Helicopter Structural frame. The Weapon wing/truss shall be interchangeable with easier removal/installation.

Load carrying capacity of Weapon wing/truss:

i) Anti-submarine Role - 350 Kg (each side)
ii) Anti-Surface role (Anti-Ship Missile) - 750 Kg (each side)
iii) Special Operations (Rocket and Gun Pod) - 250 Kg (each side)

The anticipated work involved is approximately 900 drawings for this module and its supporting documents.

2.1.5 Cowling and Firewall of DBMRH

Cowlings and fairings are aerodynamically designed composite-based components, which protect the helicopter's hydraulic equipment, flight control components, MGB, APU and Engine from all operating weather conditions and also provide smooth &

aerodynamic shape. Cowlings (Engine, MGB & APU etc.) also act as maintenance platforms. Using these maintenance platforms, the maintenance personnel carry out daily inspection and routine maintenance of Engine, MGB & APU etc.

Cowling panels in the Engine zone and air-intake to be designed for 2 different engines. Cowlings should have provisions for removable Armour Panels.

Firewalls are provided to isolate engine and APU zone which is also the fire zone for the rest of the helicopter so that any fire in the engine zone of the helicopter will not spread to other areas like cabin, cockpit and the other engine zone.

The anticipated work involved is approximately 1000 drawings for this module and its supporting documents.

2.2 General Design requirements for entire airframe of DBMRH

Overall general design requirements for entire helicopter should include:

- The helicopter should be cleared for operations up to instantaneous load factors of +2 'g' and -0.5'g' for defined AUW at sea level at cruise speed.
- The helicopter should be in service for Calendar life of 30 years or more. The fatigue life of the DBMRH airframes should be as per Operational Requirements from User.
- Total weight of structure with all the hard points and reinforcement should not exceed weight specified by design.
- Modular construction should be considered during the detail design phase.
- Noise levels should conform to DEFSTAN 00-970 Volume 2 and vibration levels should conform to ISO 2631-1 & ISO 2631-5 standards.
- Choice of material should be contemporary, corrosion resistant, with no loss of stiffness & strength, throughout the service life which should be easily available in global market for the next 20+ years in consultation with HAL.
- Special coatings for the exposed portions shall be adopted since the helicopter will be operated in saline and sandy conditions. Electrical and other items which are more prone to failure due to rain / saline water shall be protected.

- The rain water protection and drain should be considered during design stage.
- All frames and beams should be provided with tooling holes to enable sub-assembly and main assembly build.
- Lightning Protection schemes / Systems
- Electrical Bonding / Ground plane
- Water leak proof joints and Latches
- Provisions/identifications of features of levelling
- Marking labels etc.
- Interchangeability (ICY) for all Doors, Fairings, Cowlings, Firewalls Access panels, Floor boards and removable armour panels.
- DFMA
- Easy Maintainability
- Cooling provisions for Transmission and Engine Bay areas.
- Thermal insulation at hot zone areas
- Corrosion Prevention practices to be defined during Detailed Design Stage.

***Note**: Inputs like Electrical bonding, Lightning protection schemes, Structural provisions for LRUs, Tooling hole locations, PLM flowchart, etc. will be provided concurrently as the project progresses.*

3 Inputs provided by HAL to Engineering Service Provider

HAL would provide the following inputs to Engineering Service Provider for executing the work package mentioned in the subsequent paras.

1. Preliminary System diagram of DBMRH.
2. Relevant chapters of PDP Document.
3. Numerical Master Geometry or Surface Model of Helicopter in NX.
4. Extract of relevant user requirements.
5. Weight Targets
6. Estimated Weight and CG of H/C parts, internal / external stores and LRUs
7. Details of Systems/Equipment in Airframe
8. Compendium of design practices.

9. Aerodynamic loads, applicable operational loads, Landing gear loads and fatigue load spectrums for the above as applicable
10. Load report for activity listed above.
11. Stiffness/Vibration Requirements at various helicopter locations based on certification standards & user requirements.
12. Armour Panel and Weapons locations.
13. Materials Standards to be referred.
14. Fasteners Standards to be referred.
15. Part Numbering System (ATA)
16. Part marking and identification.
17. Seed and Template files for CAD Model, Drawing, MS (Material Schedule) and DRN (Drawing Release Notes)
18. Values of Aerodynamic forces, payload on Weapon stations, CG and moment of Inertia of weapons, reaction force of weapons, vibration requirements as per applicable standard etc. required for Weapon stub wing
19. Configuration Layouts
    a) Design Eye Points
    b) Neutral Seat Reference Points (NSRP)
    c) Floor locations
    d) Location of mandatory primary structural members and tentative location of other primary structural members
    e) All Hard points mentioned in ANNEXURE -II
    f) Structural provisions for all LRUs as defined in integrated conceptual Layout of Helicopter
    g) Initial Location of major cut-outs and access for maintenance. However, detailing of maintenance aspects to be worked out by Engineering Service Provider.
    h) Integrated Digital Mock-up

    Note: *Construction type and section detail are informative only and are not mandatory.*
20. Materials and Process Standards

a) Material properties.
b) Heat Treatment.
c) Surface Treatment
d) Airframe protection requirements.
e) Composite Manufacturing processes.

Note: *The above listed standards and other data are tentative and the detailed list will be finalized during D1 Phase (Refer Para 5.1). Inputs which cannot be finalised during D1 due to the dependency on the output of D2 & D3 will be provided concurrently as the project progresses.*

4 Pre-requisites of Prospective Engineering Service Provider:

The Engineering Service Provider (Design Partner) is expected to have on its own the following facilities / certifications.

1. Relevant Documents/Standards such as:
    a. DEF STAN 00970 Part 7
    b. FAR 29 amdt. 59/ CS 29
    c. All relevant MIL Specs
    d. ASME Y 14.41, ASME Y 14.47, MIL-STD-31000 (Latest Revision)
    e. Any other standards used/required for design, which are available as open document.
2. Experience on Software for carrying out 3D Modelling, Analysis, Drafting, Model Based dimensioning, System Modeling etc. (List of software to be used for execution of work is mentioned in Para 6 of this document)
3. Skilled Graduate / Post Graduate Engineers with experience of Design and Analysis of Aircraft/Helicopter airframe. Junior Designer /Analyst shall have minimum 2 years of experience. Middle level Designers/ Analyst shall have minimum 5 years of experience. Senior level Designers/ Analyst shall have minimum 10 years of experience. Shall maintain a proper employee ratio of Junior level to Middle level (Preferably 10:1) and Middle level to Senior level (Preferably 5:1).

4. External Reviewers having minimum work experience of 20 years in Airframe Design. Preferably Retired personnel from HAL/NAL/DRDO or any other private firm which is involved in similar aircraft design activities.
5. Accreditation to EN9100 / AS9100D

5 Details of Activities by Engineering Service Provider

The Engineering Service Provider is required to carry out the activities mentioned in Para 5.1[D1] to Para 5.5[D5]. Deliverables for each stage are indicated in Para 7 of this document. However, the Engineering Service Provider required to carry out additional activities which arise during detail design stage to achieve complete design and development. Comprehensive Presentation material of global standards for internal reviews, users, certification agencies and CDR Review as required by HAL at all stages of deliverables to be provided.

5.1 Preliminary Analysis and Methodology Documents (D1)

- Familiarization of configuration of H/C and interaction with peer design and analysis groups of RWRDC to get information and clarifications on the inputs provided.
- Methodology of Drawing and Model making.
- Finalisation of introductory Loads and load paths.
- Finite Element Modelling and analysis aspects.
- Validation and Verification methodology for FEM & FEA.
- Methods (SOM / Hand Calculations).
- Estimation of structural component loads from FEM analysis
- Static, Fatigue, Crash and Damage Analysis Methodology and analysis documentations.
- Methodology of FE modelling for Dynamic analysis of full airframe and detailed airframe modules.
- Assessment and acceptance of other peer groups of RWRDC.

Note: HAL RWR&DC team would review the methods/approaches proposed by Engineering Service Provider before the formal release of documents.

5.2 3D CAD Layout for interference and integration Check (D2)

- Determining the part thickness with inputs from detailed loads, required factor of safety, suitable material and its processes.
- Material selection and assignment to 3D CAD Models from the standard approved material list provided by HAL.
- Define the 3D parts considering comprehensive manufacturing and assembly procedures (DFMA) following industry best practices. The 3D modelling methodology to be followed as per manuals provided.
- Creation of Reference sets for using in different assembly configurations.
- Assembly design has to be done considering tooling (jigs and fixtures) requirements, ease of assembly and access clearances for maintenance personnel.
- Selection of Fasteners from the approved list provided by HAL.
- All fasteners are to be cleared for relevant loads. Each fastener hole/axis has to be normal to surface and co-axially aligned with the adjacent parts/assembly as per design standard practice.
- All fasteners called in the assembly are to be verified for inter-rivet pitch, edge distances, head clearance, head placement (outer or inner), type, material, grip length etc as per the compendium provided by HAL.
- Creation and Mapping of Derived requirements and Validation requests to CAD Geometry and Creation of Validation reports.
- Creation of System models and Physical Architecture and establishing Trace links to the Requirements and CAD geometry.
- Preliminary weight estimation and mapping the estimated weight data information in the layout.
- Detail sizing of metallic and composite parts including skin engineering such as zonal thickness distribution, ply details, weight & stacking sequence for

composite parts.

- All composite skins to be created using Modeling module of NX for ply wise modelling and creation of ply-book.
- Test Data Sheets for composite components of Duty Class I and II.
- Commonization of Brackets, clips and parts like splice sheets in Joints, etc. in consultation with HAL (variety Reduction concepts).
- Assembly and part Numbering assigned in assembly hierarchy as per ATA numbering system provided by HAL.
- Wave linking concept to be used for Referenced bodies and it should be excluded from Reference set for reducing the file size loading time of Assemblies.
- Master geometry surfaces are not to be edited. In case of any higher issue release, the same will be communicated by HAL.
- Adjoining system equipment and its parts like cables, tubes etc. are not to be edited. In case of any updates/changes, the same will be communicated by HAL.
- Rain Water Proofing and Interchangeability concepts for removable panels like Doors, Access panels, Cowlings etc. to be considered from initial phase of design.
- The complexity level of CAD Layouts can be classified as Simple Layout, Medium Layouts and Complex Layout. Percentage distribution of these layout are envisaged in the order of 20% (Simple), 60% (Medium) and 20%(Complex). However, target should be the completion of entire Fuselage Layout for interference check and progress to the next stages of design.

5.3 Detailed Analysis and Reports (D3)

- Finite Element (FEM) Model (Preliminary, detailed and sub-modelling)
- FEM is to be verified for its correctness as per global practices.
- FE Analysis (FEA) of primary structure, components, sub-assemblies and assemblies of H/C structure (Refer ANNEXURE -II).

- Further to the above point, special focus on FEA of hard points and ensure structural integrity.
- Sub modelling and FEA checks as per the best practices for sizing of the components considering various boundary conditions and establish margin of safety.
- The structure weight targets of parts and assemblies specified during D1 phase to be met. Proposal for further reduction in weight to be submitted. Best optimisation practices to be adopted.
- The stress analysis shall cover static, fatigue, crash and damage tolerance requirements specified by DEFSTAN00-970/FAR 29 amdt.59/ CS29 and associated Advisory Circulars. The simulation results are to be supported by hand calculations / industry standard analytical procedures, as applicable.
- Prepare stress reports in RWRDC/Global best practices for the detail design phase for CDR. Format will be mutually agreed by RWRDC and Service provider.
- Prepare reports of FEM for Stress analysis indicating number of elements, Type of elements used, Sectional details and Materials to be mentioned.
- Develop full airframe FE model including the LRUs idealized by lumped masses and inertia at their CG location to carry out dynamic analysis.
- Develop Detailed FE models (DFEM) of separate airframe modules to carry out dynamic analysis as listed in ANNEXURE -II SECTION E
- Engineering service provider should submit the FE model with detailed report of input file for carrying out the Dynamic analysis by HAL subsequently.
- Prepare Dynamic FE model reports of the full airframe and for major assemblies/installations in RWRDC format. The reports should include: detail modelling approach, idealisation considered, Material properties of metallic and composite materials, component dimensions and locations, sectional properties, mass, CG and Inertia details of LRUs/components idealized by concentrated masses.
- Documentation Support to Test plan for certification.
- Comprehensive Presentation material of global standards for internal, users,

certification agencies and CDR Review

- The complexity level of FEM and FEA can be classified as Basic, Intermediate and Advanced. Percentage distribution of these analysis are envisaged in the order of 20% (Basic), 60% (Intermediate) and 20% (Advanced). However, target should be the completion of entire Airframe Analysis and progress to the next stages of design.

All design issues are to be resolved concurrently as the Engineering Service Provider progresses and completes activities listed in D1, D2 and D3. After acceptance of 3D CAD detail design and layout for Interface Arrangement by HAL, the Engineering Service Provider can proceed with generation of detailed 3D CAD Models with MBD, 2D part drawings, DRN, BOM, Loft etc.

The 3D CAD Layout for Interface Arrangement to contain the assembled views of ribs or frames along with skins, stringers, access doors, brackets, clips, system interface components with major dimensions embedded in CAD Model itself.
The purpose of Interface arrangement 3D CAD Layout is for checking the assembly clearances between a) the parts b) parts and fasteners and c) Airframe and other LRUs.

The same layout will be used for planning the Jig Design and subsequent manufacturing activities. Review of this Interface Clearance arrangement Layout is from the start of the project on a weekly basis. This activity should be completed before CDR to facilitate the release of part drawings after CDR.
All the stress reports and design documents to be complied to relevant standards (FAR/DEFSTAN etc) in co-ordination with Airworthiness group of RWR&DC.

5.4 Detailed 3D CAD Models, MBD, Drawing and Associated Attribute forms (D4)

- Updating of CAD/FEM/FEA and all analysis reports based on CDR and configuration freeze.

- Parametric 3D CAD Models of all structural members considering the form, fit and function in the current NX Software version as that of RWRDC in metric units and in helicopter coordinate system using the seed part from PLM environment.
- Assigning material to detailed CAD Models and computing the weight and CG data for proper rolling up of data.
- Creation of Model Based Dimension in the detail design parts and assemblies as per MIL-STD-31000 (Latest Issue).
- Bill of Material (Material Schedule) in Excel format as well as it should be part of Technical Data Package (3D PDF). It should be created in RWRDC template.
- Static Snap Shot of 3D Model in Technical Data Package (3D PDF) and 2D Drawings in cgm format.
- Creation of Light Weight representation of CAD Model (.jt format) with Bounding Box information stored under same dataset.
- 2D drawings in the current version of NX by following the manuals and sample drawings provided. The part and assembly drawings shall cover all dimensions, tolerances, sealant requirements, suitable notes (including material process and finish), part markings, weight, EBOM, curing cycle, Test Data sheet reference etc.
- Mapping of Derived requirements and Validation requests to Detailed CAD Geometry and Creation of Validation reports and establishing trace links with System Models and Physical architecture models.
- Part numbering as per the ATA scheme provided by HAL.
- 2D Development View (Loft) for sheet metal parts generated using respective NX Module with creation of static snap shot in cgm format.
- Tolerances stack up analysis report for assemblies.
- Creation of Exploded view and Assembly sequence for all major assemblies.
- Applying unit effectivity and filling attributes specific to part and applicability in relevant Teamcenter forms.
- Preparation of Drawing Release Note in RWRDC format and attaching under

the item revision as a separate dataset.

- Creation of Weight & CG report with station wise weight distribution.
- 3D part and 2D drawings are to be linked with current NX software version.
- Trace linking of all the technical queries with its responses.
- Deviation notes (if any) with detail description.
- Design iterations / new inputs envisaged during this phase is estimated to be in an order of approximately up to 50% with respect to D2 and D3 deliverables. Engineering service provider should cater for amending the deliverables as part of D2 &D3.
- Updating CAD / FEM / FEA and Drawings to address the Manufacturing / assembly issues arising before the release of last drawing.
- Completion of pending stress analysis and report works if any.
- Modification to Design and Analysis Reports based on the feedback on submitted reports for acceptance of certification agencies.
- Preparation of FEM, FEA and Test orders for ground test of structural components (Refer. ANNEXURE -II) as per test plan.

- The complexity level of detail CAD models can be classified as a percentage distribution of equivalent drawing sheet size which is indicative and varies from A4 to A0 as follows. A4 – 20%, A3-30%, A2- 20%, A1- 15% and A0 15%. However, target should be the completion of entire Airframe detail design for manufacturing, assembly, Integration and testing. The percentage distribution of drawing size will be based on mutual agreement between HAL and Engineering service Provider.

5.4.1 Standard practices to be adhered

- Sketches used for modelling should be defined in ‘fully constrained’ condition and Layer settings as that of RWRDC to be followed.
- Check for suppressed feature, unused sketches and unwanted parasolids in the CAD model and remove these features unless it is retained for future

use.

- For each 3D CAD geometry of component, “Model” and “Solid” reference set (containing required bodies only) and for each assembly CAD file “Assembly”, “Model” and “Solid” reference set (containing required components and Parasolid bodies) to be created for ease of assembly.
- Wherever drawing calls for LH shown, RH opposite, model to be made for both LH & RH part with parameters. There should not be any connectivity (feature wise) between LH & RH part.
- Use of Assembly mirror option for mirror part or mirror body option is not acceptable.
- Use Analysis- Examine Geometry to check for tiny/misaligned objects, intersections/sheet boundaries/tolerances.
- Do run the Edit-Feature–Playback Option to know update failure of features of part file.
- Check for the correct material/Density has been selected for modelling – as per the Material specification.
- Use of Boolean operations should be avoided as much as possible, except unavoidable.

5.5 Engineering Change Management (D5)

The work package also includes the engineering change management from the Engineering Service Provider to update CAD and FE models, drawings, BOM, DAL resulting due to manufacturing / design issues during component manufacturing and assembly (non – conformity support), New or Change in inputs from Cross functional design groups, Inputs from Jig Fixture Design (to resolve interface issues with tool design team of HAL) ground test (to resolve design issues of component) and flight test (non – conformity support). Preparation of ground test synthesis reports for structural components (refer ANNEXURE -II).

During manufacturing and assembly, Design improvement and revisions are expected mainly on 3D models, Drawings, and Documents. It is to be noted that total number of drawings that undergoes changes depends on the number of Engineering change requests raised on the deliverables of D2 to D4. These are broadly classified as resolution for (i) Design Change Requests (ii) Production Queries (PQ) & Shop Queries (SQ) (iii) Snags (iv) Material Substitution Requests (MSR) etc. The support team should bring in the execution knowledge of the previous milestones and update the Models, Drawings, Analysis and other supporting documents.

Additional requirements from users, associated system groups, new design requirements to be considered during this phase. The classification of complexity level of detail CAD models and equivalent drawing sheet size to be considered as mentioned in D4.

It is to be noted that sufficient manpower to be accounted for carrying out the activities during this phase for the number of changes that can come over the completed design during the previous milestones. However, based on experience from previous projects, it is assumed that around 40% of peak man-hour requirement during D2 to D4 phase should be deployed during the initial period of D5 phase. It is estimated that an approximate 40% of drawings that is finalised during D4 stage will undergo changes. It includes efforts needed for making 3D Models, drawings and its associated analysis and documentations. Here, It should be noted that, the Design changes, New inputs, PQ's, Snags, testing inputs, synthesis of ground test and design support to fabrication activities are to be considered as part of activities during D5

6 Software Tools to be used for Execution

The following Software will be provided for the activities mentioned

Table 1: Software

Sl. No	Software	Major Activities
1	Teamcenter 12.4 & above (match with the versions being used by RWRDC)	PLM, System Modelling, Requirement Mapping, Attribute Forms etc.
2	NX 1926 & above (match with the versions being used by RWRDC)	Modelling with MBD, Drawing, Loft, Sequence, Explosion, Requirement Validation etc.
3	Hyper-works, MSC Patran	FEA Pre/Post Processor
4	MSC NASTRAN HyperWorks (Optistruct), LS-DYNA Abaqus, MSC Adams.	FEA (Solvers)
5	HyperWorks (Optistruct) MSC NASTRAN (embedded Fatigue) / FRANC 3D / NASGRO	F&DT Analysis
6	MS Office 2021 or latest Word, Excel, PowerPoint. Adobe Acrobat Reader, etc.	Documentation

Note: Any additional software required apart from above list for completion of work package, will be at the discretion of HAL.

7 Deliverables

The Deliverables for work package are as below:

Table 2: Deliverables

Miles tone	Deliverables	Delivery Format
1	**Primary Analysis and Methodology documents as indicated in para 5.1 (D1)**	
	Methodology of FE modelling for stress analysis of full airframe and detailed airframe modules.	Word Document in RWRDC template(.docx)
	Estimation methodology for structural component loads from FEM analysis including extraction of loads for sub modelling.	Word Document in RWRDC template(.docx)
	Analytical Methods (SOM) for stress Calculations	Word Document in RWRDC template(.docx)
	Validation and verification Methodology Report for FEM & FEA	Word Document in RWRDC template(.docx)
	Static, Fatigue, Crash and Damage analysis methodology documentations	Word Document in RWRDC template(.docx)
	FE modelling Methodology for Dynamic analysis	Word Document in RWRDC template(.docx)
	Technical Report formats (e.g.: Stress reports, Test Reports, Test Orders etc.)	Word Document in RWRDC template(.docx)
	Presentation material for Reviews	Microsoft Power Point (.pptx)
2	**3D CAD Layout for interference and integration Check as indicated in para 5.2 (D2)**	

Miles tone	Deliverables	Delivery Format
	3D CAD Layout for Interface Arrangement	NX (.prt)
	Primary Weight Estimation	Excel (.xlsx)
	Material Stock Size approximation with form classification	Excel (.xlsx)
	Initial System Model and Physical Mechanical architecture	Teamcenter
	Presentation material for Reviews	Microsoft Power Point (.pptx)
	Detailed Analysis as indicated in para 5.3 (D3)	
	Validation Report for FEM & FEA	Word Document in RWRDC template(.docx)
	For Stress Analysis: All FEM, FEA and analysis results including full airframe static model and input files towards finalization of detail drawings	Hypermesh , Patran FE Models (*.hm,*.db), Input data in NASTRAN , Optistruct and LS-DYNA format, Abaqus, NASGRO and FRANC 3D files (*.DAT / *.BDF/*.FEM/*.key,etc) and output data in MSC NASTRAN Optistruct and LS-DYNA format (*.F06, *.PCH, *.OP2, H3D,*.d3plot) etc.
	For Dynamic analysis: DFEM / local FE models (Refer ANNEXURE -II). Full airframe dynamic FE model (input files)	Hypermesh FE Models (*.HM), Input data in NASTRAN format (*.DAT / *.BDF) and output data in MSC NASTRAN format (*.F06, *.PCH, *.OP2, H3D).
	Dynamic and stress FEM reports as per	Soft copy of Word Documents

Miles tone	Deliverables	Delivery Format
	the scope of this work package containing respective assembly / parts / attachments. The FEM should include meshed model with material properties, component dimensions and locations, sectional properties, mass, CG and Inertia details of LRUs.	in RWRDC template and 2 sets of printed copy of the report
	Technical Reports as per the scope of this work package containing respective assembly / parts / attachments. (eg: Stress Reports, Test Orders etc.)	Soft copy of Word Documents in RWRDC template and 2 sets of printed copy of the report
	List of all associated FE reports, stress analysis reports, Dynamic FEM reports and the corresponding FE models and CAD Assembly/parts used.	Word Document in RWRDC template(.docx)
	Presentation material for Reviews	Microsoft Power Point (.pptx)
3	**Detailed 3D CAD Models, MBD, Drawing and Associated Attribute forms as indicated in para 5.4 (D4)**	
	3D parametric CAD models of parts in PLM	NX (.prt) / Teamcenter
	3D CAD Models of Assemblies with tree structure	NX (.prt) / Teamcenter
	Model Based Dimensions of each part	NX (.prt)
	2D Drawings of Parts and Assemblies	NX (.prt)
	Static Snap Shot of 3D Model in Technical Data Package (3D PDF)	NX (.pdf)

Miles tone	Deliverables	Delivery Format
	Static Snap shot of 2D Drawings	NX (.cgm)
	Light Weight representation of CAD Model with Bounding Box information	NX (.jt)
	Bill of Material / material schedule as per tree structure in RWRDC Template	Excel (.xlsx) /NX(.prt) / 3D PDF (.pdf)
	Installation drawings for each system assembly	NX (.prt)
	2D Development of Sheet Metal parts	NX (.prt)
	Tolerance Stack up Analysis reports	Word Document (.docx) / NX(.prt)
	Assembly Sequence for all major assemblies	NX (.prt) / Power point (.pptx)
	Unit Effectivity as per Drawing Applicability list	Teamcenter form
	Part Attributes and Applicability info	Teamcenter form
	Drawing Release Notice (DRN)	Excel (.xlsx) / Teamcenter
	Deviation slip/ Project Slip (PS) / Deviation notes or Equivalent documents as per PLM	Excel (.xlsx), NX(.prt) / Teamcenter
	Standard Of Preparation (SOP) for Airframe	Word Document (.docx) / Excel (.xlsx)
	Drawing Applicability List (DAL) Document	Word Document (.docx)
	Weight and C.G. reports with Station wise weight distribution	Word Document (.docx) / Excel (.xlsx)
	Macros / Automation files / knowledge fusion files	Excel / .exe / NX files / as applicable

Miles tone	Deliverables	Delivery Format
	Finalised FE model and Stress analysis reports, Test orders and Dynamic FEM reports as per the scope of this work package containing respective assembly / parts / attachments.	FEM in applicable formats, Soft copy of Word Documents in RWRDC template and upto5 sets of printed copy of the report
	Presentation material for Reviews	Microsoft Power Point (.pptx)
4	**Engineering Change Management (D5)**	
	Resolutions of PQs, Snags, Deviation Slips and Repair Slips during manufacturing and assembly of prototypes. Updating of drawings, 3D CAD Models, FEM, FEA, Stress Reports etc	FE model, Stress analysis reports, Dynamic FEM reports, NX Models with PMI, and Drawings for affected parts and assemblies in applicable formats Teamcenter (forms)
	Based on the inputs from design, manufacturing, ground tests, flight tests, user and certification requirements updating of drawings, 3D CAD Models, FEM, FEA, Stress Reports etc.	FE model, Stress analysis reports, Dynamic FEM reports, NX Models with PMI, and Drawings for affected parts and assemblies in applicable formats, Teamcenter (forms)
	Updated Technical Reports as per the scope of this work package containing respective assembly / parts / attachments. (eg: Synthesis Report, Stress Reports, Test Orders etc.)	Soft copy of Word Documents in RWRDC template and 2 sets of printed copy of the report
	Updated SOP & DAL	Word Document (.docx) / Excel (.xlsx)

Miles tone	Deliverables	Delivery Format
	Presentation material for Reviews	Microsoft Power Point (.pptx)

All deliverables & communication shall be in English.

8 Schedule for Airframe Work Package for DBMRH

The representative schedule for each module of the Work Package is indicated as below:

Table 3: Schedule for work packages

Sl. No	Deliverable\ Module	**Milestone 1**	**Milestone 2**	**Milestone 3**	**Milestone 4**
		Requirement Capture and Methodology (Deliverable D1)	Detail Layout and Analysis (Deliverable D2+D3)	Detailed CAD Models + MBD+DWG (Deliverable D4)	Engineering Change Management (Deliverable D5)
1	Front Fuselage - DBMRH	T0 + 2 (=T1)	T1 + 8 (=T2)	T2 + 12 (=T3)	T3 + 30
2	Centre Fuselage - DBMRH	T0 + 2 (=T1)	T1 + 8 (=T2)	T2 + 12 (=T3)	T3 + 30
3	Tail Boom& Empennage - DBMRH	T0 + 2 (=T1)	T1 + 8 (=T2)	T2 + 12 (=T3)	T3 + 30
4	Weapon Suspension System - DBMRH	T0 + 2 (=T1)	T1 + 8 (=T2)	T2 + 12 (=T3)	T3 + 30
5	Cowlings& Firewalls - DBMRH	T0 + 2 (=T1)	T1 + 8 (=T2)	T2 + 12 (=T3)	T3 + 30

Note: The Numbers indicated in the above table are in months

T0 is the placement of Purchase Order (PO) and signing of contract with the successful Engineering Service Provider.

Engineering Service provider should submit a tentative plan for executing the tasks with intermediate milestones.

9 Project Review & Schedule

Reviews like Detail Design Review, Requirement Capture Review, Critical Design Review and Technical Progress Reviews shall be conducted. The support of engineering service provider is envisaged during Ground Tests and Flight Readiness Reviews.

Regular Design / Analysis Progress Reviews are mandated between Design co-ordination team and Service provider co-ordination team for all design reviews and clarifications. Project monitoring Team review has to ensure that the activities are progressing satisfactorily and are being performed in required manner. The Engineering service provider shall update the deliverables based on the feedback at all stages of project schedule as and when required. Project reviews & schedules are as shown below.

Table 4: Schedule for reviews

Sl. No.	Description	Time Period
1	Design / Analysis Progress reviews	Once a Week
2	Design Technical meeting	Need basis
3	Project Management Review	Monthly
4	Management review	Quarterly

10 Quality of Deliverables

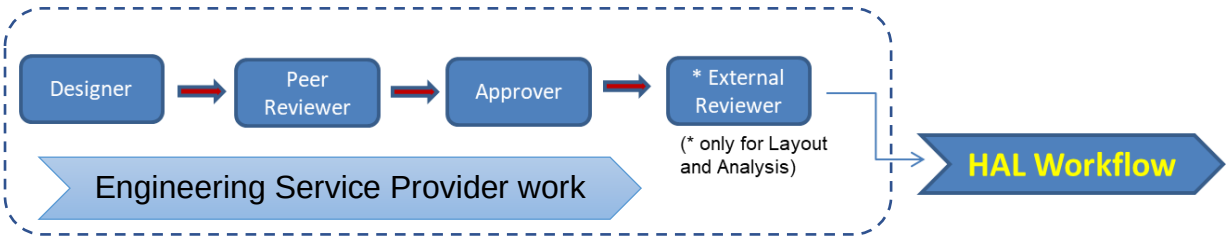
As the timely delivery of reports, drawings and models is critical to the program, the Engineering Service Provider should set up Internal Design quality Check team with Subject Matter Experts for ensuring their correctness and completeness.

Product Quality Targets:

In order to reduce iterations and improve the quality of deliverables, it is desirable to meet the following quality targets for First Time Right (FTR) by the Engineering Service Provider:

3D Design Layouts (D2)	: > 85%
FE Modeling and Analysis (D3)	: > 98%
Technical content of stress and dynamics reports(D3)	: > 98%
Part and assembly models and drawings(D4)	: > 95%

A Schematic representation of workflow proposed for Layout, Detail Drawing and Analysis that to be followed by Engineering Service Provider before delivering to HAL is as shown below:



11 Acceptance of Design

Design work is carried out with continuous interactions with Engineering service provider and HAL. Approvals required at various stages of design and it would be mandatory to have acceptance of final design data (Drawings, CAD models, FE Models, Analysis, Reports etc) as mentioned in deliverables for D1 to D5. Design committee nominated by HAL Management will be the approving authority for Design data submitted by Engineering service provider. Following stages would be considered for acceptance of design:

a) Confirmation and Acceptance on inputs from various cross functional Design and Analysis groups based on the Helicopter Level PDR.

b) Approval of Detail Design Layouts and Analysis by RWRDC for progressing with manufacturing drawings/details.

c) Acceptance of Drawings and Analysis reports for release of SOP.

d) Acceptance of mandatory design changes based on feedback from other cross functional teams.

12 General Conditions on Work place

The Engineering Service Provider should execute this work package in HAL premises. The Engineering Service Provider should also place adequate number of Engineers for Design, Analysis and co-ordination purpose on day-to-day basis at HAL premises. HAL would provide work place and other basic facilities at its premises for the Design and co-ordination team.

Engineers of Service Provider placed for Design, Analysis and coordination would have to follow the work timings, rules and regulations of HAL. If Subject matter expert is of foreign origin, it is required to follow the prevailing procedures of HAL for security clearances

The Engineering Service Provider is not permitted to bring and use any laptops/ PCs / or any other electronic gadgets inside the HAL work premises. The Service Provider shall not make any attempt directly or through its resources to keep a copy of the Design work being carried out at HAL campus or at Vendor Premises for this work package. Similarly, the Service Provider shall not attempt to transfer / transmit /copy / print / hand sketches or take backup of any file, document or any other type of Design information in to any type of storage device. The Design Intellectual Property of work carried out as part of this work package will be exclusively with HAL only. Refer ANNEXURE -III for expected IT security policies that to be adopted.

To execute the work package, the following IT facilities will be provided by RWRDC, HAL for the engineers posted at HAL campus

a) Desktop Computers / CAD Workstations with MS Office for individual engineers.
b) Design Software Tools / Analysis Software Tools as per Table-1 installed in the Desktop Computers/ CAD Workstations
c) Scanning /Printing Facility.

Engineers who will be assigned to execute the work package should have adequate experience in the relevant field as defined in Para 4. The Engineers deputed by the Design Partner for this work package need to go through a verification procedure. The Engineering service provider shall submit the Bio-Data of the Engineers to be deployed for verification and approval by HAL after award of CONTRACT. The deputed Engineers would be required to execute the assigned job independently. The Engineers deputed by Engineering Service Provider should possess hands-on experience as no separate training will be provided by HAL.

The Engineering service Provider shall have a HR Policy to retain the deputed Engineers for the said CONTRACT period. This is very essential since attrition results in inordinate delays in delivery schedule and lead to uncertainty in contract execution.

In case, any Employee positioned at site by Engineering service provider are found unsatisfactory with respect to performance and or Interaction/Compliance to HAL requirements/Policies, HAL reserves the right to send back the Employee with suitable replacement by Engineering Service Provider.

13 Procedure for Review of the Engineering services

HAL will constitute Project Technical Monitoring Committee (PTMC) for each Work Package as specified in section 5 of this document. This committee will consist the domain experts from within HAL and other organization at the discretion of HAL Management.

The Engineering Service provider is expected to provide the deliverables as specified in section 7 of this document to the single point contact identified by HAL against Work Package in section 7. The PTMC's set up against Work Package will review the deliverables. The recommendations of the PTMC's should be incorporated in the final version of the deliverables.

The deliverable is deemed to be complete only after PTMC accepts the same. Payment shall be linked to successful completion of delivery milestones.

14 Delay in Input / Output

Any delay in providing inputs by HAL because of technical/non-technical reasons beyond a week time and causing the halt of design process to be recorded and duly coordinated by both agencies to review the matter for meeting the time schedules. Delays affecting time schedule, cost and grey areas if any (with respect to non-availability of technical details) will be referred to Project Technical Monitoring Committee (PTMC).

Delay in output (deliverables) beyond the reasons mentioned here would be subject to penalty clause as per the commercial contract

15 Engagement of Third-party services

The Engineering service provider shall not subcontract this work package in part or full. However, the Engineering service provider can engage the third-party services of consultants or consultancy firms. The Engineering service provider should take prior approval for such engagements and the area of consultancy of third-party services with regard to the work package from HAL.

16 Program Manager

Engineering Service Provider shall appoint a program manager for managing the entire program of DBMRH Airframe Design and Analysis. The program manager will be the single point contact for all communications between HAL and Engineering Service Provider. The Program Manager will coordinate all technical disciplines associated with this program and will assure the performance of Supplier tasks in accordance with the program needs according to the statement of work.

ANNEXURE -I

Three View Diagram and ISO View of DBMRH

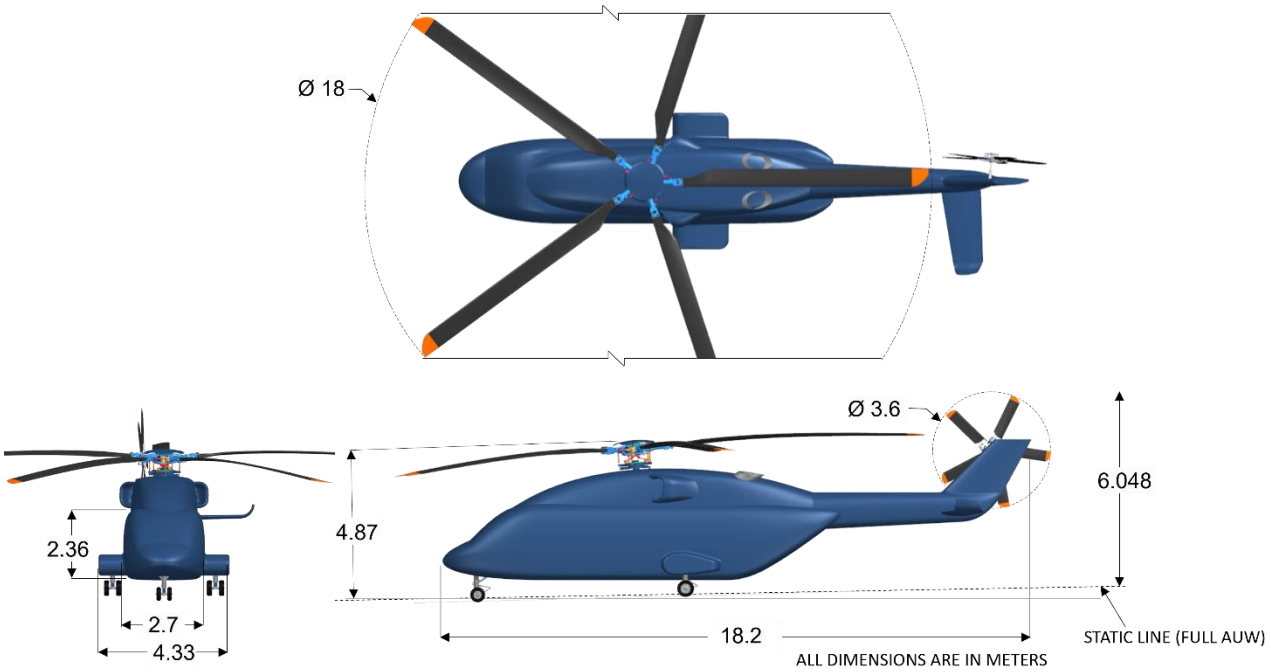


Figure 1 : Three View Diagram of DBMRH

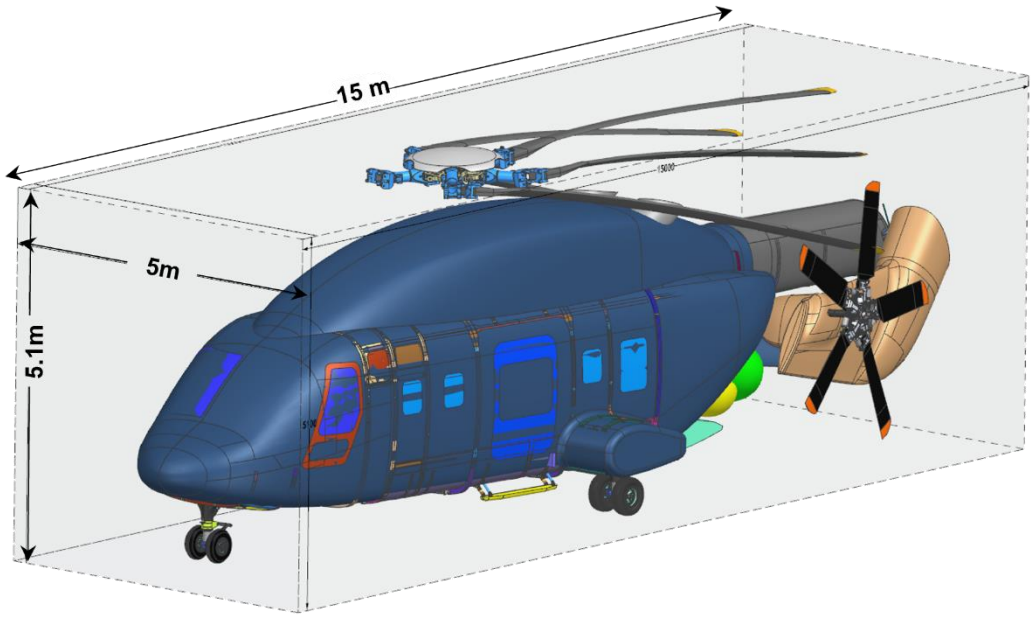


Figure 2: ISO VIEW of DBMRH in folded condition

ANNEXURE -II

FEM & FE Analysis requirements

A. List of FEM and FEA requirements for stress analysis of Airframe:

SL. No	**Components**
1	Full airframe FE model development /analysis (Inertia relief)
2	Sub assembly of Cockpit, Transmission Deck, Engine Deck, Centre Fuselage, Tail Boom (Folding) & Empennage, Rear Fuselage, Roof Deck Structure etc.
3	Bottom structure with floor board for all mass items- fuel load, internal/external cargo load, Landing Gear (LG) load, armament load etc.
4	Critical Frames analysis, sub modelling and analysis, buckling analysis of frames, panels, beams etc.
5	Doors and Ramp analysis
6	Cowlings, Fairings, Access covers, Steps and Maintenance platforms
7	GTV FEM analysis for anchoring
8	Airframe Fatigue life analysis
9	Damage tolerance analysis of critical airframe locations - LG, LG support structures, tail boom, gear boxes support structures, engine mounts, engine mount support structures etc as per FAR
10	Airframe crash analysis
11	Bird strike Analysis

B. List of hard points for FEM & FEA (stress analysis):

SL. No.	**DBMRH Hard Points**
1	Main Landing Gear structural attachment
2	Nose Landing Gear Structural Attachment
3	Transmission deck
4	TGB & IGB Support Structures
5	Engine mounts and Engine deck
6	Tail Boom and attachments
7	Horizontal Stabilizer (HSB) and its Attachments
8	Vertical fin and Attachments

SL. No.	**DBMRH Hard Points**
9	Helicopter lifting points
10	Rescue Hoist
11	Slithering Beam
12	Weapon stub wing and structural attachments
13	External Cargo Hook Attachment
14	Mooring Points
15	Jacking Points
16	Steps
17	Hard point for External Ladder
18	Internal Cargo on Floor Board
19	Engine maintenance Platform
20	MGB maintenance Platform
21	Ramp
22	Engine Lifting crane Points provision
23	Support Structure for Wheel Brake system LRUs, Nose wheel Lock cable attachments, Parking Brake cable attachments.
24	Lashing point and Tail Guard.
25	Emergency Floating Gears
26	Fuel tank support structure
27	Gun attachment provision (floor mount gun 2(12.7mm) +4 (7.62mm) = 6)
28	Ammunition Box attachment Structure provisions
29	FCS components attachment Structure Provisions (Static displacement evaluation)
30	Seats support Structures (all designated roles)
31	Equipment Panels
32	Armour Panels installation Provisions
33	Actuator attachments (Static displacement evaluation)
34	Tail Guard and Supporting structures
35	Tail Drive Shaft Support Structure
36	Support structure for Flare and chaffs dispenser

SL. No.	**DBMRH Hard Points**
37	Stretchers provision structures
38	Auxiliary power unit (APU) structural mounts
39	Ship deck harnessing (ASIST)
40	Miscellaneous Structural provisions (Antennas, LRUs etc)
41	AVCS actuator mounting provisions

Note: Analysis as per FAR 29 amdt. 59 / DEFSTAN 00-970/CS 29 amdt. 8

C. Documentation:

Preparation and Submission of stress reports for the analyses listed in Table A & B and including below listed:

SL. No.	**Stress Reports**
1	Documentation Support to Test plan for certification
2	All Frames, Beams, Longerons, Stiffeners etc.
3	Shells for front, Mid, top, bottom fuselages
4	Tail cone
5	Floor board of Cockpit, Cabin and Ramp
6	Ammunition box support structures
7	Keel and support beams
8	Equipment Panels supports
9	FCS Component structural attachments
10	Miscellaneous

D. FEM, FEA, Test Orders & Synthesis reports related to Ground Tests:

SL. No.	**Preparation Testing documents, FEM and FEA**
1	Break Away Fuselage test
2	Tail boom test (Static + Fatigue)
3	Vertical fin Test (Static + Fatigue)
4	Horizontal Stabilizer Test (Static + Fatigue)
5	Transmission Deck (Static + Fatigue)
6	Engine mounts (Static + Fatigue)
7	Rescue hoist (Static + Fatigue)

SL. No.	**Preparation Testing documents, FEM and FEA**
8	Slithering boom (Static + Fatigue)
9	Cargo Attachment (Static + Fatigue)
10	Helicopter Lifting sling & H/c support bracket
11	Lashing ropes
12	Ramp test
13	Mooring Points
14	Lashing rings
15	Engine field removal crane
16	Jacking points
18	Bird Strike
19	Ground Test Vehicle
20	ASIST Installation in Bottom structure.

E. List of FE models required for Dynamic analysis:

SL. No.	**Component/Module**	**Remarks**
1	Full airframe model	Global model
1	Cockpit and nose	DFEM
2	Mid fuselage	
3	Tail-boom with folding mechanism	
4	Transmission deck	
5	Engine deck	
6	Doors and ramp	
7	Horizontal stabiliser and Vertical fin	
8	LRU racks and instrument panels	
9	Weapon stub wing	
10	Armour panels	
11	MGB and engine cowlings and firewalls	

Note: All Tables mentioned above are indicative and is subjected to change as design phase progresses

ANNEXURE -III

IT Security policies

- Any requirement of resource allocation / de-allocation, User ID creation / deletion, Application Access, Access Control List, etc should be submitted to HAL for creation, updation and deletion.
- Police verification should be undertaken for the vendor engineers selected for HAL Project and to be submitted to RWRDC, HAL for issuing ID cards and authorization to work, prior to starting of the work.
- Highest level of integrity shall be possessed by vendor engineers/staff who are working in HAL project, which belongs to Ministry of Defence, Govt of India and strictly not to disclose any minute details or information or data of the HAL project to outside agencies, family members, friends, relatives, social media, over internet, mails, chats, Land line phone, internet groups, print & visual media etc.,
- While working inside HAL premises, bringing Internet Dongles, USB storage devices, WIFI devices, camera's, smart phones, smart watches, pen drive, external storage devices, SSD devices, microphones, card readers, micro cameras, Go-pro cameras, listeners etc. copying and taking out of manuals, documents, printouts etc., are strictly prohibited
- All the vendor staff working for HAL project shall sign the IT security undertaking as per the format provided by HAL
- A Non-Disclosure Agreement (NDA) shall be signed by the vendor with HAL as per the format provided by HAL, for keeping the confidentiality of the work being carried-out in HAL premises, by vendor and vendor's engineers/staff/representatives.