
**Space systems — Spacecraft and launch
vehicle combined operation plan (COP)
at launch site — General format**

*Systèmes spatiaux — Plan d'opérations combinées (COP) des véhicules
spatiaux et des lanceurs sur le site de lancement — Format général*

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

The purpose of this document is to provide spacecraft (SC) and launch vehicle (LV) organizations with the general format for presenting the Combined Operation Plan (COP).

Currently, launch service providers have their own COP at each launch site. Standardization of COP will minimize cost and time to have the common baseline of the general operation requirements between SC and LV.

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Space systems — Spacecraft and launch vehicle combined operation plan (COP) at launch site — General format

1 Scope

This document provides general format for spacecraft and launch vehicle Combined Operation Plan (COP).

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at <http://www.electropedia.org/>

— ISO Online browsing platform: available at <http://www.iso.org/obp>

COP Combined Operation Plan

LV Launch Vehicle

ML Movable Launcher

PLA Payload Adapter

RF Radio Frequency

SC Spacecraft

4 General requirements

General requirements shall include:

- a) requirements for entering the COP;
- b) requirements applicable to all operations;
- c) launch site facilities; and
- d) range safety.

5 SC/PLA mating and fairing-encapsulation (operation plan at spacecraft processing facility)

The SC/PLA mating and fairing-encapsulation (operation plan at the SC processing facility) shall include:

- a) an overall description of the SC/PLA mating and fairing-encapsulation;
- b) the operation sequence and work allocation/responsibility;

- c) the schedule; and
- d) details of the operation.

6 Encapsulated-fairing mating to core vehicle

The encapsulated-fairing mating to the core vehicle shall include:

- a) an overall description;
- b) the operation sequence and work allocation/responsibility;
- c) the schedule; and
- d) details of the operation.

7 Operations at the Vehicle Assembly Building (VAB)

The operations at the Vehicle Assembly Building (VAB) shall include:

- a) an overall description;
- b) the schedule; and
- c) details of the operation.

8 Final RF dress rehearsal

The final RF dress rehearsal shall include:

- a) an overall description;
- b) the schedule; and
- c) details of the operation.

An example of the COP based on a general format is provided in [Annex A](#).

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Annex A (informative)

Draft format — Example of a COP based on a general format

This annex provides an example of a SC and Launch Vehicle Combined Operation Plan (LV COP) at a launch site, based on a general format. Requirements are examples only.

Spacecraft and Launch Vehicle Combined Operation Plan at launch site, general format

1 Scope

This document provides a general format for a spacecraft and launch vehicle Combined Operation Plan (COP).

The COP defines requirements, procedures and the schedule for SC/LV-integrating operations conducted at a launch site by both the Spacecraft (SC) and the Launch Vehicle (LV) organization. The COP is applicable to the following operations that start from the mating of the SC and Payload Adapter (PLA) to launch (L-0):

- (1) SC/PLA mating(s);
- (2) Fairing-encapsulation;
- (3) SC/PLA(s) and fairing mating to core vehicle;
- (4) Operations at VAB (*1);
- (5) Launch preparation up to lift-off.

(*1) The following two facilities are assumed for spacecraft processing at the launch site:

- i) Spacecraft processing facility:

A facility where the SC's stand-alone operation (final assembly, propellant loading), SC/PLA mating(s) and fairing-encapsulation are conducted.

- ii) Vehicle Assembly Building:

A facility where the SC/PLA(s) and fairing are mated to the core vehicle (i.e. upper stage of LV).

2 Normative references

The following documents are applicable to the COP. In the event of a conflict in the description of this COP and the following documents, the descriptions of the COP supersede that of the referenced documents.

- | | | |
|-----|-------------|---|
| [1] | (TBD) | Spacecraft/Launch Vehicle Interface Control Document(ICD) |
| [2] | (TBD) | Safety Regulation for Launch Site Operation/Flight Control Operation. |
| [3] | (TBD) | Spacecraft Contamination Control Plan. |
| [4] | ISO 14620-2 | Safety requirements – Part 2: Launch site operations |
| [5] | ISO 26870 | Launch pad and integration site operational documents |

3 Terms, definitions and abbreviated terms

(1) Definitions

Operation Plan: Operational schedule showing operational chaining, responsible and safety requirement level (if not defined in another document)

Upper Composite: Spacecraft mated on its adaptor and encapsulated inside the fairing

(2) Abbreviated terms

COP	Combined Operation Plan
EGSE	Electric Ground Support Equipment
ICD	Interface Control Document
LV	Launch Vehicle
MGSE	Mechanical Ground Support Equipment
NFI	Non-Flight Item
NVR	Non Volatile Residue
PLA	Payload Adapter
RCS	Reaction Control (gas jet) System
RF	Radio Frequency
SC	Spacecraft
UC	Upper Composite
VAB	Vehicle Assembly Building

4 General requirements

4.1 Requirements for entering the COP

The following requirements shall be satisfied before entering the COP:

- (1) The SC, LV and launch range shall be ready to enter the COP; this readiness shall be formally agreed between the three parts after presentation of their respective preparation status (before the first combined operation) and will include:
 - i) no show stoppers; and
 - ii) all anomalies still to recover are known and agreed.
- (2) Specific MGSE and EGSE including a harness necessary for the SC organization provided by the LV or launch range organization shall have been controlled, validated and formally agreed by the SC organization. The SC organization shall have been trained to their use if necessary.
- (3) Safety rules applicable on the launch site shall be known and accepted by the three parts (local application of [4]).
- (4) Safety responsibilities shall be known and accepted: range safety is overall responsible but for the Launch Complex where the LV organization is responsible.
- (5) Working rules (local application of [5]) shall be known and accepted.

- (6) SC team formation for the use of cranes, rolling systems and height of the work table.
- (7) UC air conditioning plan agreed between LV and SC.
- (8) A nominal COP planning with all foreseen combined operations on LV and SC operations during the COP shall be available and formally accepted at least by the SC and LV parts.
- (9) A directory shall be available and provided to SC, LV and range teams identifying (name and phone number):
 - i) LV, SC and range responsible people;
 - ii) safety responsible people; and
 - iii) other practical information (logistics, planning, etc...).

The coordination responsible for the SC and LV sides shall be identified and a coordination process (daily meetings) shall be agreed.

4.2 Requirements applicable to all operations

The following requirements are applicable to all the operations scoped in the COP.

“TBD” depends on the specific COP plan for the mission accepted and signed by the LV and SC operations’ responsible before its beginning.

4.2.1 Spacecraft

- (1) Cleanliness and contamination control:
Cleanliness and contamination requirements per reference document [3].
- (2) Periodical SC-health monitoring:
Periodic health-check of SC is conducted once per (TBD) days.
- (3) Battery charge:
Battery charge for SC is conducted at least during (TBD) hours periodically.
- (4) Photographs:
Photographing is conducted as follows:
 - i) L-(TBD): Non-Flight Item(NFI) removal before SC/PLA mating;
 - ii) L-(TBD): NFI removal after SC/PLA mating and encapsulation;
 - iii) L-(TBD): MLI installation after SC/PLA mating; and
 - iv) L-(TBD) to L-0: Before access door closeout of fairing.

4.2.2 Launch Vehicle

The following operations conducted for launch vehicle integration are considered hazardous and SC-operations are prohibited during these operations:

- (1) pyrotechnics circuit connection: TBD hours@L-(TBD);
- (2) arming of interlock devices: TBD hours@L-(TBD);
- (3) pressurization of gas tanks: TBD;
- (4) propellant loading for auxiliary propulsion system: L-(TBD).

Daily coordination between the SC, LV and possibly the range will be conducted to establish the sequence of operation of the day. It is organized by the LV operational responsible.

4.3 Launch site facilities

- (1) RF links and networks:

(TBD)

- (2) Operation communication system:

The following channels for the communication system are available for SC in conformance with the ICD [1]:

- i) channels (TBD) and (TBD) for SC-stand-alone operation; and
- ii) channel (TBD) for communication with LV organization after encapsulated-fairing is mated to core vehicle (operations at Vehicle Assembly Building).

- (3) Monitoring camera:

The SC is monitored for security purposes at spacecraft processing facilities.

- (4) Environment condition real-time monitoring systems:

Environment condition real-time monitoring system will be available at SC-check out room at the spacecraft processing facility to monitor the following:

- i) SC health status;
- ii) temperature inside the fairing; and
- iii) toxicity detectors for safety purposes.

- (5) Environmental condition recording for post treatment:

The environmental condition recorded measurement will be available at SC-check out room at spacecraft processing facility to verify the following:

- i) temperature and relative humidity inside the UC or the transportation platform; and
- ii) shocks on the UC or the transportation platform.

Range safety:

- (1) Hazardous operations for SC:

[Table A.1](#) identifies hazardous items for SC:

Table A.1 — SC Hazardous item identification

Category	Hazardous systems	Hazardous medium
Toxics	Propulsion system	Hydrazine, or derivatives Other propellants (TBD)
High pressure gas	Reaction Control System (RCS)	GHe (TBD)
RF (Radio Frequency) Emission	S-/X-band antennas	Radio frequency

- (2) Hazardous Operations for LV:

[Table A.2](#) identifies hazardous items for LV:

Table A.2 — LV Hazardous Item Identification

Category	Hazardous systems	Hazardous medium
Toxics	Main propulsion systems Auxiliary propulsion systems	Propellants (TBD)
High Pressure Gas	Propellant tanks Roll and Attitude Control System (RACS)	Helium, Nitrogen Other (TBD)
Pyrotechnics	Solid propulsion ignition systems Separation Systems	Pyrotechnics
RF (Radio Frequency) Emission	S-/X-band Antennas	Radio frequency

4.4 Regulations

Conductible operations and personnel are limited during operations that includes hazardous media. Operation planning will be established in agreement between the SC and LV organization. Real time coordination will be under the LV's responsibility.

(1) Number limitation of personnel:

Number of personnel that can operate during hazardous operations are limited, as described in [Table A.3](#).

Table A.3 — Operable number of personnel at processing facilities

Spacecraft processing facility		Vehicle Assembly Building (VAB)	
Airlock	TBD	Ground and dedicated LV Floors	TBD
Assembly hall	TBD	Payload and Fairing Check-out Floor	TBD
Propellant loading room	TBD	—	—

(2) RF emission regulations:

RF emission by the SC and LV may be prohibited during the following operations, depending on safety requirements based on SC and LV designs (number of protection barriers for pyrotechnics and qualified sensitivity levels):

- (1) SC's pyrotechnics line connection at the spacecraft processing facility (not applicable to SC);
- (2) LV's pyrotechnics line connection and arming of interlock devices at the VAB; and
- (3) Power-on after LV-arming.

After LV arming, accessibility is strictly regulated under LV responsibility according to safety rules. In particular, when the power of the SC or LV is on, personnel can be prohibited to access the SC and LV.

5 SC/PLA mating and fairing-encapsulation (operation plan at spacecraft processing facility)

5.1 Overall description of SC/PLA mating and fairing-encapsulation

Combined operations during this period are as follows:

- (1) SC and PLA mating(s);
- (2) Fairing encapsulation (if not implemented at the VAB with the same sequence); and
- (3) Eventual transportation of the SC/PLA composite to the VAB (if encapsulation at the VAB) – See Clause 6.

5.2 Operation sequence and work allocation/responsibility

The operation sequence is as follows. A parenthesis indicates the work-responsible organization:

- (1) SC and PLA mating:
 - i) NFI removed before mating (SC);
 - ii) lifting and crane operation of the SC and transfer to above PLA. (SC) to a given decided distance from the PLA;
 - iii) hand-over of crane operation to the LV organization;
 - iv) final SC approach on the PLA (LV);
 - v) mechanical and electrical mating of the SC to the PLA (LV);
 - vi) visual inspection (SC and LV);
 - vii) MLI installation, if required (SC); and
 - viii) battery charge (SC).
- (2) Fairing encapsulation:
 - i) NFI removed before mating (SC);
 - ii) final preparation of the fairing for encapsulation (LV);
 - iii) encapsulation of the SC/PLA including mechanical, electrical and venting connections (LV);
 - iv) conditioned-air supply to fairing (LV);
 - v) battery charge (SC);
 - vi) periodic SC health monitoring (SC); and
 - vii) access door installation.(LV).

5.3 Schedule

The typical schedule for this period is shown in [Figures A.1](#) and [A.2](#).

SC/PLA Mating	Day1	Day2
NFI Removing before Mating(SC)		
Lifting & Mating SC to PLA.(SC & LV)		
Visual Inspection(SC & LV)		
MLI Installation(if required)(SC)		
Battery Charge(SC)		

Figure A.1 — SC/PLA mating schedule (typical)

Encapsulation of SC/PLA	Day1	Day2
NFI Removing before Mating(SC)	■	
Preparation for Encapsulation(LV)	■	
Encapsulation of SC/PLA(LV)	■	
Conditioned-Air Supply(LV)	■	
Periodic Health Monitoring(SC)		■
Battery Charge(SC)		■
Access Door Installation(LV)		■

Figure A.2 — SC/PLA encapsulation schedule (typical)

5.4 Details of operation

Detailed operations are conducted as follows:

(1) Crane or rolling support operation:

For encapsulation preparation, crane or rolling support operation schedule and allocation, see Figure (TBD). The allocation will be coordinated and established by both the SC and LV organizations.

(2) Conditioned-air supply:

Conditioned-air with the required cleanliness level will be supplied into the fairing to maintain the required temperature level. Conditioned-air will be supplied through a large door or a dedicated system. This system design shall take care not to generate any air over-speed prohibited to the SC. Conditioned-air supply will be conducted by the LV organization in conformance with the ICD (1).

(3) Height worktable:

The height worktable is available to the SC at SC-stand-alone operation when removing the NFI before the SC mating to the PLA.

The height worktable shall be available to the SC up to encapsulation whatever the encapsulation logic and process.

(4) Grounding:

The grounding of the SC is conducted by the SC organization before the SC is mated to the PLA, SC-stand-alone operation including battery recharge.

After the SC is mated to the PLA, the grounding of the SC is secured through the mating plane of the PLA. The grounding of the PLA is conducted by the LV organization. The bonding between mating plane of the SC and the PLA is measured and guaranteed by the LV organization.

(5) Mating SC to PLA:

Details of the SC/PLA mating are as follows. A parenthesis indicates the work-conducting organization:

- i) visual inspection of mating plane on SC (SC) and LV (LV) sides;
- ii) separation system installation (LV); and
- iii) umbilical connector connections (LV).

(6) Battery charge:

In case the SC's battery charge does not use the umbilical connector, a cable for the SC's battery charge will be connected by the SC organization on the SC-side to the PSS and on the ground side to

the Battery Enable Relay Box (BERB), a part of the EGSE. This cable is disconnected when battery charge is completed.

In case the SC's battery charge uses the umbilical, the SC organization can monitor it in coordination with the LV organization for what concerns the planning.

In any case, it is understood that umbilical lines in this configuration have been controlled previously by the LV organization and validated with the SC organization which has accepted them formally.

(7) Toxics monitoring:

Toxics monitoring is conducted by the LV organization. Personnel will enter the processing room after confirming toxics are not detected.

6 Upper Composite mating to core vehicle

6.1 Overall description

The combined operations at this period are as follows:

- (1) the UC or SC/PLA transportation to the VAB;
- (2) the eventual fairing encapsulation (if implemented at the VAB) – See Clause 5; and
- (3) the fairing mating to Upper Stage.

6.2 Operation sequence and work allocation/responsibility

The operation sequence is as follows. A parenthesis indicates the work-responsible organization:

- (1) UC or SC/PLA transportation to VAB:
 - i) preparation of transporter (LV);
 - ii) periodic SC-environment monitoring (SC);
 - iii) large door closeout (LV);
 - iv) lifting the UC or SC/PLA to the transporter (LV);
 - v) thermal, mechanical and humidity monitoring/recording implementation;
 - vi) weather judgment for transportation (LV who informs the SC);
 - vii) conditioned air supply from the air-supply trailer (LV);
 - viii) transportation to the VAB (LV); and
 - ix) environment record sent for data post processing and ICD [1] conformance verification.
- (2) UC mating to upper stage:
 - i) lifting or rolling the UC and mating to the upper stage (LV);
 - ii) mechanical and electrical connections to the LV, eventually to the ground through the fairing umbilical;
 - iii) air duct connection to fairing (LV);
 - iv) periodic SC-environment monitoring (SC);
 - v) SC-health monitoring (SC);
 - vi) SC-battery charge (SC).

6.3 Schedule

The typical schedule for this period is shown in [Figure A.3](#).

Fairing Mate to Core Vehicle	Day1	Day2	Day3
Preparation of Transporter(LV)	█		
Periodic Health Monitoring(SC)	█		
Large Door Closeout(LV)	█		
Lifting Fairing to Transporter(LV)	█		
Weather Judgement(LV)		█	
Conditioned-Air Supply(LV)		█	
Transportation to VAB(LV)		█	
Lifting/Rolling Fairing and Mate to Upper Stage(LV)		█	
Air Duct Connection Fairing			█
Periodic Health Monitoring(SC)			█
Battery Charge(SC)			█

Figure A.3 — Fairing/core vehicle mating schedule (typical)

6.4 Details of operation

Detailed operations are conducted as follows:

(1) