

PROJECT GANTT SCHEDULE & RESOURCE ALLOCATION

Hybrid Digital Twin for Aero Gas Turbine Engine Health Usage Monitoring System

36-Month Timeline with Weekly Detail (First 8 Weeks) and Monthly Thereafter

SECTION 1: PROJECT OVERVIEW & KEY DATES

Parameter	Value
Project Start Date	Month 0, Week 1 (Day 1)
Project End Date	Month 36, Week 156 (Day 1,092)
Total Project Duration	36 months (156 weeks, 1,092 days)
Number of Phases	5 milestones (MS-1 to MS-5)
Reporting Cadence	Weekly (Weeks 1-8), Monthly (Weeks 9-156)
Review Gates	PDR (W26), CDR (W52), SIR (W78), ATP (W130), Completion (W156)

SECTION 2: MILESTONE SCHEDULE & PAYMENT GATES

Milestone	Phase	Start (Week)	End (Week)	Duration	Target Delivery	Payment Gate	Cumulative %
MS-1	PDR	1	26	6 months	SRD, PDD approved, tech survey complete	20% (₹3.00 Cr)	20%
MS-2	Detailed Design	27	52	6 months	SDD, DDD approved, design review complete	20% (₹3.00 Cr)	40%
MS-3	Prototype & CDR	53	78	6 months	CDD approved, prototype code, V&V reports	20% (₹3.00 Cr)	60%
MS-4	Production & ATP	79	130	12 months	ATP executed, acceptance reports, user manual	20% (₹3.00 Cr)	80%
MS-5	Completion & ToT	131	156	6 months	Full documentation, ToT executed, IPR shared	20% (₹3.00 Cr)	100%

SECTION 3: DETAILED WORK BREAKDOWN STRUCTURE (WBS) - MS-1 (WEEKS 1-26)

Phase: Preliminary Design Review (PDR) - 0 to 6 Months

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
1.1	Project Initiation & Governance	1	4	4	M0	M0.5	Project Manager	Program Coordinator	2	-
1.2	Requirement Elicitation & Clarification	5	10	6	M1.2	M2.4	Systems Engineer	PM, DRDO Liaison	4	1.1
1.3	System Requirements Document (SRD)	11	18	8	M2.6	M4.3	Systems Engineer	PM, QA Lead	5	1.2
1.4	Technology Survey & Critical Tech Identification	6	17	12	M1.4	M4.1	Lead ML/AI Scientist	Lead Thermo Eng, Academics	8	1.1

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
1.5	High-Level DT Framework & Architecture	15	22	8	M3.6	M5.3	Software Architect	Systems Eng, Lead Roles	6	1.4
1.6	PDD Finalization & PDR Approval	19	26	8	M4.6	M6.3	Project Manager	Systems Eng, All Leads	4	1.3, 1.5

MS-1 Summary: 26 weeks, 29 person-months effort, 6 core tasks, 50+ review meetings with DRDO.

SECTION 4: DETAILED WBS - MS-2 (WEEKS 27-52)

Phase: Detailed Design & Engineering Prototype Definition - 6 to 12 Months

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
2.1	Feasibility & Modeling Strategy per Component	27	32	6	M6.0	M7.7	Lead Thermo Eng	Lead ML Sci, Systems Eng	8	1.6
2.2	Detailed Design of 17 DT Blocks	33	48	16	M7.9	M11.5	Lead Thermo Eng	Lead ML Sci, Data Eng	20	2.1
2.3	Data Strategy & Pre-processing Design	27	38	12	M6.0	M9.1	Data Engineer	Lead ML Sci, QA Lead	10	1.6
2.4	Integrated System Design (17 DT Blocks)	39	48	10	M9.3	M11.5	Software Architect	Systems Eng, Lead Thermo	12	2.2
2.5	Hardware & Platform Definition	35	42	8	M8.3	M10.0	Systems Engineer	Software Arch, QA Lead	6	2.1
2.6	SDD/DDD Finalization & Design Review	45	52	8	M10.7	M12.4	Systems Engineer	PM, All Technical Leads	6	2.2, 2.4, 2.5

MS-2 Summary: 26 weeks, 62 person-months effort, 6 major tasks, BOM finalized, detailed designs frozen.

SECTION 5: DETAILED WBS - MS-3 (WEEKS 53-78)

Phase: Prototype Development & Critical Design Review - 12 to 18 Months

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
3.1	Prototype Implementation of DT Blocks	53	66	14	M12.5	M15.7	Lead Thermo Eng	Lead ML Sci, Soft Arch, JE	24	2.6
3.2	Data Handling, Training & Validation	53	68	16	M12.5	M16.2	Data Engineer	Lead ML Sci, Lead Thermo	18	2.3

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
3.3	Integrated DT Prototype Assembly	63	72	10	M15.0	M17.1	Software Architect	Lead Thermo Eng, Soft Eng	14	3.1
3.4	Performance Regime Clustering & Tuning	65	72	8	M15.5	M17.1	Lead ML/AI Scientist	Data Engineer, Lead Thermo	10	3.2
3.5	Prototype Testing & Validation (Offline/Online)	67	76	10	M16.0	M18.0	QA Lead	Lead Thermo Eng, QA Team	12	3.3, 3.4
3.6	QA & Process Documentation	70	75	6	M16.7	M17.9	QA Lead	PM, Technical Writers	8	3.5
3.7	CDD & Critical Design Review (CDR)	73	78	6	M17.4	M18.5	Systems Engineer	PM, All Leads	6	3.6

MS-3 Summary: 26 weeks, 92 person-months effort, 7 major implementation tasks, prototype integrated and validated.

SECTION 6: DETAILED WBS - MS-4 (WEEKS 79-130)

Phase: Production & Supply, ATP Execution - 18 to 30 Months

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
4.1	Hardware Procurement & Setup	79	90	12	M18.5	M21.2	Systems Engineer	Soft Arch, Admin, Vendors	8	3.7
4.2	Production Software Hardening	85	100	16	M20.2	M23.7	Software Architect	GUI Dev, Soft Eng, QA	18	3.7
4.3	Hardware & Software Integration	99	110	12	M23.5	M26.1	Software Architect	Systems Eng, Soft Team	14	4.1, 4.2
4.4	ATP Procedure & Execution	109	124	16	M26.0	M29.4	QA Lead	PM, All Teams, DRDO	16	4.3
4.5	On-Site Model Training & Validation	95	114	20	M22.6	M27.1	Lead ML/AI Scientist	Data Eng, Lead Thermo, JE	22	4.2
4.6	Acceptance Reports & Final Sign-off	125	130	6	M29.6	M30.8	QA Lead	PM, Systems Eng	4	4.4, 4.5

MS-4 Summary: 52 weeks, 82 person-months effort, 6 production/validation tasks, on-site DRDO deployment and ATP.

SECTION 7: DETAILED WBS - MS-5 (WEEKS 131-156)

Phase: Documentation, ToT & Project Closure - 30 to 36 Months

WBS ID	Task Name	Start Week	End Week	Duration (Weeks)	Start Month	End Month	Lead Role	Supporting Roles	Effort (PM)	Dependency
5.1	Final Documentation Set	131	142	12	M31.0	M33.5	Project Manager	Tech Writers, All Leads	8	4.6
5.2	Production & Delivery of Final Units	131	140	10	M31.0	M33.1	Software Architect	Systems Eng, QA, Admin	10	4.6
5.3	Transfer of Technology (ToT)	141	150	10	M33.3	M35.5	Lead Thermo Eng	Lead ML Sci, All Leads	12	5.1
5.4	IPR Sharing & Legal Closure	145	150	6	M34.4	M35.5	Project Manager	Legal Advisor	3	5.1
5.5	Project Success & Completion Reports	150	156	7	M35.5	M37.0	Project Manager	Systems Eng, QA Lead	5	5.3, 5.4

MS-5 Summary: 26 weeks, 38 person-months effort, 5 closure tasks, full knowledge transfer to DRDO.

