Stratos V

Preliminary Project Planning

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DARE
Delft Aerospace Rocket Engineering

STRATOS V

DARE

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Summary

The following report provides a preliminary planning for the flagship project of Delft Aerospace Rocket Engineering (DARE), Stratos V. A NASA systems engineering framework will be followed. This covers the planning, design, production, launch and post-launch phases. The Stratos V rocket serves as a demonstrator for a reusable launch vehicle using the DLX-150 Firebolt engine developed by the previous DARE flagship project: Project Sparrow. Firstly, a brief outlook on the history of the Stratos series and DARE is described.

It is determined that the best way to proceed is by creating goals that follow from the Mission Need Statement (MNS) and Project Objective Statement (POS). These goals are broken up into primary, secondary and moon goals. They are all created with the mission in mind and are goals that will provide direction and milestones to be accomplished.

The report then discusses the mission, stakeholder and system requirements. The mission requirements are necessary to fulfill the MNS, while stakeholder requirements are distributed by stakeholder and ranges from DARE to launch and test sites. The system requirements cover what the rocket itself must be able to do.

After this, an overview of the 2022/23 team's structure and organisation method is discussed. The method used is a section/department combination. A full list of all workers, part and full time, is shown, coded for each type of worker. The role of each of the management team is also explained.

Risk analysis is also a necessary part of any project. Analyzing the risks incurred by a project before they become an issue allows for more preparation for the project and a better outcome overall. Stratos V uses an organisational risk analysis method and SWOT analysis to find any risks and opportunities within the project and rank them. This can be used to mitigate any risks by first identifying them before they become real threats.

In order to plan the Stratos V project, several diagrams are created to aid in its organisation. The first outlines the structure of the team utilising an organogram to divide the future workload using sections as well as departments. The Work Flow Diagram (WFD) and Work Breakdown Structure (WBS) give an outline and insight into each task that has be undertaken for the duration of the project per each phase. Functional analysis is also performed using a Function Flow Diagram (FFD) and Functional Breakdown Structure (FBS), providing a breakdown of what each section of the rocket must do.

Finally, finances are covered and conclusions are drawn regarding the planning as a whole. Finances shows the overall expected budget in the likely and worst case scenarios, as well as a rundown of each departments expected costs, including some miscellaneous and logistical aspects. There are also justifications and contingencies for each cost. In the conclusion the plans' goals, requirements and risks are covered once again and ultimately the practicality of the plan is considered. The plan is determined to be fundamentally sound and the project can proceed to the next phase.

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Nomenclature

Acronyms

3D	3 Dimensional
Cryo	Cryogenic
DARE	Delft Aerospace Rocket Engineering
FBS	Functional Breakdown Structure
FFD	Functional Flow Diagram
FTS	Flight Termination System
GOV	Government
GPS	Global Positioning System
HFC	Hot-Fire Campaign
LOx	Liquid Oxygen
LS	Launch Site
MG	Moon Goal
Misc	Miscellaneous
MNS	Mission Need Statement
ORG	Organisation
PCB	Printed Circuit Board
PG	Primary Goal
POS	Project Objective Statement
PRP	Propulsion
RSK	Risk
RUD	Rapid Unscheduled Disassembly
SAF	Safety Board
SG	Secondary Goal
SIV	Stratos IV
SPA2	Sparrow Year 2
SPO	Sponsors
STA	Stakeholder
STR	Structures
SV	Stratos V
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TEST	Test Site
TU Delft	Delft University of Technology
WBS	Work Breakdown Structure
WFD	Work Flow Diagram
WS	Workspaces

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1 Introduction

The aerospace industry is focusing more and more on sustainability. In the launch vehicle industry, this translates into the use of less toxic propellants and the transition to reusable launch vehicles. Unfortunately, Europe is behind in terms of reusable launch vehicles when compared to the United States of America. In contrast, Delft Aerospace Rocket Engineering (DARE), the student rocketry society at TU Delft, always aims to be at the forefront of rocketry. By offering practical education to the students on reusable launch vehicles, the society ensures that they advocate for and are part of this change in the future.

The aim of this report is to outline the Stratos V project and its preliminary planning. This project is being conducted in order to demonstrate the feasibility of a reusable and sustainable launch vehicle in student and amateur rocketry by designing, building, testing, launching and recovering a liquid bi-propellant, refurbishable rocket. The Stratos V team believes this will pave the way for future DARE rockets to become fully reusable and that it will bring DARE engineers closer to the future needs of the industry. This report gives an overview of the Stratos V project, as well as the team architecture and structure for 2022/23.

The report is structured as follows. The history of the Stratos program and DARE is given in chapter 2. Then, chapter 3 provides a mission and project overview of Stratos V, as well as its goals. All mission and stakeholder requirements are considered in chapter 4. Project management is outlined in chapter 5 along with team composition. The SWOT and organisational risk analysis are covered in chapter 6. Work Flow Diagrams and Work Breakdown Structures are included in chapter 7, as well as overall planning of the project. Functional analysis is performed in chapter 8. Finally, chapter 9 provides a budget overview and planning, taking into account the likely and worst case scenarios, and chapter 10 gives a full conclusion to the preliminary planning.

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2 An Outlook on DARE and Stratos

The aim of this chapter is to give an overview of Delft Aerospace Rocket Engineering and the Stratos project.

Figure 2.1 Delft Aerospace Rocket Engineering's Logo

Based in the Netherlands and associated with the Delft University of Technology, DARE has been pushing the limits of student and amateur rocketry since its founding in 2001. The scope of its projects ranges from small-scale vehicles and demonstrators to high-powered competition rockets and high-performance test platforms. The society has also partaken in spreading the essentials of rocketry via education, hands-on experience and solving problems in a team setting. In addition to contributions in multidisciplinary fields of academic research, DARE has been active in establishing relationships with other rocketry societies all over the world.

DARE houses a variety of projects and departments that usually pertain to the development of its larger *flagship* missions. These have been the Stratos projects - a family of high-altitude rockets; and Project Sparrow - a thrust-vectored, liquid rocket engine development program.

A group of very motivated TU Delft students started the Stratos sounding rockets family with Stratos I (2009): the first large launcher developed by DARE, featuring a two-stage solid rocket. Stratos I successfully reached 12.5 [km], breaking the European student altitude record, although it failed to recover successfully. Stratos II (2014) set out to reach 50 [km], but was scrubbed due to a leak in the engine's feed system. With the lessons learned from Stratos II, a follow-up Stratos II+ (2015) was successfully launched and recovered - featuring in-house developed electronics, a single-stage hybrid rocket engine, and a two-stage recovery design. This rocket broke DARE's own record by reaching 21.5 [km]. Stratos III (2018) sought to go beyond the Kármán line with a newer hybrid engine design and primarily composite structure. However, an anomaly resulted in a Rapid Unscheduled Disassembly shortly after launch.

(a) Stratos II/II+ **(b)** Stratos III **(c)** Stratos IV

Figure 2.2 The previous Stratos mission patches. Stratos I did not have a dedicated patch.

Stratos IV (2021) was DARE's latest endeavour in high-altitude rockets. It focused on minimising the mass of the Stratos III vehicle while keeping the same engine. Additional improvements included increased structural rigidity, active roll control and increased reliability of components. Due to the Covid-19 pandemic and other unforeseen events, the project saw a lengthy delay - however, the team was steadfast in reaching the launch campaign phase. Despite multiple resolution attempts, a feed system component failure made for a high-risk and unsafe operation, resulting in an aborted launch.

Nevertheless, the project was able to showcase the huge leap in students' capabilities and allowing students to gain hands-on experience with developing a space-capable launcher.

After Stratos IV, Project Sparrow (2022) briefly took over the role of the flagship project of DARE with the aim of developing 15 [kN] bi-propellant, Ethanol - LOX rocket engine, DLX-150. As of August 2022, Project Sparrow has conducted seven hot fires with this engine. With the development of the engine going well, the newly recruited 2022/23 team was confident enough to start working on the flight system utilizing the engine. The team decided to return to the Stratos name due to its recognition in the aerospace industry. Hence, the Stratos V project was born.

3 Mission Overview

This chapter covers the aim and the goals of the project. The Mission Need Statement is covered in section 3.1, defining the overarching mission, while the Project Objective Statement discussed in section 3.2 is specific to the current 2022/23 year of Stratos V. Lastly, the project goals are covered in section 3.3.

3.1 Mission Need Statement

The Mission Need Statement was chosen based on trends in the aerospace industry. With the emphasis being put on sustainability, breaking altitude records is no longer enough to be distinctive. Currently, within the context of the launch vehicle industry, going sustainable means going reusable. According to Horizon, The EU Research and Innovation Magazine, "The race is on to develop a European reusable rocket that can ensure Europe's autonomous and cost-effective access to space while increasing the sustainability of launches" [1].

Furthermore, a number of new technologies have been developed over the years in DARE, such as the DLX-150 Firebolt EthaLOX engine by Project Sparrow or the reefed Huygens-family disk gap band main parachute by SPEAR II. These technologies allow the creation of a fully recoverable, refurbishable rocket, which is a major proof of concept for reusable launch vehicles.

This reasoning is encapsulated in the *Mission Need Statement* below, which describes the desired outcome of the project. When it is accomplished, the project comes to a successful end.

"To develop a technology demonstrator for a reusable launch vehicle."

3.2 Project Objective Statement

For the academic year 2022/23, it was decided to perform the preliminary and detailed system design of the vehicle and to develop the subsystems necessary for performing the coldflow of the rocket. This way, the Stratos V 2023/24 team can also design parts of the rocket, while the Stratos V 2022/23 team can focus on performing a coldflow. This will allow troubleshooting of many fluid system-related issues, which were prevalent in previous DARE projects and ultimately prevented Stratos IV from launching. The selected subsystems are the Fuel and Oxidizer Tanks, the Avionics Bay, the Engine Bay, and the Engine Other subsystems, such as the pressurant tank from the Tanks section and the Recovery Cone, will only be dealt with preliminarily. These sections of the rocket are described in greater detail in chapter 5.

In the process of the creation of the POS, some major constraints were identified. Firstly, the rocket has to use liquid bi-propellant, as the only large engine in development in DARE is the DLX-150, which uses EthaLOX. Secondly, the rocket has to break the internal DARE record of 21.5 km as an altitude requirement is necessary. The team does not want to depend on the records of other student teams since they can easily be broken by the time Stratos V would launch.

Consequently, the *Project Objective Statement* specific for the 2022/23 team was derived:

"To perform the preliminary system design as well as the detailed design and testing of selected subsystems of a recoverable and refurbishable liquid

bi-propellant rocket capable of breaking the DARE altitude record by a team of students during the academic year 2022/23."

3.3 Goals

This section lists the goals derived from the MNS and POS. They are listed based on hierarchy and are divided into primary, secondary and moon goals. Primary goals are goals that need to be achieved to fulfil the MNS, while achieving secondary goals facilitates completing primary goals. Moon goals are goals that can be achieved after achieving the others. Some of the goals are tagged with *-T*, signifying that they are team goals, only applying to the year 2022/2023. All goals apply to every team member.

Development of electric pumps was included in these goals, as the DLX-150 is optimized to run with higher feed pressures. Given the complexity of these pumps, they cannot be realistically developed outside of the flagship project in DARE. Furthermore, the Project Sparrow team has made considerable progress in their design, and they offer considerable benefits to future Stratos projects. Consequently, it was decided to keep their development within Stratos V, even though they are not strictly necessary for its success. Since they are not the focus of the project, only part-time engineers will be working on these.

Primary Goals

CODE	GOALS
[PG-1]	Design, build, test, launch, recover and re-launch a refurbishable bi-propellant rocket capable of breaking the DARE altitude record.
[PG-2]	Mature and iterate on the design of and test the DLX-150 liquid rocket engine.
[PG-3]	The project shall be documented to the extent that people who have not been part of the design process can continue development.

Secondary Goals

CODE	GOALS
[SG-1-T]	Perform a cold flow of selected subsystems of the rocket by September 2023.
[SG-2-T]	Ensure growth of social media presence through DARE social media channels and website.
[SG-3-T]	Secure an office space during 2022/2023 year.
[SG-4-T]	Find a larger workshop for rocket assembly.
[SG-5]	Mature the design of and test the DTP-E74 fuel pump.
[SG-6]	House a payload within the Stratos V rocket.

Moon Goals

CODE	GOALS
[MG-1-T]	Perform static fire test by September 2023.
[MG-2]	Design oxidizer pump for DLX-150.

4 Requirements

The requirements set for the project within this chapter need to be met to reach the project goals. The mission requirements are in place to fulfil the Mission Need Statement and are handled within section 4.1. Meanwhile, the stakeholder requirements in section 4.2 are in place to keep a healthy relationship with the stakeholders corresponding to DARE and the project.

4.1 Mission Requirements

The table in this section is a set of requirements that must be fulfilled in order to consider the mission (as defined by the Mission Need Statement) a success. These requirements are for the entire duration of the project. These are not necessarily technical requirements: while the project is largely technical, there are other aspects to consider too. These requirements are shown in Table 4.1.

Table 4.1 Mission Requirements

CODE	Requirement
[MSN-01]	The Stratos V project shall launch a rocket with a cryogenic liquid bi-propellant propulsion system
[MSN-02]	The Stratos V rocket shall be recovered
[MSN-03]	The Stratos V rocket shall be refurbishable
[MSN-05]	The Stratos V rocket shall break the DARE altitude record
[MSN-06]	The Stratos V project shall not run over budget
[MSN-07]	The Stratos V team shall document the project's design choices and operations in the form of written reports
[MSN-08]	The Stratos V team shall hand over the project to a new team in the academic year 2023/2024
[MSN-09]	The Stratos V team shall continue developing the 'Firebolt' engine for flight
[MSN-10]	The Stratos V team shall maintain a healthy working environment, as defined in the Stratos V code of conduct
[MSN-11]	The Stratos V rocket shall return sufficient data in order to allow for post-launch analysis
[MSN-12]	The Stratos V project shall attain a contract with a compatible launch site
[MSN-13]	The Stratos V team shall ensure an engine test location is available for the duration of the project
[MSN-14]	The Stratos V team shall maintain a good relationship with all stakeholders
[MSN-15]	The Stratos V rockets' reusability shall be assessed by inspecting the recovered rocket
[MSN-16]	The Stratos V rocket shall launch before the end of 2024

4.2 Stakeholder Requirements

The stakeholders are all the parties that may affect or be affected by the project. Their identification is critical to the outcome of the project, mission boundaries, and problem complexity. The stakeholders' needs are assessed and compiled in a comprehensive list of requirements. Tables 4.2 to 4.8 show these requirements, grouped by stakeholder.

Table 4.2 DARE stakeholder requirements

CODE	Requirement
[STA-DARE-01]	In case of a budget request, this shall not exceed [TBD] EUR
[STA-DARE-02]	Knowledge gained during the project shall be documented and transferred to the rest of the DARE society
[STA-DARE-03]	The Stratos V team shall promote DARE
[STA-DARE-04]	The Stratos V team shall adhere to the DARE code of conduct
[STA-DARE-05]	The Stratos V project shall not put DARE at financial risk
[STA-DARE-06]	The Stratos V project shall not put DARE at legal risk
[STA-DARE-07]	The Stratos V team shall not request more resources from DARE than agreed upon
[STA-DARE-08]	The Stratos V team shall peacefully prevent and resolve any conflicts with other activities within DARE
[STA-DARE-09]	The Stratos V team shall keep DARE informed about partnerships
[STA-DARE-10]	The project shall be handed over to the next full-time team at the end of the academic year 2022/2023

Table 4.3 Safety Board stakeholder requirements

CODE	Requirement
[STA-SAF-01]	The system shall satisfy all Safety Board requirements
[STA-SAF-02]	The Stratos V team shall adhere to all application guidelines set by the Safety Board
[STA-SAF-03]	All tests with a safety risk shall be supervised by at least one Safety Officer
[STA-SAF-04]	The Stratos V team shall take Safety Officer availability into account when planning tests

Table 4.4 Sponsors stakeholder requirements

CODE	Requirement
[STA-SPO-01]	The Stratos V team shall maintain a good relationship with sponsors
[STA-SPO-02]	The Stratos V team shall respect all agreements made with sponsors
[STA-SPO-03]	The Stratos V team shall respect all contracts made with sponsors
[STA-SPO-04]	The Stratos V team shall not damage the sponsor image/reputation

Table 4.5 Stratos V stakeholder requirements

CODE	Requirement
[STA-SV-01]	The Stratos V team shall adhere to the Stratos V Code of Conduct
[STA-SV-02]	The Stratos V team shall actively promote student rocketry
[STA-SV-03]	The Stratos V team shall only share truthful information about its resources and activities
[STA-SV-04]	The Stratos V team shall promote a sustainable approach to engineering.

Table 4.6 Test sites stakeholder requirements

CODE	Requirement
[STA-TEST-01]	The system design shall conform to the rules and regulations of the test site
[STA-TEST-02]	The test site shall be left in the same or better state as it was upon arrival
[STA-TEST-03]	The test(s) shall be conducted within the time frame imposed by the test site
[STA-TEST-04]	The Stratos V team shall respect all agreements made with the test site
[STA-TEST-05]	The test shall be performed according to the test site regulations
[STA-TEST-06]	All necessary documentation shall be timely supplied to the test site
[STA-TEST-07]	The Stratos V team shall maintain a good relationship with all test site staff
[STA-TEST-08]	The Stratos V team shall not disclose sensitive information about the test facility to externals

Table 4.7 Launch site stakeholder requirements

CODE	Requirement
[STA-LS-01]	The system design shall conform to the rules and regulations of the launch site
[STA-LS-02]	The launch site shall be left in the same or better state as it was upon arrival
[STA-LS-03]	The launch campaign shall be conducted within the time frame agreed upon with the launch site
[STA-LS-04]	The Stratos V team shall respect all agreements made with the launch site
[STA-LS-05]	The launch campaign shall be performed according to the launch site regulations
[STA-LS-06]	All necessary documentation shall be timely supplied to the launch site
[STA-LS-07]	The Stratos V team shall maintain a good relationship with the launch site staff
[STA-LS-08]	The error bounds of the dispersion zone shall remain within the agreed upon safety range
[STA-LS-09]	The simulation shall be verified and validated to the standards of the launch site

Table 4.8 TU Delft stakeholder requirements

CODE	Requirement
[STA-TUD-01]	The Stratos V Project shall not damage the university's image
[STA-TUD-02]	The Stratos V team shall adhere to the TU Delft Code of Conduct
[STA-TUD-03]	The Stratos V team shall respectfully use TU Delft's facilities
[STA-TUD-04]	The Stratos V team shall maintain a good relationship with the TU Delft staff

5 Project Management Architecture

This chapter covers the management structure for the project. The Stratos V team will adopt a new project management methodology for the team when compared to previous years. An overview of the team is provided in section 5.2, which shows all team members, their respective departments and their membership status. The team is the size of a medium-sized company, so establishing an efficient way of managing the project is essential to accomplishing its goals.

5.1 Team Structure

The team structure is defined according to the organisational matrix shown in Figure 5.1. The columns are departments, each containing people specialized in one certain discipline of rocket engineering. The chiefs who manage the departments are responsible for assigning and monitoring work done in their department. Furthermore, they are responsible for manufacturing and testing within them. The only non-technical department is PR & Partnerships, which maintains public relations and performs acquisitions.

The sections, organised in rows, are defined as sets of assembled components grouped by similar functionality and position within the rocket or organizational activities supporting the launcher operations. A section fulfills one or multiple of the fundamental functions of storing propellant, feeding the engine, producing thrust, maintaining structural integrity or recovering the vehicle. The team has formed seven such sections: Nosecone, Recovery Bay, Tanks, Avionics Bay, Engine Bay, Engine, Ground System, Turbo-machinery and Launch Campaign. Each section team contains people actively working on it. The heads of these sections are responsible for the state of their section, the compatibility with other sections and integration of sub-subsystems within it, essentially acting as system engineers. They are informed about any changes that occur within their section and are responsible for planning and keeping track of the timeline.

The intersections between a certain department column and a certain section row contains the full-time and part-time engineers from the department who are working on that particular section. As work progresses, it is expected that people will be shifted from one section to another based on better evaluations of workload to be performed in the future. An overview of all members of the team and their role is given in section 5.2.

Management-wise, the Chief Engineer oversees the work of the department chiefs, keeping track of work done in every department, ensuring quality of work and helping out departments with their technical challenges. Conversely, the Systems Engineer oversees the section heads and facilitates communication between them such that all sections are correctly integrated into one system. The Operations Manager and Treasurer (same person) ensures the proper conducting of all operations and is responsible for the fund allocation of each department. Furthermore, he is working closely with PR & Partnership Manager to timely track the financial side of the project. Finally, the Team Manager officially represents the team and the project and keeps track of all the aspects of the team, be it technical, financial, organizational, image- or health-related. A more detailed description of all the responsibility, accountability, support, consultation, and informing structures between all sections, departments and management can be found in the RASCI chart in Table 5.1. It is structured in two parts: product breakdown (subsystems of the vehicle) and non-technical activities.

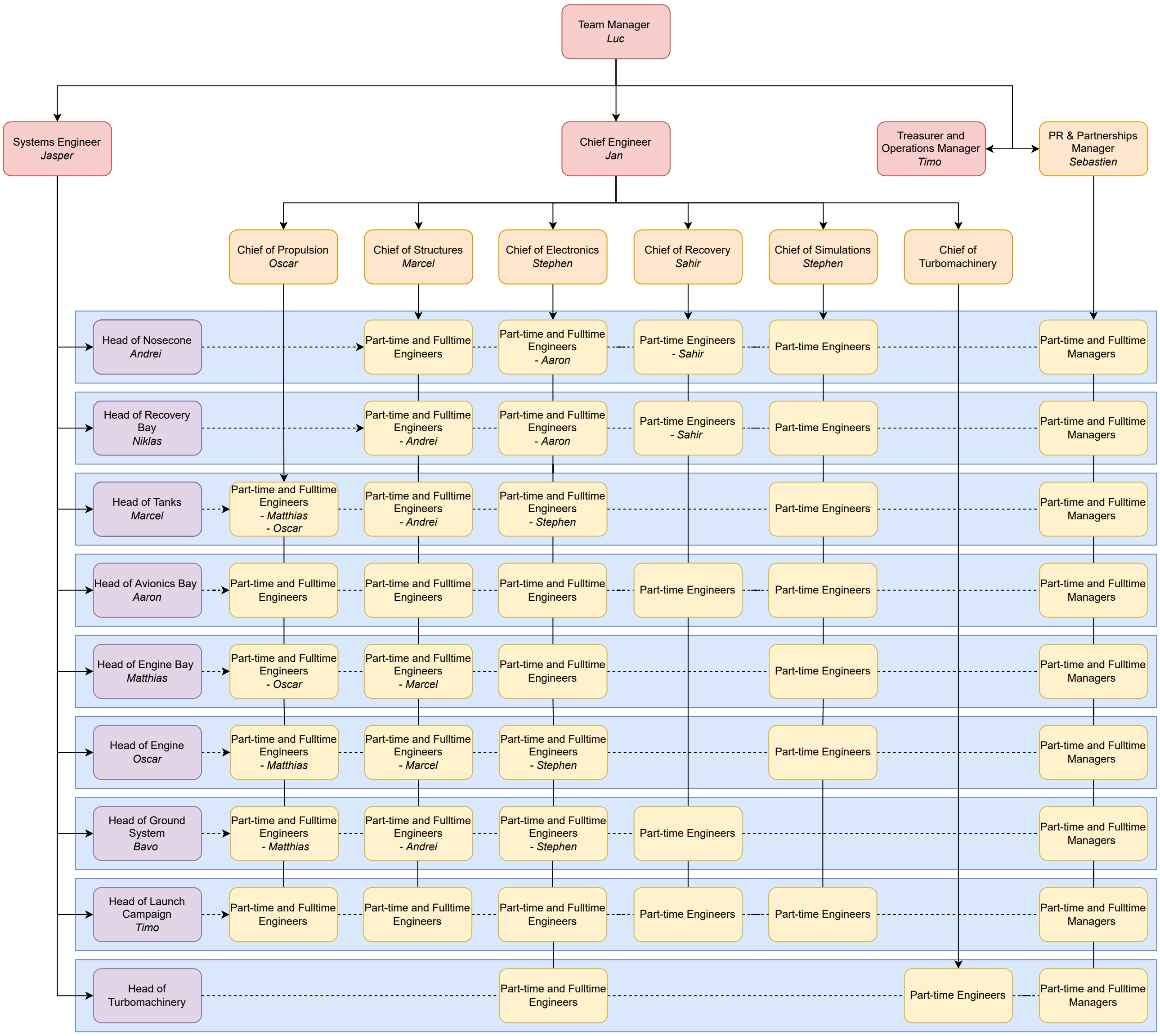

Figure 5.1 2022/23 Team organogram

Table 5.1 RASCI chart for Stratos V by product and work breakdown structure

	Team Manager	Treasurer and Operations Manager	Systems Engineer	Chief Engineer	Nosecone Team	Recovery Bay Team	Tanks Team	Avionics Bay	Engine Bay Team	Engine Team	Ground System Team	Launch Campaign Team	Propulsion	Structures	Electronics	Simulations	PR & Partnerships
Nosecone			S, C	A, C	S, C	I					I	I		R	R	S, I	S, I
Recovery Bay			S, C	A, C	I	S, C	I				C	I		R	R	S, I	S, I
Tanks			S, C	A, C		I	S, C	I			I	I	R	R	R	S, I	S, I, C
Avionics Bay			S, C	A, C			I	S, C	I		C	I		R	R	S, I	S, I
Engine Bay			S, C	A, C			I	I	S, C	C	C	I	R	R	R	S, I	S, I
Engine			S, C	A, C					C	S, C	I	I	R		R	S, I	S, I
Ground System			S, C	A, C	I	I	I	I	I	I	S, C	C	R	R	R		S, I
Launch Campaign	A	R	C	C	I	I	I	I	I	I	I	S, C	I	I	I	R, C	S, C
Non-tech	A, S, C, R																
Content creation	A, S, C	S, C	S	S									R	R	R	R	R, S, C
Acquisition of partners	A, S, C	S, C	C	S, C									R	R	R	R	R, S, C
Managing partners	A, S, C	S, C															R
Public relations	A, S, C	S, C															R
Treasury	A, C	R	C	C									C	C	C	I	S, C
Chairing core team meetings	A, R	C	C	C									C	C	C	C	C
Taking minutes of core team meetings	A			R													R
Organizing internal team events	A, R	R, S, C															S
Organizing external team events	A, S, C	R, S, C															R, S, C
Managing online working environment	A		R	R									S, C	S, C	S, C	S, C	S, C
Managing physical workspaces	A, S, C	R		R									R, I	R, I	R, I	R, I	R, I

R = Responsible, A = Accountable, S = Support, C = Consulted, I = Informed

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5.2 Team Composition

In this section the overview full team is shown in Table 5.2, in which rows have been colour-coded to represent the role of the person in the team. If a person has multiple roles, the highest-ranking one is used for the colouring. The relationships between departments and sections, as well as the various responsibilities associated with these groups, have already been discussed in section 5.1. There are a total of 63 people working on the project, out of which 16 are full-time members, 2 are interns, and the remaining 45 are part-time members.

Table 5.2 Stratos V team composition

Legend: Management Chiefs Heads Full-timers Interns Part-timers

Name	Role	Membership
Luc Gemassmer	Team Manager	Full-time
Timo Kramer	Operations Manager and Treasurer, Head of Launch Campaign	Full-time
Jan Struzinski	Chief Engineer	Full-time
Jasper Welgemoed	Systems Engineer	Full-time
Sebastien Welters	PR & Partnerships Manager	Full-time
Alessandro Tesse	PR & Partnerships member	Part-time
Aurora Niewenhuis	PR & Partnerships member	Part-time
Diovandi Basheera Putra	PR & Partnerships member	Part-time
Rashmi Siriwardane Arachchilage	PR & Partnerships member	Part-time
Tom Gleeson	PR & Partnerships member	Part-time
Zayid Almarzooqi	PR & Partnerships member	Part-time
Oscar Junius	Chief of Propulsion, Head of Engine	Full-time
Matthias Christiaens	Propulsion engineer, Head of Engine Bay	Full-time
Sarissa Aurori	Propulsion engineer	Full-time
Jason Oortman	Propulsion engineer	Intern
Pavlos Dionysopoulos	Propulsion engineer	Intern
Ana-Maria Pelin	Propulsion engineer	Part-time
Django van der Plas	Propulsion engineer	Part-time
Filip Aleksandrowicz	Propulsion engineer	Part-time
Floris van Kesteren	Propulsion engineer	Part-time
Jan Grobusch	Propulsion engineer	Part-time
Jiri Kovar	Propulsion engineer	Part-time
Kosma Krzyżanowski	Propulsion engineer	Part-time
Lucas Hofman	Propulsion engineer	Part-time
Nathaniel Steenhuis	Propulsion engineer	Part-time
Niek Meijering	Propulsion engineer	Part-time
Oisín Fitzgerald	Propulsion engineer	Part-time
Tomás Reis	Propulsion engineer	Part-time
Trayana Georgieva	Propulsion engineer	Part-time
Marcel Kwapień	Chief of Structures, Head of Tanks	Full-time
Andrei Petrache	Structures engineer, Head of Nosecone	Full-time
Luca Elbracht	Structures engineer	Full-time
Alex Nedelcu	Structures engineer	Part-time
Björn Kleipool	Structures engineer	Part-time

Dionysis Papaioannou	Structures engineer	Part-time
Gonçalo Nespral	Structures engineer	Part-time
Kübra Almaz	Structures engineer	Part-time
Oliver Ross	Structures engineer	Part-time
Riccardo Brambilla	Structures engineer	Part-time
Tijs Peeters	Structures engineer	Part-time
Stephen Goldebeld	Chief of Electronics, Chief of Simulations	Full-time
Aaron Bracke	Electronics engineer, Head of Avionics	Full-time
Bavo Vlyminckx	Electronics engineer, Head of Ground System	Full-time
Alan Hanrahan	Electronics engineer	Part-time
Ane Hinrichs	Electronics engineer	Part-time
Elvin Chen	Electronics engineer	Part-time
Gregorio Boccaccini	Electronics engineer	Part-time
Jasper Jeuken	Electronics engineer	Part-time
Jefferson Yeh	Electronics engineer	Part-time
Laura Tabaksblat	Electronics engineer	Part-time
Thomas Derksen	Electronics engineer	Part-time
Elias Bögel	Simulations engineer	Part-time
Jan Grobusch	Simulations engineer	Part-time
Jasper Jeuken	Simulations engineer	Part-time
Tiia Tikkala	Simulations engineer	Part-time
Sahir Sujahudeen	Chief of Recovery, Simulations engineer	Full-time
Niklas Knöll	Recovery engineer, Head of Recovery Bay	Full-time
Alexis Harvey	Recovery engineer	Part-time
Nachiket Dighe	Recovery engineer	Part-time
Alessandro Battegazzore	Chief of Turbomachinery	Part-time
Dominic Campbell-Pitt	Turbomachinery engineer	Part-time
Jung Kyu Kim	Turbomachinery engineer	Part-time
Marco Camporeale	Turbomachinery engineer	Part-time
Ruán Ó hAnluain	Turbomachinery engineer	Part-time
Wilson Woltersdorf	Turbomachinery engineer	Part-time

6 Organisational Risk Analysis

This chapter covers the risk analysis and mitigation methods to be employed by the Stratos V team. A project of this size can incur many risks, especially with many external factors involved. The exact methods of risk analysis are discussed in section 6.1, including a risk register, risk map table and mitigation methods. A SWOT analysis is conducted in section 6.2.

6.1 Risk Analysis Map

During the entirety of the project, unexpected issues may arise that can have negative influences on the project. These risks can be either organisational or technical. In this report, only the organisational risks will be assessed and mitigated, as it is too early to create a list of relevant and specific technical risks. In order to find appropriate mitigation strategies, it is first necessary to define methods for classifying risks. The method used by the 2022/23 team is outlined below:

- Risks have two fundamental characteristics, impact and probability, which are both subject to mitigation strategies.
- The risks' impact is classified in 5 qualitative levels, which, from least to most severe, are: Mild, Moderate, Elevated, Severe, Critical.
- The risks' probability is classified in 5 qualitative levels, which, from least to most probable, are: Very Low, Low, Medium, High, Very High.
- To evaluate overall risk level, the two characteristics need to be combined. This will be done by means of a risk map - a two-dimensional matrix with cells containing all combinations of impact and probability level, maintaining a qualitative assessment rather than a quantitative one.

With these considerations in mind, the identified risks are shown in Table 6.1.

Table 6.1 Organisational Risk Register

Risk-ID	Risk	Impact	Probability	Mitigation	Impact after mitigation	Probability after mitigation
RSK-ORG-01	Stratos V loses access to the military test-site	Critical	Low	Reduce the risk of engine failure at the test-site by using extensive procedures and increase safety so that in case of failure the engine fails safely	Severe	Very Low
RSK-ORG-02	Stratos V can not cover some of the expenses	Severe	Medium	Make sure we close the budget gap between income and expenses, also have occasional finance reviews to prevent non-useful expenditures	Severe	Low
RSK-ORG-03	Another pandemic lockdown occurs	Elevated	Low	Set up an organised online environment that can be used directly in case of the faculty closing down	Moderate	Low
RSK-ORG-04	A full-time or management person falls ill or is unavailable for a longer period of time	Moderate	Medium	Have plans in place on who will take over the tasks that belonged to the specific person	Mild	Medium
RSK-ORG-05	Stratos V loses access to the ACH	Severe	Low	Look for alternative machining, assembly and small testing locations, ensure rules in ACH are respected and relationships with staff are maintained	Elevated	Low

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Table 6.1 Organisational Risk Register

Risk-ID	Risk	Impact	Probability	Mitigation	Impact after mitigation	Probability after mitigation
RSK-ORG-06	Someone from Stratos V or DARE gets severely injured at a Stratos V activity	Critical	Low	Ensure testing and other operations are done in a safely manner and following procedures. Ensure insurance up to spec	Severe	Very Low
RSK-ORG-07	A Stratos V full-timer decides to quit the project	Severe	High	Ensure a healthy working environment and involve all full-time members in the project and project decisions. Also ensure progress is documented so others can take over tasks	Elevated	Low
RSK-ORG-08	Stratos V is not able to find a big enough space to assemble the full rocket	Critical	Medium	Look for options well before the actual assembly, set aside money for possible rent of a workspace	Critical	Very Low
RSK-ORG-09	A delivery or in-kind sponsorship is delayed	Moderate	Very High	Make sure to order things well on time. If you know you'll need something but not straight away, still order it	Moderate	Medium
RSK-ORG-10	Members of the team lose motivation to work on the project	Elevated	Very High	Try to keep all members involved with the project and regularly organise fun activities with the team.	Elevated	Medium

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Table 6.1 Organisational Risk Register

Risk-ID	Risk	Impact	Probability	Mitigation	Impact after mitigation	Probability after mitigation
RSK-ORG-11	Members of the team break a rule in the code of conduct	Moderate	Medium	Discuss timely with the team if for example you will miss a session or have to leave early. Ensure everyone has read and accepted the code of conduct	Mild	Low
RSK-ORG-12	Stratos V loses any essential software access or files are accidentally deleted	Critical	Medium	Have all files stored on multiple hard-drives as backups as well as a separate cloud service.	Moderate	Low
RSK-ORG-13	A deadline gets wrongly estimated	Elevated	High	Set margins in deadlines with room for delays	Mild	High
RSK-ORG-14	A conflict between members occurs	Elevated	Medium	Make sure communication on the team is well and everyone is on the same page regarding the project	Elevated	Low
RSK-ORG-15	Someone gets stuck on their workpackage	Elevated	High	The chiefs of each department needs to make sure everyone is comfortable and understands their workpackage as well as performing regular checks on the the workpackage progress.	Moderate	Medium

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Now, a risk map can be made according to the simple procedure laid out at the beginning of this section. This risk map can be seen in Table 6.1.

Table 6.2 Organisational Risk Map after mitigation

Probability / Impact	Very Low	Low	Medium	High	Very High
Critical	RSK-ORG-08				
Severe	RSK-ORG-01 RSK-ORG-06	RSK-ORG-02			
Elevated		RSK-ORG-05 RSK-ORG-07 RSK-ORG-14	RSK-ORG-10		
Moderate		RSK-ORG-03 RSK-ORG-12	RSK-ORG-09 RSK-ORG-15		
Mild		RSK-ORG-11	RSK-ORG-04	RSK-ORG-13	

6.2 SWOT Analysis

A SWOT analysis was performed as well. This method of analysis allows the team to determine any Strengths, Weaknesses, Opportunities and Threats to the project. By knowing these in advance, the risks or benefits they carry can be mitigated or expanded upon before it becomes a relevant issue. It also provides the team with foresight and a better understanding of the project as a whole. This analysis can be seen in Figure 6.1.

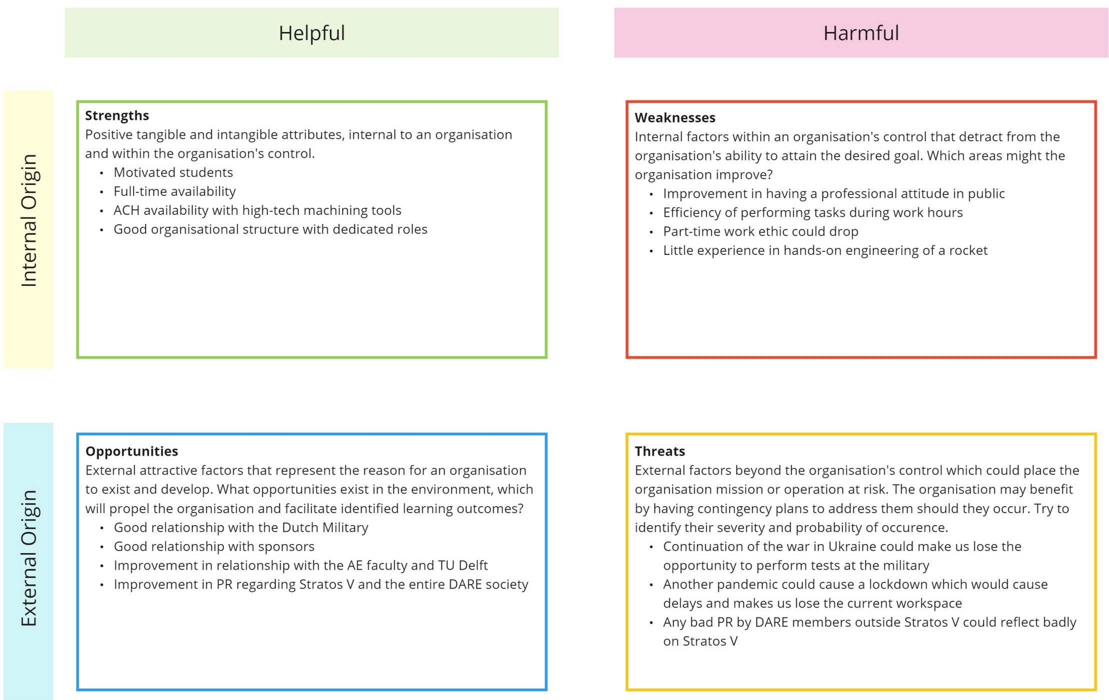

Figure 6.1 SWOT Analysis

7 Project Planning

The planning of a project is a key ingredient in a successful project. To plan this project in the most effective way possible, the Stratos V team used the method explained in the NASA Systems Engineering Handbook [2], a tried and true process. This chapter will cover the planning of each phase in diagram form. These are Work Flow Diagrams and Work Breakdown Structures for each phase described in Table 7.1. The Work Flow Diagrams come first, providing an overview of the tasks needed in each phase, while the Work Breakdown Structure diagrams shown afterward give subtasks and thus a more specific view of what needs to be done in each phase.

7.1 Planning Methodology

The process used to plan the project was largely inspired by the NASA Systems Engineering Handbook [2]. This consists of a categorical breakdown of everything required to achieve a goal or set of goals by splitting a program into phases separated by decision points. The distinction allows for ease of management once the approval of a project and its goals are met. The phases entail the discovery of the missions goals, its evolving stages of design and key decisions, verification & validation activities, manufacturing & assembly, operations, and lastly the close-out. A summary of these phases can be found in Table 7.1 on the following page.

7.2 Top-Level Work Flow and Tasks Breakdown

For each phase of the project, a Work Flow Diagram is shown with all tasks necessary to achieve the goals of the project. This covers each of the six phases shown in Table 7.1. The Work Flow Diagrams provide clear insight into the top level tasks to be accomplished in each phase and provide foresight at any stage of the project. Next to that, the tasks are ordered chronologically, therefore giving a better overview of when to perform certain tasks.

Since Work Flows only present top level tasks, Work Breakdown Structures are introduced, so that lower level tasks can also be mentioned. Since the top level tasks are too large on their own, the sub tasks are necessary to be able to complete the tasks in a structured manner. Unlike the Work Flows, Work Breakdown Structures are only made for phases up to and including Phase B - subsystem design, as it is expected that detailed tasks for later phases will not become apparent until the team gets closer to starting them. Detailed planning can only go so far, but will be updated constantly whenever more detailed tasks become clear. The Workflow Diagrams are shown in Figure 7.1 and Figure 7.2, while the Work Breakdowwn Structure is found in Figure 7.3 and Figure 7.4.

7.3 Gantt Chart

In order to have a clear and concise overview of the time frame of each task during the project, as well as the duration of each phase, a Gantt chart is created. Next to that, all major deadlines are also indicated on the chart. This helps the team in keeping track of all tasks, and helps in preventing delays in the project. The Gantt charts can be found in Figures 7.5 to 7.11.

Table 7.1 Project Life-Cycle Phases, inspired by the NASA Systems Engineering Handbook [2]

Phase		Purpose	Output	General Milestones
Formulation	Pre-Phase A: Concept Studies	To produce a broad spectrum of ideas and alternatives for missions from which new programs/projects can be selected. Determine feasibility of desired system, develop mission concepts, draft system-level requirements, identify potential technology needs.	Feasible system concepts in the form of simulations, analysis, study reports, models, and mockups	Project Concept/Planning Review
	Phase A: Concept and Technology Development	To determine the feasibility and desirability of a suggested new major system and establish an initial baseline compatibility with NASA's strategic plans. Develop final mission concept, system-level requirements, and needed system structure technology developments.	System concept definition in the form of simulations, analysis, engineering models, and mockups and trade study definition	Systems Requirement and Systems Definition Reviews
	Phase B: Preliminary Design and Technology Completion	To define the project in enough detail to establish an initial baseline capable of meeting mission needs. Develop system structure end product (and enabling product) requirements and generate a preliminary design for each system structure end product.	End products in the form of mockups, trade study results, specification and interface documents, and prototypes	Preliminary Design Review
Implementation	Phase C: Final Design and Fabrication	To complete the detailed design of the system (and its associated subsystems, including its operations systems), fabricate hardware, and code software. Generate final designs for each system structure end product.	End product detailed designs, end product component fabrication, and software development	Critical Design, Production Readiness, System Integration Reviews
	Phase D: System Assembly, Integration and Test, and Launch	To assemble and integrate the products to create the system, meanwhile developing confidence that it will be able to meet the system requirements. Launch and prepare for operations. Perform system end product implementation, assembly, integration and test, and transition to use.	Operations-ready system end product with supporting related enabling products	Test, Operational, and Flight Readiness Reviews
	Phase E: Operations	To conduct the mission and meet the initially identified need and maintain support for that need. Implement the mission operations plan.	Desired system, Mission completion	Post-Launch and Post-Flight Reviews
	Phase F: Closeout	To implement the systems decommissioning/disposal plan developed in Phase E and perform analyses of the returned data and any returned samples.	Product closeout	Decommissioning Review

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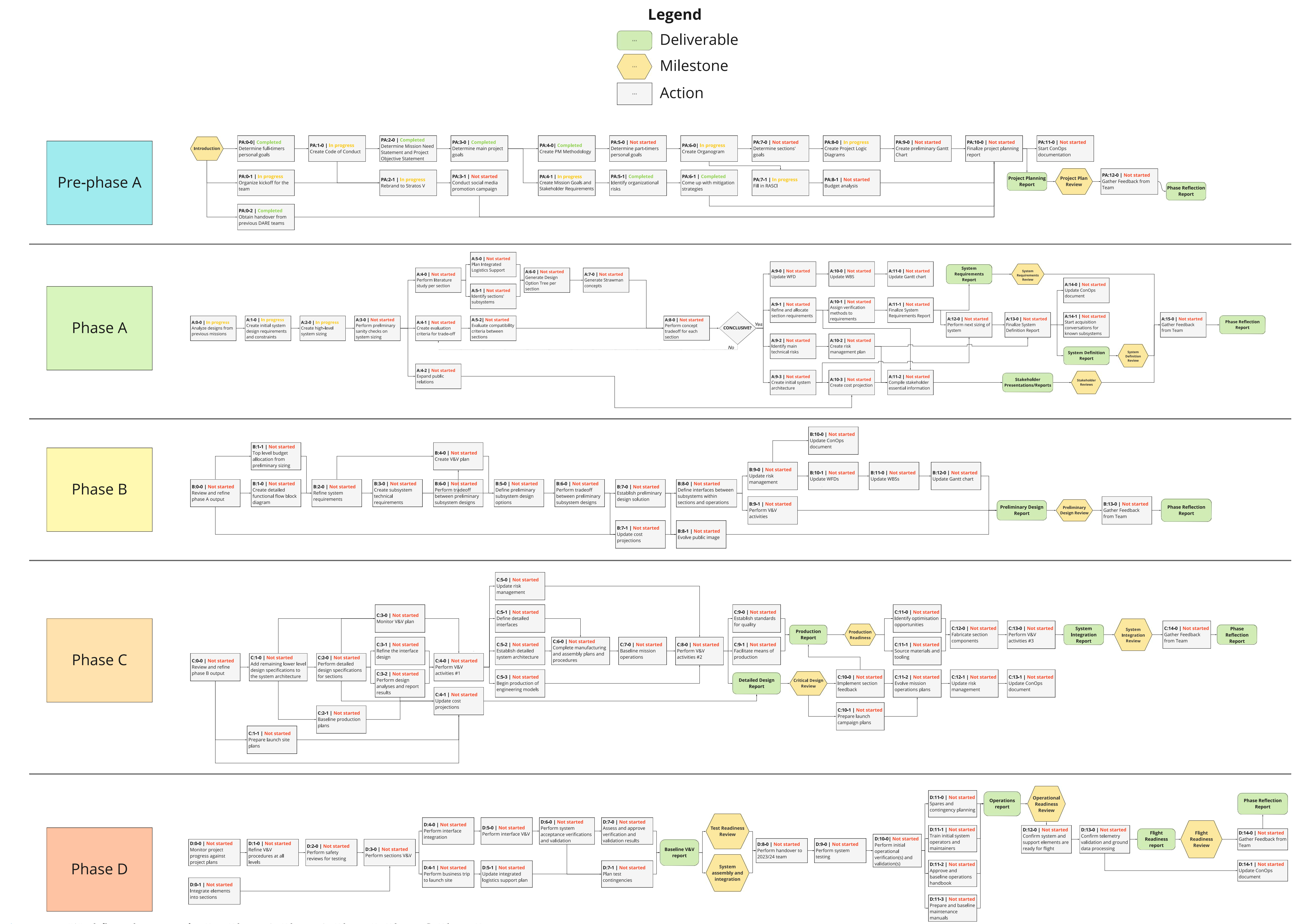

Figure 7.1 Workflow diagrams for Pre-Phase A, Phase A, Phase B, Phase C, Phase D

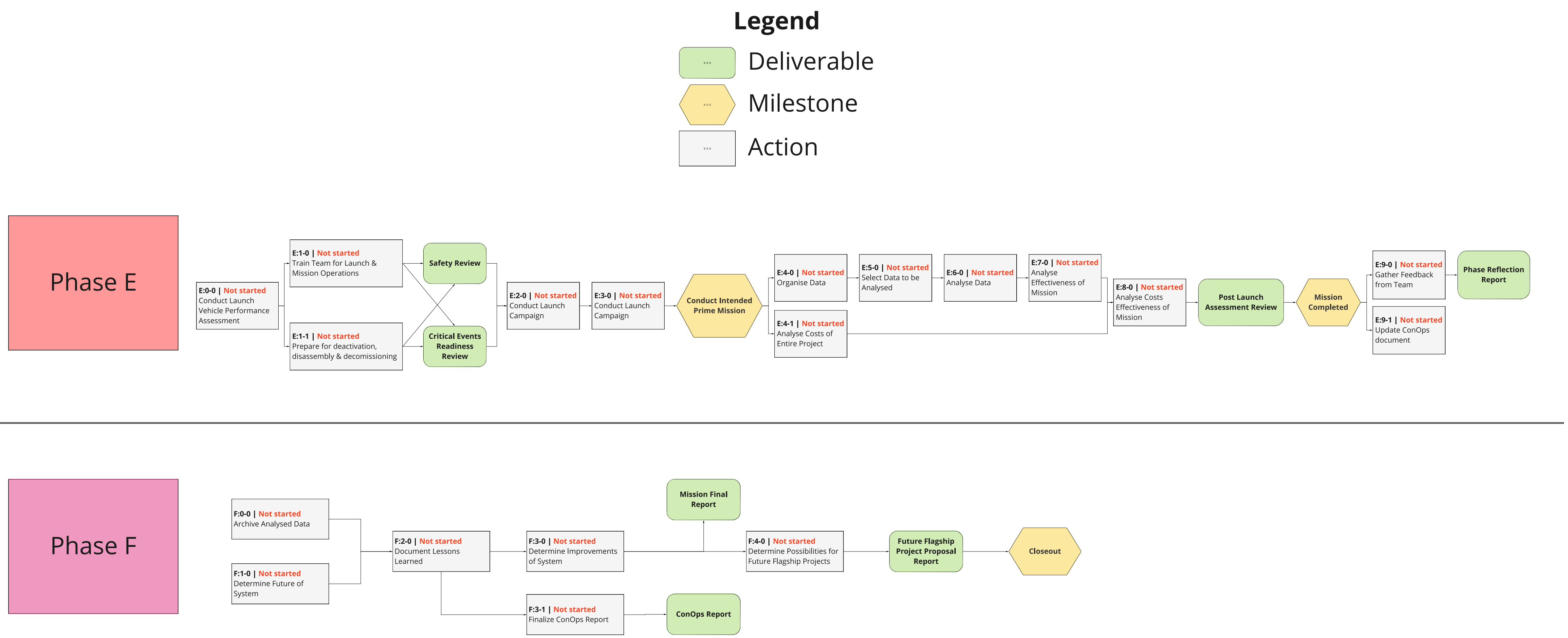

Figure 7.2 Workflow diagrams for phases E and F

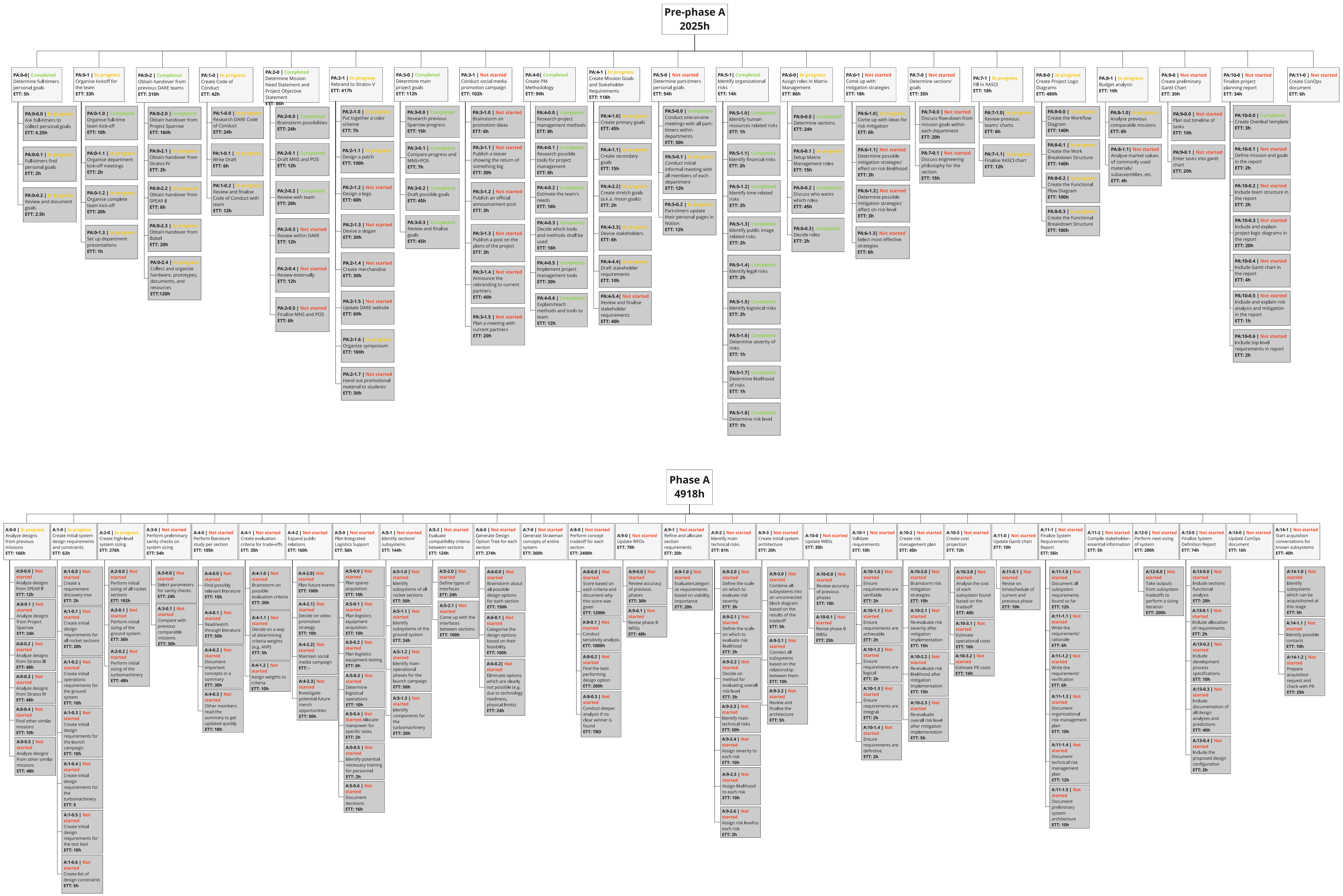

Figure 7.3 Work Breakdown Structure for Pre-Phase A and Phase A

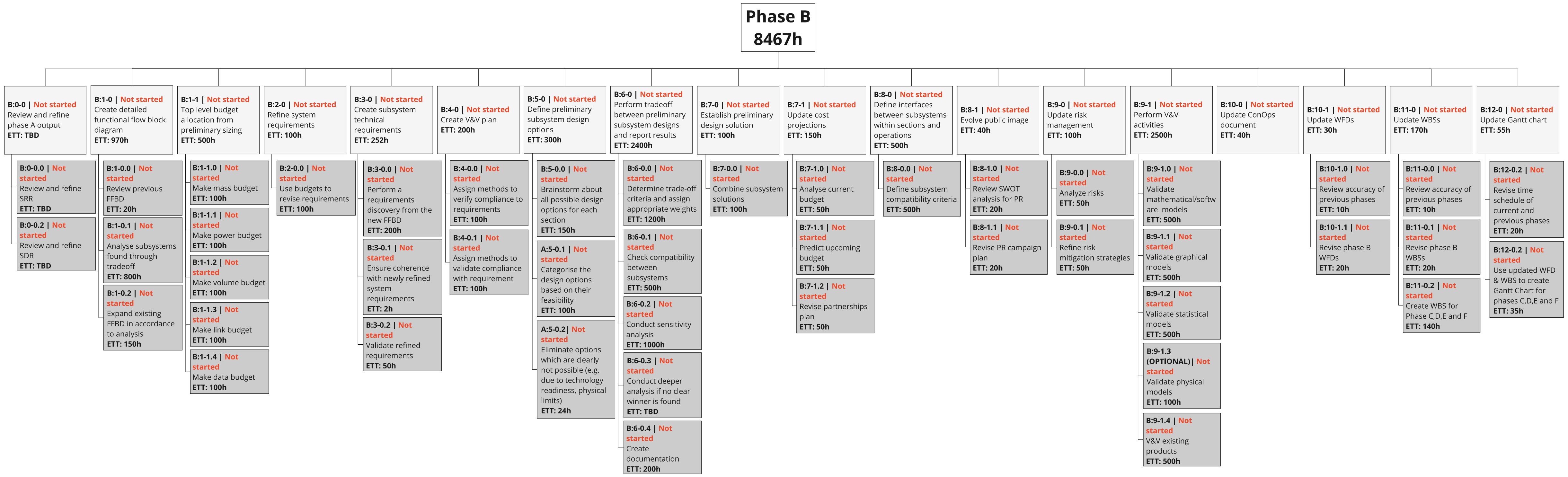

Figure 7.4 Work Breakdown Structure for Phase B

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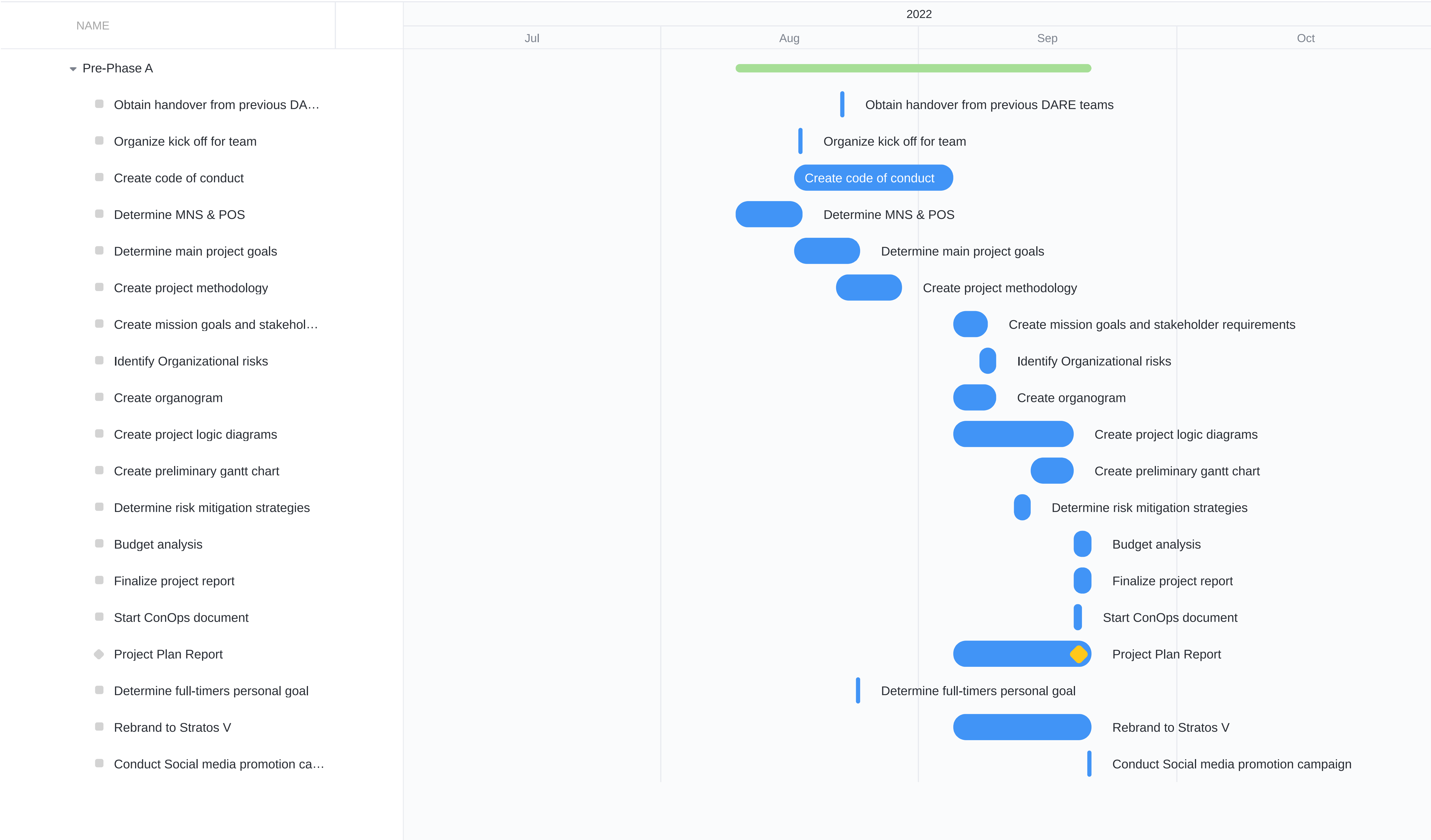

Figure 7.5 Gantt chart: Pre-Phase A

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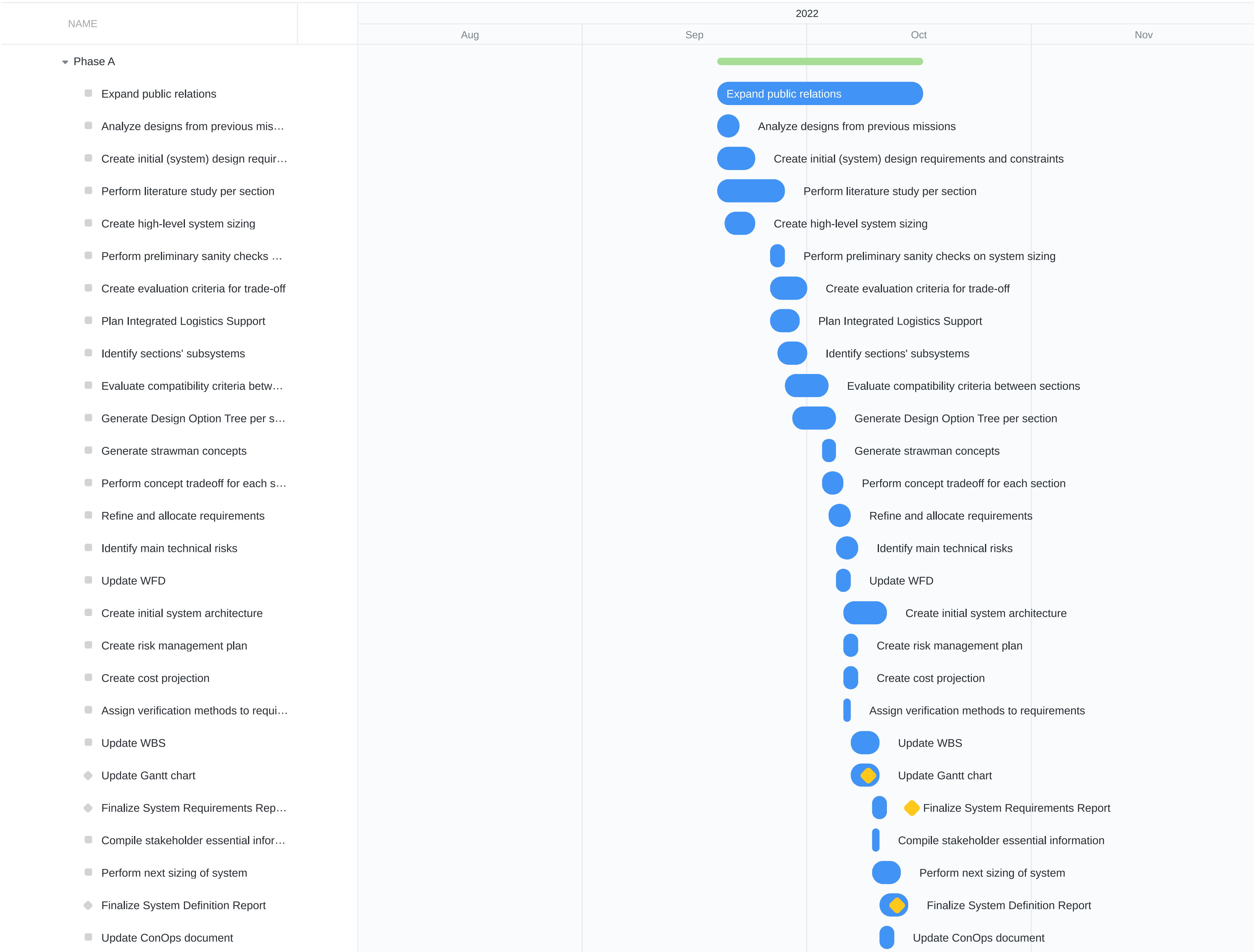

Figure 7.6 Gantt chart: Phase A

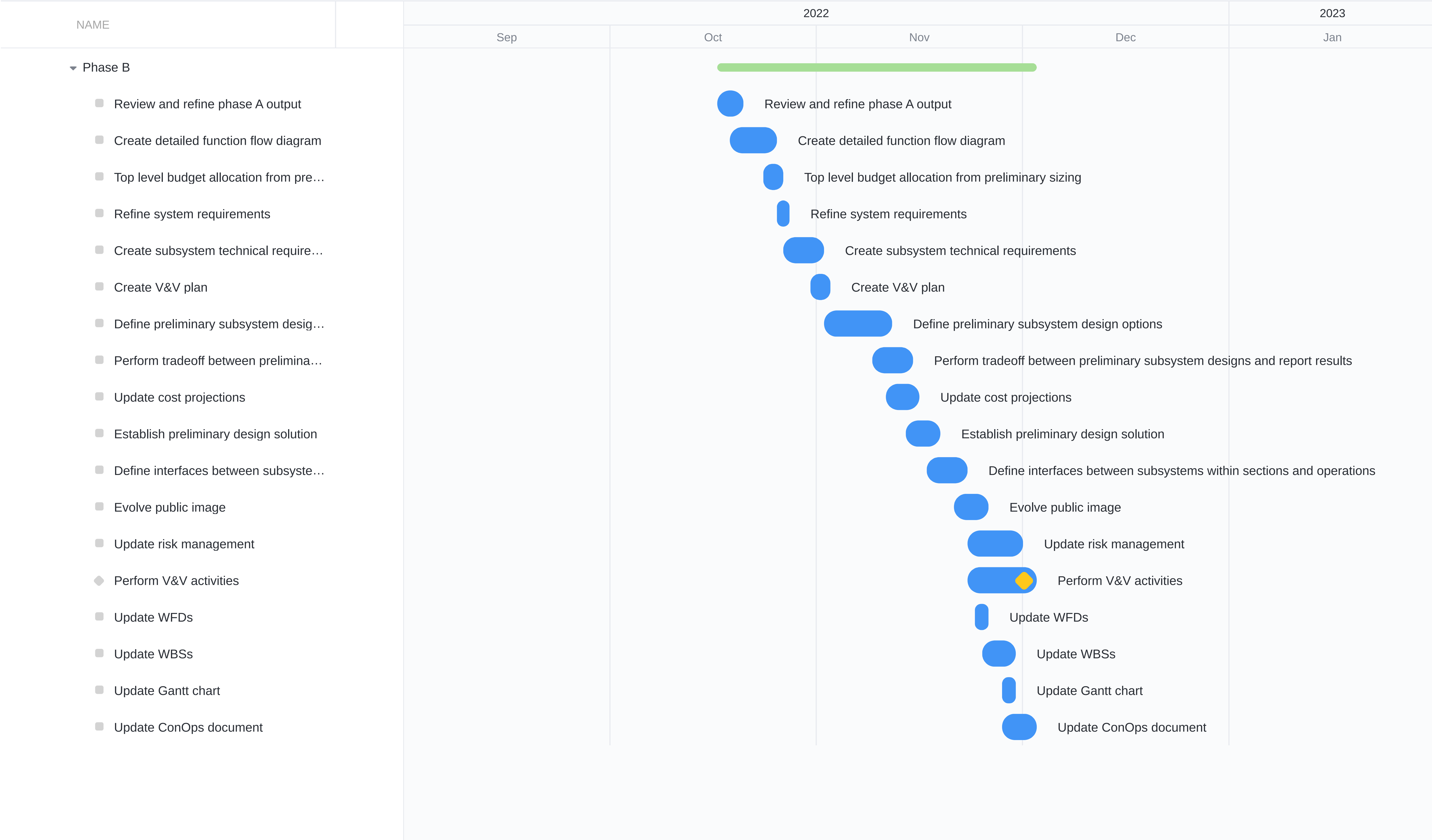

Figure 7.7 Gantt chart: Phase B

Figure 7.8 Gantt chart: Phase C

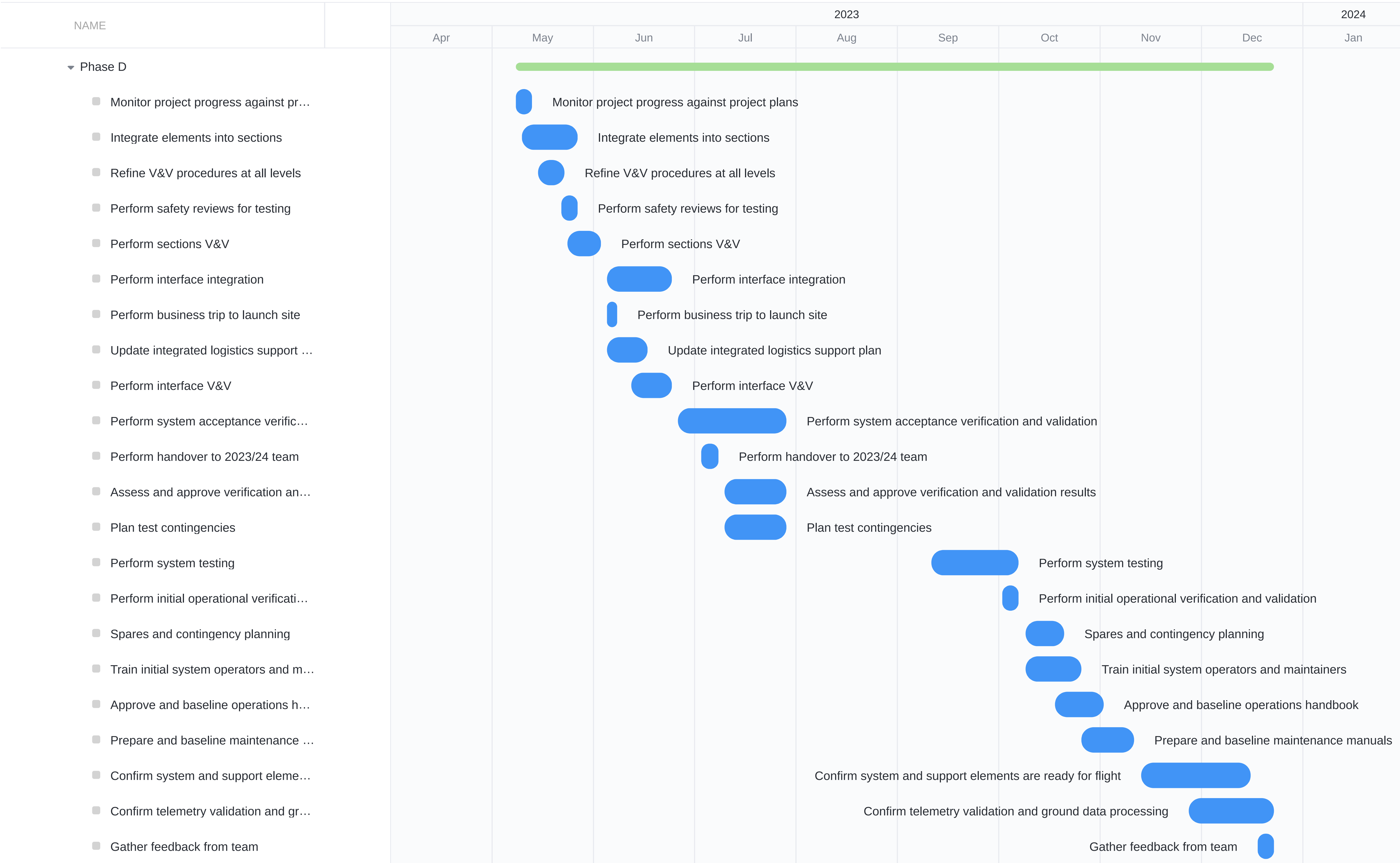

Figure 7.9 Gantt chart: Phase D

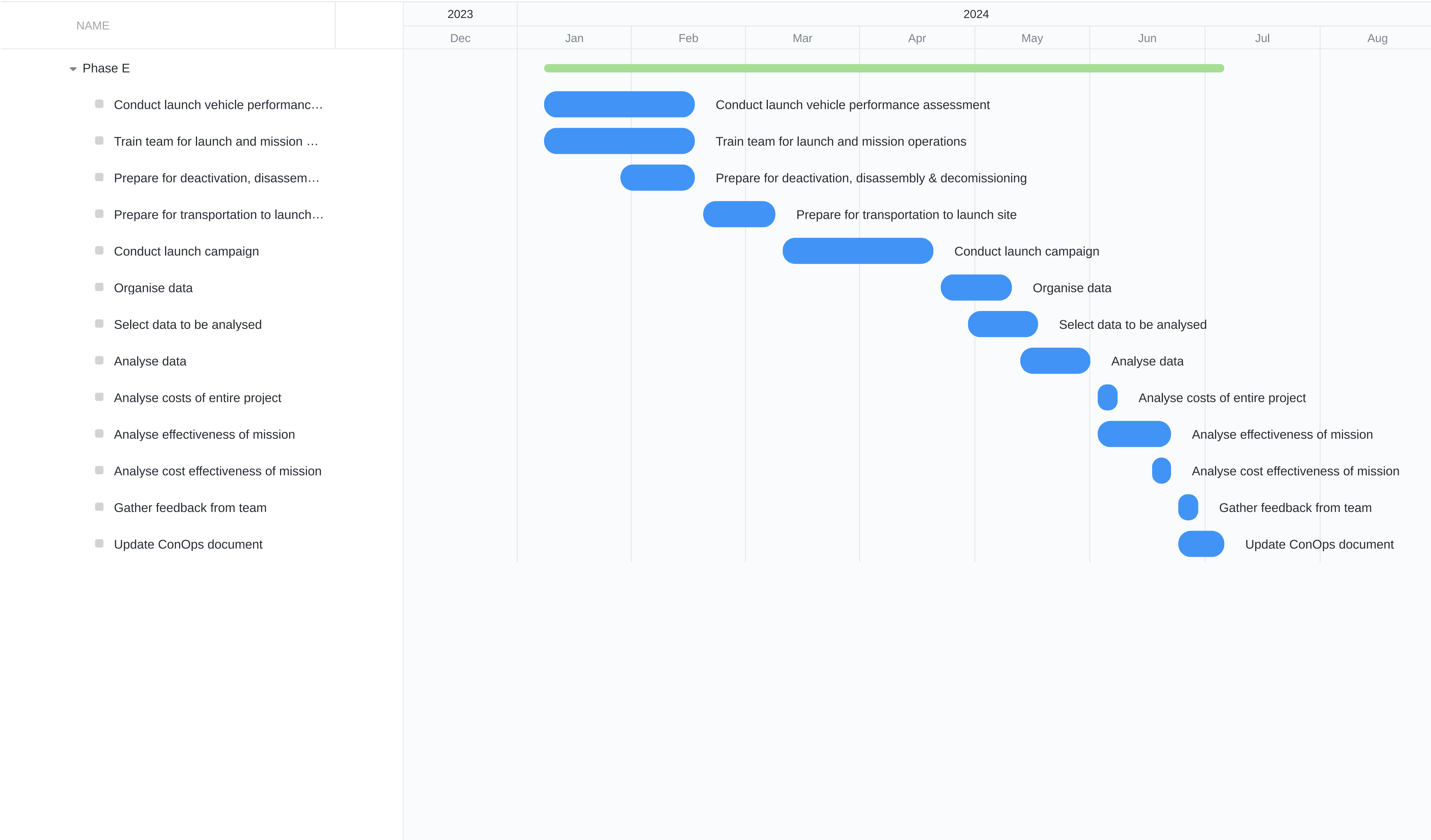

Figure 7.10 Gantt chart: Phase E

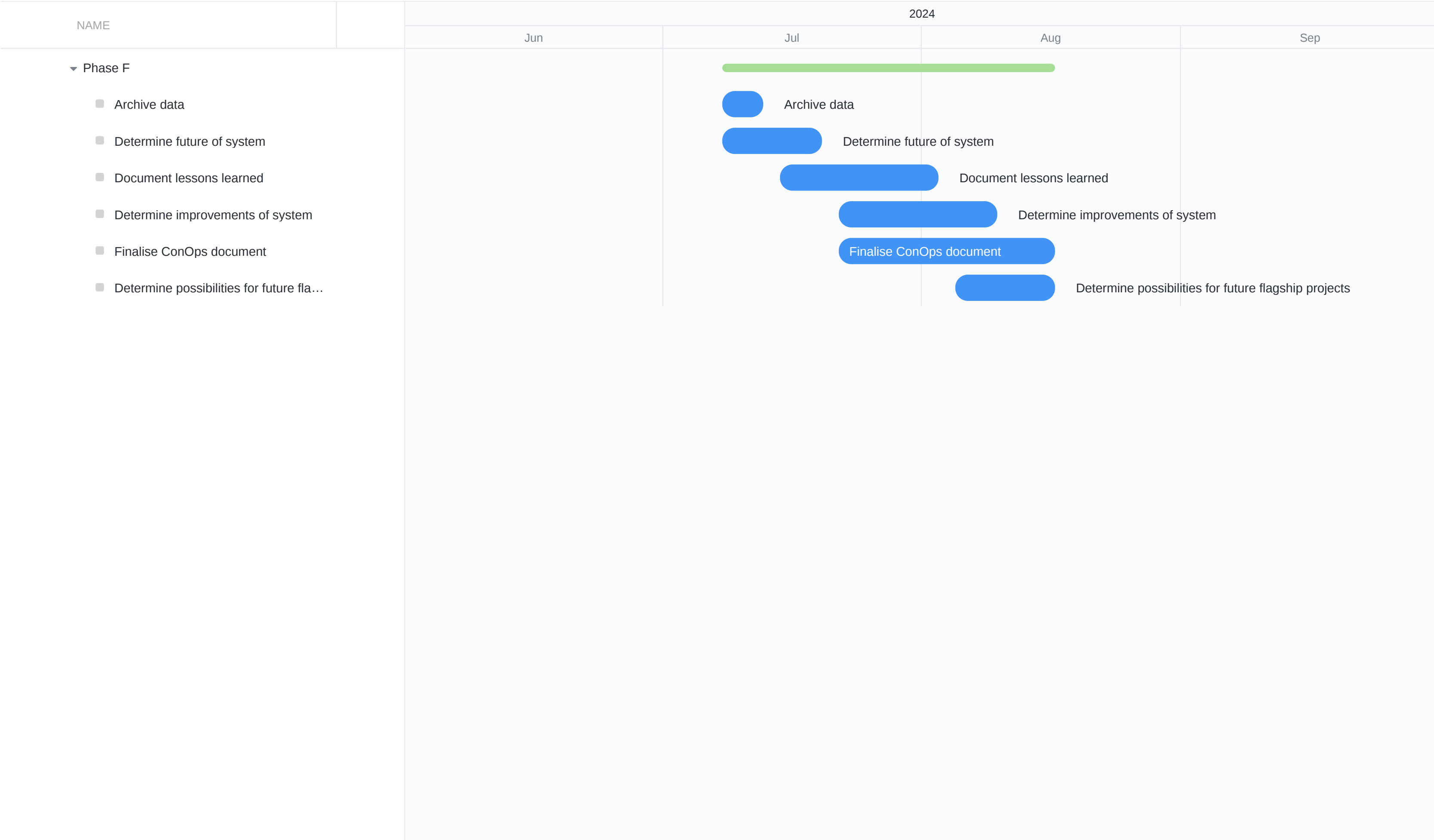

Figure 7.11 Gantt chart: Phase F

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8 Functional Analysis

Determining the functions of the rocket allows for easier formulation of requirements, and facilitates the planning of the project as a whole. The Functional Flow Diagram (FFD) and the Functional Breakdown Structure (FBS) provide a visual summary of what the rocket must do in each functional phase. The FFD is introduced in section 8.1, while FBS is covered in section 8.2.

8.1 Functional Flow Diagram

The Functional Flow Diagram provides a general, chronological overview on *what the system has to accomplish to successfully achieve the objectives of the mission*. Therefore, the diagram does not encapsulate the design process, as that is not a function of the system itself. The FFD begins at the production of the system and ends with the vehicle retrieval after the mission has been completed. At this point in the project, processes are still high level as the current goal is to get an overview of how the system would work. The flow diagram is shown in Figure 8.1.

8.2 Functional Breakdown Structure

The Functional Breakdown Structure provides a step-by-step breakdown of the processes shown in the Functional Flow Diagram. This diagram is usually one level deeper and aids its user in understanding a function in a more detailed way, since the functions mentioned in the Functional Flow Diagram are too broad on their own. The Functional Breakdown Structure is visible in Figure 8.2 and Figure 8.3. Section specific functions are colour tagged to facilitate creation of the future section requirements.

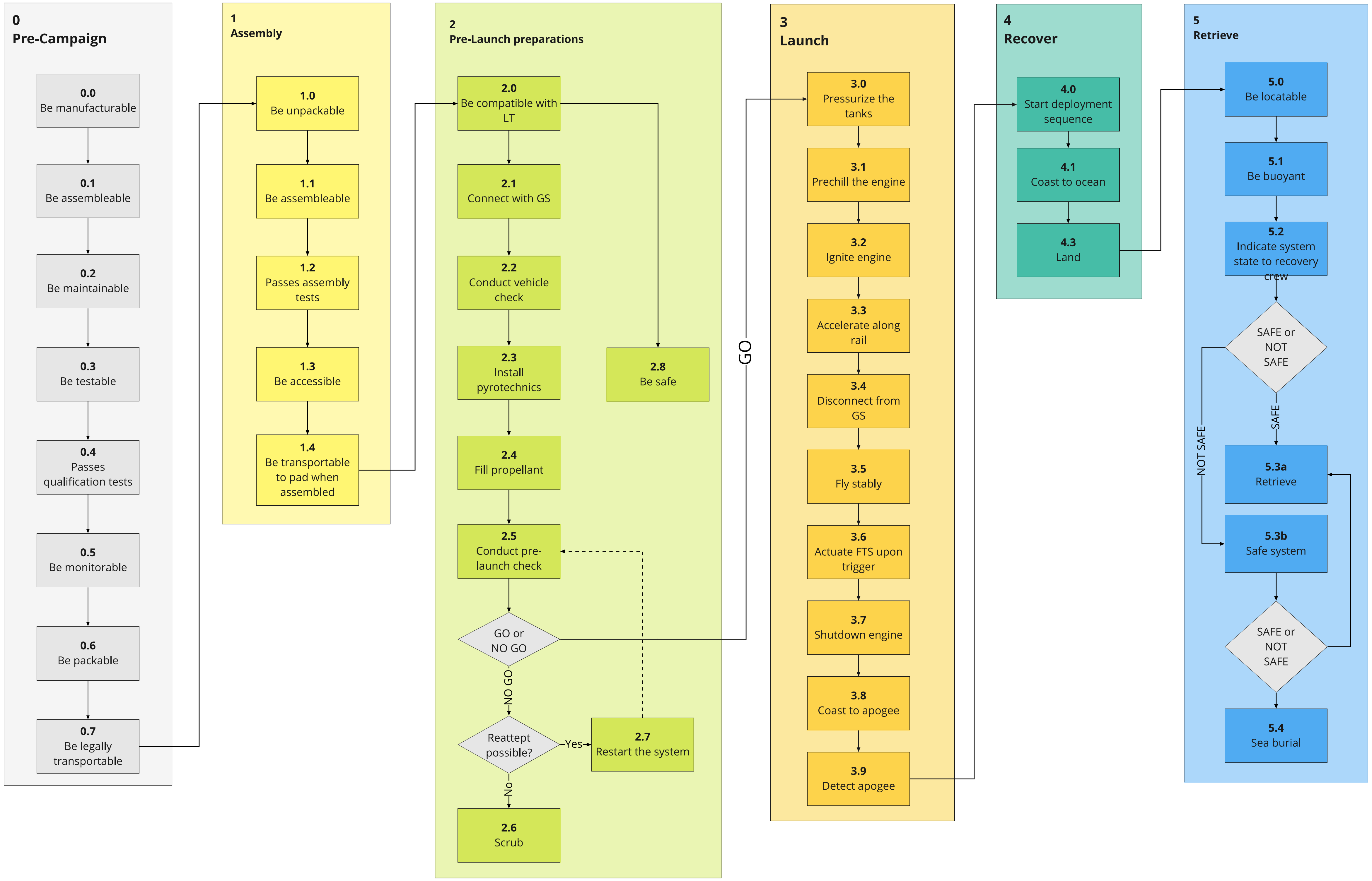

Figure 8.1 Stratos V Mission Functional Flow Diagram

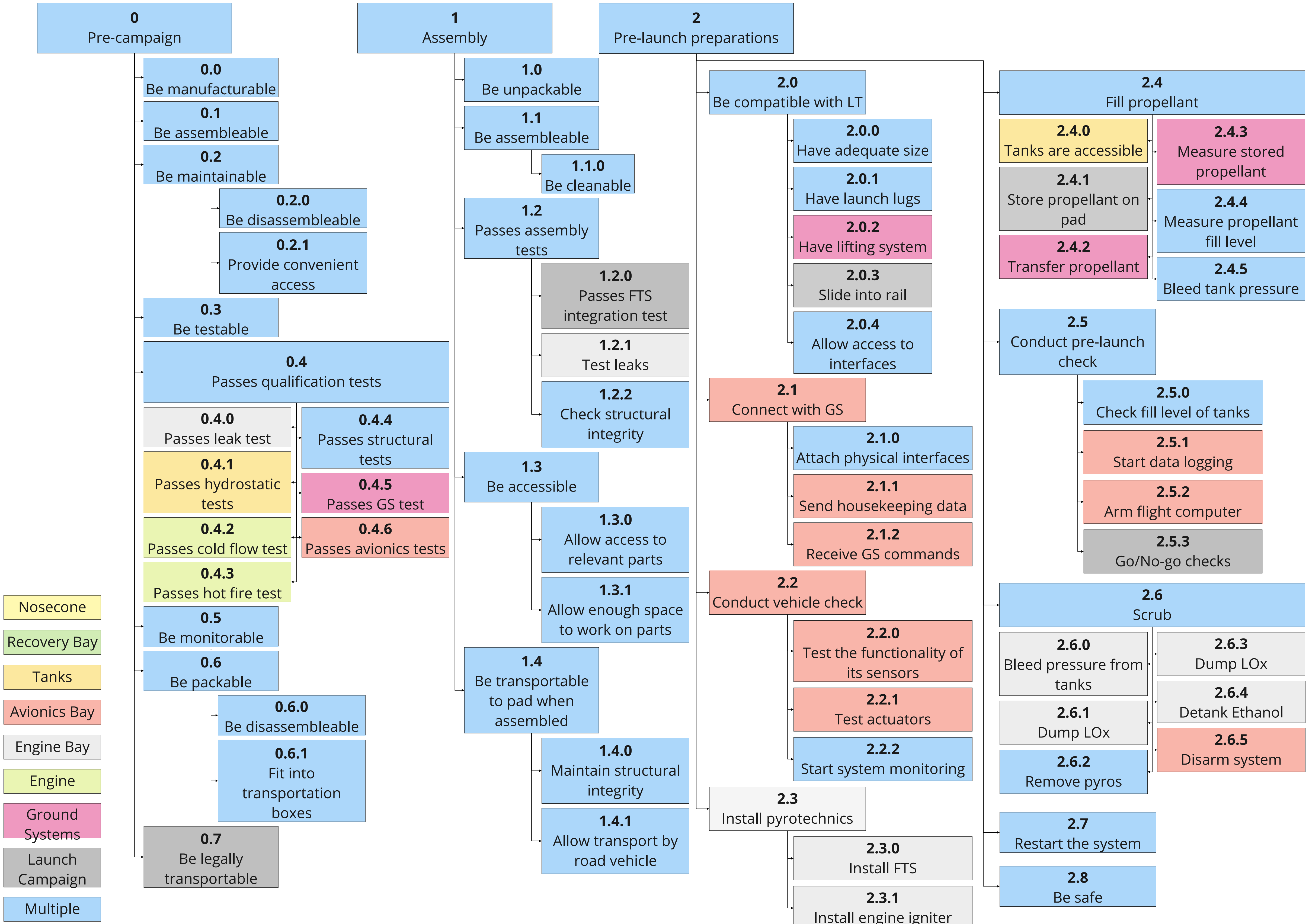

Figure 8.2 Stratos V Flow Breakdown Structure

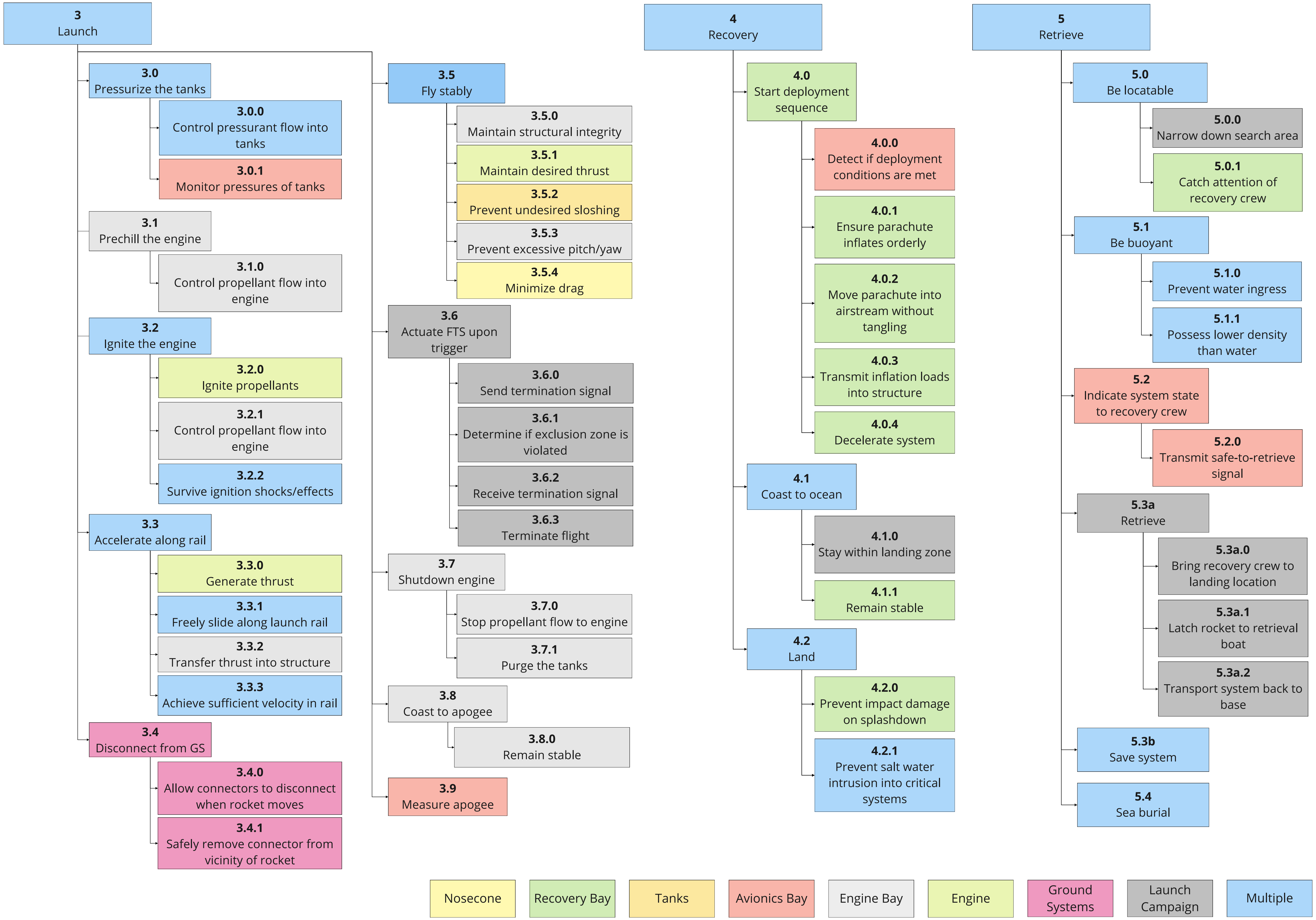

Figure 8.3 Stratos V Flow Breakdown Structure

9 Finances

As with any project, good finances are key to be able to keep going and increase innovation. In this chapter, the budgets of all the departments are laid out in detail, consisting of most of the expected expenses. Firstly, the total (preliminary) budget is given for the entire project. Then, this budget is split into different sections, with each section containing a department: the Electronics budget is found in section 9.2, the Propulsion budget in section 9.3, the Recovery budget in section 9.4, the Structures budget in section 9.5, the PR and Partnerships budget in section 9.6, the Launch Campaign budget in **??**, and the miscellaneous budget in section 9.7.

9.1 Preliminary Budget

To have an indication of the expenses of the full project per department, a preliminary budget needs to be made. Chiefs of the departments estimated what needs to be bought and what's the approximate cost based on previous Stratos and Project Sparrow expenses. These expected expenses were then checked by both the treasurer and chief engineer and altered where necessary. All the expenses are noted down as two different values. Namely, the 'likely cost' and the 'worst cost'. As the names suggest, the likely cost is the cost that is expected. The 'worst case' cost represents the most conservative estimate. On both of these costs a contingency is applied which differs per expenditure, depending on the certainty of the cost estimation. In Table 9.1 the full budget can be seen split into the different departments and activities. Launch campaign cost is an estimated figure.

Table 9.1 Stratos V Departments Preliminary Budget

Department	Total Likely Cost [€]	Total Worst Cost [€]
Electronics	€23,002.50	€59,212.50
Propulsion	€133,917.20	€225,339.25
Recovery	€8,250.00	€40,500.00
Simulations	€0.00	€0.00
Structures	€25,092.80	€229,491.00
PR and Partnerships	€4,111.00	€10,628.50
Launch Campaign	€100,000.00	€150,000.00
Miscellaneous	€17,342.84	€27,386.84
Total	€311,698.34	€772,612.09

Now all these department budgets will be further investigated by listing all the expected expenses. this will be done by giving the likely amount that need to be bought, the worst amount that needs to bought, the most likely the cost will be and the worst cost it can be. On top of both these costs, a contingency is placed as a 'safety' margin. Next to that, for each expenditure, a justification is given for the estimate of the costs.

9.2 Electronics Budget

Table 9.2 Stratos V Electronics Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
PCB Components	25	50	€ 200.00	€ 300.00	50%	General cost and experience
PCBs	30	50	€ 30.00	€ 50.00	50%	Iterations per board and JLC PCB cost
Drone telemetry antennas	2	4	€ 80.00	€ 100.00	50%	SIV
Wiring	1	2	€ 2,500.00	€ 3,000.00	50%	SIV and personal
On board cameras and infrastructure	5	10	€ 100.00	€ 250.00	50%	SIV
FTS	1	2	€ 500.00	€ 500.00	50%	SIV
Connectors	25	2	€ 2,500.00	€ 3,000.00	50%	Experience
Pressure Sensors	10	15	€ 175.00	€ 250.00	50%	Farnell
Other sensors	20	25	€ 50.00	€ 100.00	50%	Experience
Tools	5	10	€ 2,500.00	€ 3,000.00	50%	SIV and personal
Miscellaneous	1	1	€ 1,000.00	€ 1,000.00	50%	SIV
3D prints	10	15	€ 2.50	€ 5.00	50%	SIV
Aluminium housings	10	15	€ 50.00	€ 75.00	50%	Farnell

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9.3 Propulsion Budget

Table 9.3 Stratos V Propulsion Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Engine						
Print	3	5	€ 9,000.00		20%	Industry experts
Injector Manifold	3	5	€ 452.00		20%	SPA2
Injector Faceplate	3	5	€ 214.00		50%	SPA2
Pintle	3	5	€ 150.00		35%	SPA2
Film injector	3	5	€ 476.00		20%	SPA2
ChAD	3	5	€ 404.00		20%	SPA2
Nuts and bolts	21	35	€ 5.00	€ 7.50	10%	SPA2
Pintle seal	21	35	€ 80.00	€ 100.00	10%	SPA2
Battleship nozzles	2	3	€ 400.00		25%	SPA2
Testbed Feed						
Venturi	1	3	€ 650.00		30%	SPA2
LOx venturi fittings	1	3	€ 250.00		20%	SPA2
Repairs/upgrades	1	8	€ 1,000.00		50%	SPA2
Venturi tubing	1	1	€ 30.00		30%	SPA2
Flight Feed						
Cryo ball valve	5	7	€ 800.00		50%	Online search
None-cryo ball valve	5	7	€ 250.00		100%	Online search
Assorted fittings	1	1	€ 3,000.00		30%	SPA2
Flight valve act ethanol	9	13	€ 800.00		40%	4 times ground actuator estimate, assuredautomation.com
Flight valve act LOx	9	13	€ 1,000.00		40%	4 times ground actuator estimate, assuredautomation.com
Mass flow reg ethanol	2	3	€ 4,000.00		25%	Proper ones but halved
Mass flow reg LOx	2	3	€ 4,000.00		25%	Proper ones but halved
Venturi ethanol	1	2	€ 650.00	€ 2,500.00	30%	SPA2 / 3d print

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Table 9.3 continued from previous page

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Venturi LOx	1	2	€ 650.00	€ 2,500.00	30%	SPA2 / 3d print
Diff. press. sensors budget	2	2	€ 3,600.00		15%	SPA2
Seals	1	1	€ 100.00	€ 150.00	100%	SPA2
Various items	1	1	€ 100.00		100%	SPA2
Venturi tubing	2	4	€ 30.00		30%	SPA2
			Engine Assembly			
LOx cleaning supplies	3	5	€ 500.00		100%	SPA2, multiplied to account for more tests and launch campaign
Ultrasonic cleaning bath	0	2	€ 100.00	€ 150.00	10%	vevor.com
Various tools	3	5	€ 70.00	€ 150.00	10%	SPA2
Welding	1	2	€ 800.00	€ 1,200.00	50%	SPA2
			Testing			
Ethanol	1	1	€ 3,000.00	€ 4,000.00	100%	online search, 0.5 ton
LOx + N2	7	10	€ 1,250.00		30%	SPA2
Distilled water	1	1	€ 200.00	€ 250.00	20%	SPA2, 0.5 ton
Various testing devices	2	5	€ 80.00	€ 150.00	20%	SPA2
			Ground System Feed			
Quick Disconnect	1	2				Unknown
Filling arm	2	4				Unknown
Spill trays	4	8	€ 70.00		10%	SPA2
Assorted fittings	1	1	€ 400.00	€ 600.00	50%	SPA2
Tubing	1	1	€ 100.00	€ 200.00	50%	SPA2
Seals	1	1	€ 100.00	€ 150.00	100%	SPA2
Flexhoses	2	5	€ 200.00	€ 300.00	20%	SPA2

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9.4 Recovery Budget

Table 9.4 Stratos V Recovery Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Main parachute	1	2	€ 1,500.00	€ 4,000.00	50%	Rough estimate from experience of SIV/SPEARII considering very large parachute
Drogue	1	2	€ 800.00	€ 1,500.00	50%	Similar to SIV
Drogue deployment device	1	2	€ 800.00	€ 2,000.00	50%	Very similar to SIV/SPEAR, from experience
Main deployment device	1	2	€ 600.00	€ 1,500.00	50%	Will likely be simpler than Drogue (lower ejection velocity)
Retrieval Hardware	1	2	€ 1,500.00	€ 4,000.00	50%	Likely will require GPS/Beacon, worst case will require more advanced hardware
Testing	1	1	€ 300.00	€ 1,000.00	50%	Very similar to SIV/SPEAR, from experience

9.5 Structures Budget

Table 9.5 Stratos V Structures Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Laminating Supplies	1	1	€ 200.00	€ 1,000.00	100%	SIV, contingency from SIV including inflation
General untensils	1	1	€ 100.00	€ 500.00	100%	SIV
Tools	1	1	€ 250.00	€ 500.00	100%	SIV
Miscellaneous	1	1	€ 500.00	€ 1,000.00	100%	SIV
Nosecone coupler stock	1	1	€ 100.00	€ 100.00	100%	SIV

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Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Rec. Bay seperation collar stock	1	1	€ 76.20	€ 76.20	100%	SIV
Top skirt seperation collar stock	1	1	€ 76.20	€ 76.20	100%	SIV
Bottom skirt stock	1	1	€ 55.00	€ 55.00	20%	SIV
Engine Bay collars stock	1	1	€ 55.00	€ 55.00	20%	SIV
Additional Al smaller stock	1	1	€ 500.00	€ 1,000.00	20%	SIV
Carbon carbon fin leading edges	1	1	€ 2,000.00	€ 2,000.00	20%	SIV
Van Rental welding	1	1	€ 75.00	€ 100.00	50%	SIV
Van Rental Curing	2	2	€ 75.00	€ 100.00	50%	SIV
Van Rental Testing	2	2	€ 75.00	€ 100.00	50%	SIV
Van Rental Painting	1	1	€ 100.00	€ 200.00	50%	SIV
Van Rental Painting	2	2	€ 75.00	€ 100.00	50%	SIV
Van Rental Skirt Adhering	1	1	€ 75.00	€ 100.00	50%	SIV
LOX tank	1	2	€ -	€ 11,371.80	200%	Based on Acecare composite tanks
Ethanol tank	1	2	€ -	€ 10,577.70	100%	Based on Acecare composite tanks
Helium tank	1	2	€ 1,000.00	€ 5,000.00	100%	Based on current prices of similar pressure vessels
Carbon prepreg	1	1	€ -	€ 1,200.00	20%	SIV
Twaron prepreg	1	1	€ 1,100.00	€ 1,800.00	20%	SIV
Towpreg	1	1	€ -	€ 700.00	27%	SIV
Dry Carbon Fibers	1	1	€ 50.00	€ 100.00	20%	SIV
Adhesive Film	1	1	€ -	€ 300.00	20%	SIV
Hydrostatic testing	1	4	€ -	€ 1,000.00	10%	SIV
Vibrations testing	1	4	€ -	€ 10,000.00	10%	SIV
Unexpected and unplanned expenditures	1	3	€ 5,000.00	€ 5,000.00	50%	-

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Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Mould Nosecone	1	1	€ 2,500.00	€ 3,333.00	10%	SIV
Mould Shells	1	1	€ 2,500.00	€ 3,333.00	10%	SIV
Test bed steel stock	1	1	€ 120	€ 400	20%	Amazon, Metals4U
Tank flanges	2	4	€ 30	€ 50	10%	Sparrow
Tank end caps	4	6	€ 300	€ 400	20%	Sparrow
GS reinforcement Al stock	1	1	€ 230	€ 400	20%	Eurotruss

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9.6 PR and Partnerships Budget

Table 9.6 Stratos V PR and Partnerships Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Stickers Patch	300	600	€0.05	€0.10	20%	Online search
Stickers Logo	300	600	€0.05	€0.10	20%	Online search
PR Rocket Model	1	1	€1,000.00	€2,000.00	100%	Estimate based on SIV
Big posters/banners	5	10	€70	€100	30%	Online search
HDD	1	2	€60.00	€80.00	20%	Cost of current HDD
Rocket Liveries	1	1	€500.00	€600.00	100%	SIV
GoPros	2	5	€120.00	€170.00	50%	Second hand GoPros cost
Cables	5	10	€5.00	€10.00	100%	Online search
SSD	1	1	€150.00	€150.00	30%	Online search
Microphone	0	1	€200.00	€500.00	30%	Online search
Camera mounts	2	5	€10.00	€25.00	50%	Online search
Movie Camera	0	1	€100.00	€500.00	30%	Online search
Lights	0	2	€50.00	€100.00	30%	Online search
Online storage	24	25	€3.00	€10.00	50%	Google drive 200GB worst case 2TB

9.7 Miscellaneous

Table 9.7 Stratos V Miscellaneous Preliminary Budget

Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
One.com subscription 2022	1	1	98.92	n/a	-	Needed for email domain (SIV)
One.com subscription 2023	1	1	98.02	n/a	-	Needed for email domain (SIV)
Bank account cost 2022-2023	12	12	15.75	n/a	-	Needed for bank account (SIV)
Symposium 2022	1	1	500	n/a	-	Sparrow symposium

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Component	Amount Likely	Amount Worst	Likely Cost [€]	Worst Cost [€]	Contingency	Justification
Symposium 2023	1	1	1,600.00	2,000.00	-	Sparrow symposium
Symposium 2024	1	1	1,600.00	2,000.00	-	Sparrow symposium
Company travel in NL (for 3 ppl)	5	10	60.00	80.00	-	Travel cost estimate nl
Company travel outside NL (for 3 ppl)	3	5	300.00	500.00	-	Travel cost estimate EU
Company stay outside NL (for 3 ppl, 1 night)	3	5	60.00	100.00	-	Accomodation cost estimate EU
Food (2 days, 3 ppl)	3	5	50.00	70.00	-	Food estimate
Space Tech Expo						
Transport Devaña	1	1	400.00	500.00	-	Costs for 800[km] of Devaña
Stay	1	1	1500.00	2000.00	-	Online search for 20+ ppl
Transport (Train)	12	15	56.00	70.00	-	Train: 56 round cost pp, Delft-Bremen
Food (20 ppl)	3	4	70.00	100.00	-	Avg. food per day for 20 ppl according to Sparrow HFC
Cold- and Hot-fire Campaigns						
Stay scouting	6	8	554.00	600.00	-	HFC2.3 Sparrow
Travel	6	8	300.00	400.00	-	HFC2.3 Sparrow
Food	6	8	220.00	300.00	-	HFC2.3 Sparrow
Other Events						
Rocket Reveal Event	1	1	2,500.00	4,000.00	-	Sparrow Symposium with extras due to event size

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STRATOS

10 Conclusion

This report provides prospective planning for any involved parties on how the Stratos V team will accomplish the aim of *"developing a European technology demonstrator for a reusable launch vehicle"*. It illustrates the project's route towards sustainability within rocketry in Europe and within DARE, while contributing to the educational experience of its members.

The Mission Need Statement (MNS) and Project Object Statement give insight and clarity on the mission and goals of the Stratos V project, and the team running it in this year. The Project Objective Statement reads: *"To perform the preliminary system design as well as the detailed design and testing of selected subsystems of a recoverable and refurbishable liquid bi-propellant rocket capable of breaking the DARE altitude record by a team of students during the academic year 2022/23."*. These statements provide the basis for the rest of the planning and the project goals - with the latter split into primary, secondary, and moon goals. Primary goals directly relate to the MNS, secondary goals are in support of the primary, and moon goals directly stem from the members' ambitions. In addition, a distinction is made for goals that especially pertain to the current year's team. Along with the stakeholder requirements, they form the requirements that need to be met in order to successfully complete the project. To ensure efficient communication and workload distribution, the team has decided to split its members into departments. These departments will work together on predefined sections of the rocket, while managing their department specific workload individually. A risk analysis is conducted, mapping out organisational risks, and developing mitigation strategies. Following this a SWOT analysis was conducted, identifying Strengths, Weaknesses, Opportunities and Threats to the project. The project is split into 7 phases following a NASA systems engineering approach: pre-phase A, followed by phases A through F. Work Flow Diagrams (WFDs) have been made for all phases, with pre-phase A, phase A, and phase B receiving Work Breakdown Structures (WBSs) as well. The tasks from the WBSs are used to generate a Gantt-chart. Further WBSs will be made in later phases, together with updates to the WFDs and existing WBSs. A Functional Flow Diagram was made, from which a Functional Breakdown Structure was derived. This serves to identify the functions the system must perform, which flow into requirements in later phases. Finally, preliminary budgets have been estimated for each department. These budgets are to be approved by the DARE board and altered if the board deems it necessary. The Stratos V team will strive to gain in-kind or monetary sponsorships to cover these costs.

After the review of this report we will move forward to phase A. We will progress by following the WFD of phase A starting with an analysis of previous projects on a technical perspective.

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