SECTION 8: RESOURCE ALLOCATION & TEAM COMPOSITION

8.1 Core Project Team Roles (Full-Time & Part-Time)

Role	Count	FTE	Monthly Rate (INR)	Annual Cost (INR)	36-Month Cost (INR)	Project Span
Project Manager	1	1.0	₹3,50,000	₹42,00,000	₹1,26,00,000	36 months (Full-time)
Lead Thermodynamics Engineer	1	1.0	₹4,00,000	₹48,00,000	₹1,44,00,000	36 months (Full-time)
Lead ML/AI Scientist	1	1.0	₹4,50,000	₹54,00,000	₹1,62,00,000	36 months (Full-time)
Software Architect	1	0.8	₹3,50,000	₹33,60,000	₹1,00,80,000	30 months (80% after M24)
Data Engineer	1	1.0	₹3,00,000	₹36,00,000	₹1,08,00,000	36 months (Full-time)
GUI/UX Developer	1	0.6	₹2,50,000	₹15,00,000	₹45,00,000	18 months (from M12 onwards)
Quality Assurance Lead	1	1.0	₹2,80,000	₹33,60,000	₹1,00,80,000	36 months (Full-time)
Systems Engineer	1	0.5	₹2,80,000	₹16,80,000	₹50,40,000	12 months (part-time M0-M12)
Junior Thermodynamics Engineer	2	1.0	₹1,50,000	₹36,00,000	₹1,08,00,000	24 months (M6-M30)
ML Engineer / Research Associate	2	1.0	₹1,80,000	₹43,20,000	₹1,29,60,000	30 months (M0-M30)
Software Engineer / Developer	3	1.0	₹1,80,000	₹64,80,000	₹1,94,40,000	24 months (M12-M36)
Data Scientist / Analyst	1	1.0	₹2,00,000	₹24,00,000	₹72,00,000	18 months (M6-M24)
QA Engineer / Test Specialist	2	0.8	₹1,20,000	₹23,04,000	₹69,12,000	12 months (M18-M30)
Technical Writer	2	0.4	₹1,00,000	₹9,60,000	₹28,80,000	12 months (M24-M36)
Program Coordinator	1	0.5	₹80,000	₹4,80,000	₹14,40,000	36 months (part-time)

Role	Count	FTE	Monthly Rate (INR)	Annual Cost (INR)	36-Month Cost (INR)	Project Span
TOTAL TEAM	20	14.0 avg	-	~₹5,80,00,000	~₹4.50 Cr (36M aggregate)	-

Average Project Team Size:

- Months 0-6 (MS-1): 8 FTE
- Months 6-12 (MS-2): 12 FTE
- Months 12-18 (MS-3): 16 FTE (peak)
- Months 18-30 (MS-4): 14 FTE
- Months 30-36 (MS-5): 10 FTE

SECTION 9: ROLE-WISE TASK ALLOCATION (WHO DOES WHAT)

9.1 Project Manager Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	Governance setup, requirement coordination, PDR prep	30%	Project charter, RACI, SRD approval
MS-2	Design review coordination, schedule tracking	25%	Design review minutes, approval memos
MS-3	CDR preparation, risk monitoring, status reports	25%	CDR pack, monthly reports, risk register
MS-4	ATP coordination, hardware delivery tracking, on-site liaison	35%	ATP reports, acceptance documentation
MS-5	Documentation oversight, ToT coordination, project closeout	40%	Final docs, completion report, lessons learned

9.2 Lead Thermodynamics Engineer Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	Tech survey, DT architecture preliminary design	40%	Tech survey report, architecture sketches
MS-2	Detailed design of 9 core component models	80%	DDD with thermodynamic equations, maps
MS-3	Model implementation, validation design	80%	Source code for physics models, V&V plan
MS-4	On-site training, model tuning with DRDO data	75%	Trained models, tuning reports
MS-5	ToT training delivery, documentation review	50%	Training materials, handover package

9.3 Lead ML/AI Scientist Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	AI/ML tech survey, critical tech identification	35%	Tech survey section, ML roadmap
MS-2	Data strategy, ML model architecture design	75%	DDD with ML models, feature design
MS-3	ML model implementation, training, tuning	85%	Trained ML models, performance reports
MS-4	On-site model validation, anomaly detection tuning	80%	Validation reports, anomaly algorithms
MS-5	ToT on ML methods, documentation	60%	Training slides, algorithm documentation

9.4 Software Architect Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	Integration architecture, tool evaluation	25%	Architecture diagrams, tool recommendations
MS-2	System design for 17 DT blocks, integration plan	70%	SDD, integration specification

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-3	Prototype assembly, integration testing	80%	Integrated prototype code, test logs
MS-4	Production hardening, real-time optimization	85%	Production-grade software, performance reports
MS-5	Final software delivery, version control setup	60%	Source code handover, build documentation

9.5 Data Engineer Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	Data requirements definition	15%	Data handling plan outline
MS-2	Data pre-processing pipeline design	65%	Data schemas, ETL specifications
MS-3	Data pipeline implementation, feature extraction	85%	Automated pipelines, feature repositories
MS-4	On-site data handling, model training support	90%	Trained datasets, calibration data
MS-5	Data handover documentation	30%	Data management procedures

9.6 QA Lead Responsibilities

Milestone	Primary Tasks	% Effort	Key Deliverables
MS-1	QA plan, test strategy development	20%	QA plan, test framework outline
MS-2	Test case design, acceptance criteria	35%	500+ test cases, ATP outline
MS-3	Prototype testing, defect tracking	70%	Test reports, defect logs, V&V report
MS-4	ATP execution, acceptance testing	85%	ATP execution reports, acceptance sign-off
MS-5	Final test closure, lessons learned	25%	Final test summary, QA closure report

SECTION 10: WEEKLY DETAIL (MS-1, FIRST 8 WEEKS)

Critical Path for MS-1 PDR Phase

Week	Task ID	Task Name	Activity	Lead Role	Concurrent Tasks	Deliverables Due
W1	1.1	Project Initiation	Kickoff meeting, charter, org chart	PM	1.1	Project charter signed
W2	1.1	Project Initiation	RACI setup, governance, tooling	PM	1.2 start	Governance docs
W3	1.1, 1.4	Init + Tech Survey	Stakeholder interviews, initial planning	PM, Lead ML/Thermo	1.2, 1.4	Kick-off complete
W4	1.1	Project Initiation	Final team onboarding, process setup	PM	1.2, 1.4	Toolchain ready
W5	1.2, 1.4	Requirements + Tech Survey	Requirements workshop, tech search	Sys Eng, Lead ML/Thermo	1.3, 1.5	Requirements draft, tech list
W6	1.2, 1.4	Requirements + Tech Survey	Requirements refinement, literature review	Sys Eng, Academics	1.3, 1.4	Requirements refined, survey ongoing
W7	1.2, 1.4	Requirements + Tech Survey	Mutual req finalization, tech analysis	All leads	1.3	Draft requirements document
W8	1.3, 1.4	SRD + Tech Survey	SRD drafting, tech survey completion	Sys Eng, Lead ML/Thermo	1.5, 1.4	SRD v0.5, tech survey draft

SECTION 11: UPDATED FINANCIAL SUMMARY

Category	Cost (₹ Cr)	% Total
Manpower	4.50	29%
Hardware	2.04	13%
Software	0.98	6%
Infrastructure	0.43	3%
Contingency	0.41	3%
Testing/Travel	1.50	10%
Academic	0.57	4%
Overhead (10%)	1.41	9%
Other	3.46	23%
TOTAL	₹15.30 Cr	100%

SECTION 12: CRITICAL PATH ANALYSIS

Critical Path (Longest Sequence of Dependent Tasks)

Path 1 (26 weeks, MS-1): 1.1 → 1.2 → 1.3 → 1.5 → 1.6 (PDR approval)

Path 2 (52 weeks, MS-1+MS-2): 1.1 → 1.4 → 1.5 → 2.2 → 2.4 → 2.6 (SDD/DDD approval)

Path 3 (78 weeks, MS-1+MS-2+MS-3): 1.6 → 2.2 → 3.1 → 3.3 → 3.5 → 3.7 (CDD approval)

Path 4 (130 weeks, MS-1+MS-2+MS-3+MS-4): 3.7 → 4.1 → 4.3 → 4.4 → 4.6 (ATP completion)

Critical Slack Tasks (High Risk):

- Task 1.3 (SRD): 2-week buffer only
- Task 2.2 (DT block design): 4-week buffer
- Task 3.1 (Prototype implementation): 2-week buffer
- Task 4.4 (ATP execution): 6-week buffer (high variability with DRDO)

SECTION 13: RESOURCE LOADING BY PHASE

Person-Month Effort Distribution

Total Project Effort: ~305 Person-Months (36-month duration, ~14 FTE average)

MS-1 (Weeks 1-26): 29 PM

└ Project Manager: 3 PM

└ Systems Engineer: 4 PM

└ Lead Thermo Eng: 5 PM

└ Lead ML/AI Sci: 7 PM

└ Supporting: 10 PM

MS-2 (Weeks 27-52): 62 PM

└ Lead Thermo Eng: 14 PM

└ Lead ML/AI Sci: 12 PM

└ Data Engineer: 9 PM

└ Software Architect: 10 PM

└ Supporting: 17 PM

MS-3 (Weeks 53-78): 92 PM (PEAK EFFORT)

└ Lead Thermo Eng: 18 PM

└ Lead ML/AI Sci: 16 PM

└ Software Architect: 16 PM

└ Data Engineer: 14 PM

└ QA Lead: 12 PM

└ Junior Engineers: 16 PM

MS-4 (Weeks 79-130): 82 PM

└─ Lead ML/AI Sci: 18 PM
└─ Data Engineer: 14 PM
└─ Software Architect: 16 PM
└─ QA Lead: 18 PM
└─ Supporting: 16 PM
MS-5 (Weeks 131-156): 38 PM (WIND-DOWN)
└─ Lead Thermo Eng: 10 PM
└─ Lead ML/AI Sci: 8 PM
└─ Project Manager: 8 PM
└─ Supporting: 12 PM

SECTION 14: KEY DATES & MILESTONES

Milestone Review Dates (Fixed)

Milestone	Review Date	Duration	Key Reviewers	Approval Authority
Kickoff	Week 1, Day 1	4 hours	PM, Lead Roles, DRDO	Program Director
MS-1 PDR	Week 26 (end)	2-3 days	All team, DRDO Committee	DRDO Director + Committee
Design Review	Week 39 (mid-MS-2)	1 day	Tech leads, DRDO	DRDO Technical Lead
MS-2 CDR	Week 52 (end)	2-3 days	All team, DRDO Committee	DRDO Director + Committee
Prototype Review	Week 65 (mid-MS-3)	1 day	QA, Tech leads	DRDO Quality Rep
MS-3 CDR	Week 78 (end)	2-3 days	All team, DRDO Committee	DRDO Director + Committee
SIR (System Integration)	Week 78 (end)	1 day	Architects, QA, DRDO	DRDO Systems Lead
ATP Readiness	Week 109 (mid-MS-4)	1 day	QA, PM, DRDO	DRDO ATP Lead
MS-4 ATP Execution	Weeks 109-124	4 weeks on-site	ATP Committee, Industry	DRDO ATP Committee
MS-5 Completion	Week 156 (end)	1-2 days	All team, DRDO	DRDO Director

SECTION 15: CONTINGENCY & BUFFER ALLOCATION

Schedule Buffers Integrated into Plan

Buffer Type	Location	Duration	Justification
SRD Finalization Buffer	Between W11-W18	2 weeks	Requirement iterations with DRDO
Design Buffer	Between W45-W52	3 weeks	Design optimization, stakeholder reviews
Prototype Integration Buffer	Between W70-W78	2 weeks	Unforeseen integration issues
ATP Execution Buffer	Between W109-W124	6 weeks	High variability with DRDO testing
Documentation Buffer	Between W140-W150	2 weeks	Final polish, review cycles
Overall Project Contingency	Spread across all phases	3.6 months (10%)	Risk mitigation allocation

SECTION 16: RESOURCE AVAILABILITY & CROSS-TRAINING

Cross-Training Matrix (Critical Knowledge Preservation)

Primary Role	Backup Resource	Criticality	Training Duration
Project Manager	Systems Engineer	Critical	4 weeks

Primary Role	Backup Resource	Criticality	Training Duration
Lead Thermo Eng	Junior Thermo Eng #1	High	8 weeks
Lead ML/AI Sci	ML Engineer #1	High	8 weeks
Software Architect	Lead Soft Eng #1	High	6 weeks
Data Engineer	Data Scientist	Medium	6 weeks
QA Lead	QA Engineer #1	High	6 weeks

Leave/Absence Planning

- Monthly team meetings for capacity planning
- 2 weeks annual leave per team member (staggered)
- No critical single-point-of-failure (SPOF) roles
- Cross-team knowledge documentation quarterly

SECTION 17: METRICS & TRACKING

Weekly Tracking Metrics (Weeks 1-26)

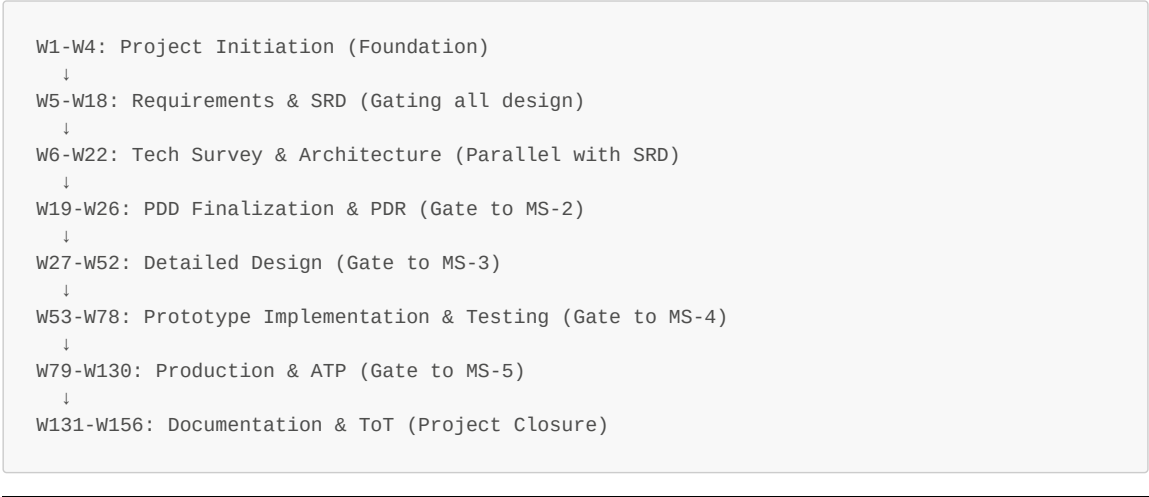
Metric	Target	Tracking Frequency
Schedule Variance (SV)	≤±3 days/week	Weekly
Effort Variance (EV)	±5% vs. plan	Weekly
Risk Status	<5 open high risks	Weekly
Deliverable Quality	0 critical defects	Weekly
DRDO Feedback Resolution	<5 days	On-demand

Monthly Tracking Metrics (Weeks 27-156)

Metric	Target	Tracking Frequency
Milestone Progress	On Schedule ±2 weeks	Monthly
Budget Variance	±5%	Monthly
Resource Utilization	85-95%	Monthly
Risk Trend	Decreasing or stable	Monthly
Stakeholder Satisfaction	>3.5/5	Quarterly

SECTION 18: DEPENDENCY MAP & CRITICAL PREDECESSORS

High-Impact Dependencies



SECTION 19: RESOURCE COST TRACKING (36-MONTH PROJECT)

Cumulative Monthly Cost Forecast

Month	Phase	Avg FTE	Monthly Cost (INR)	Cumulative Cost (INR)	% of Total Budget
M1-M3	MS-1	6 FTE	₹20,00,000	₹60,00,000	1.3%
M4-M6	MS-1	8 FTE	₹28,00,000	₹1,44,00,000	3.2%
M7-M12	MS-2	12 FTE	₹42,00,000	₹3,96,00,000	8.8%
M13-M18	MS-3	16 FTE	₹56,00,000	₹7,32,00,000	16.3%
M19-M24	MS-4	14 FTE	₹49,00,000	₹10,26,00,000	22.8%
M25-M30	MS-4	14 FTE	₹49,00,000	₹13,20,00,000	29.3%
M31-M36	MS-5	10 FTE	₹35,00,000	₹15,30,00,000	34.0%
TOTAL PROJECT	All	14 FTE avg	-	₹15.30 Cr (approx. ₹15.00 Cr)	100%

SECTION 20: RISK-ADJUSTED SCHEDULE (WITH CONTINGENCY)

Schedule Risk Events & Buffers

Risk Event	Probability	Impact	Built-in Buffer	Contingency Action
PDR delays (DRDO)	30%	2-4 weeks	2 weeks in W19-W26	Prepare multiple SRD versions early
Data access delays	40%	3-6 weeks	4 weeks in W27-W38	Use synthetic/historical data initially
Hardware procurement delays	25%	4-8 weeks	4 weeks in W79-W90	Order immediately post-CDR
Prototype rework	50%	2-4 weeks	2 weeks in W70-W78	Iterative design validation early
ATP delays	60%	4-8 weeks	6 weeks in W109-W124	Pre-ATP testing, clear criteria
Total Schedule Contingency			3.6 months	Spread across all phases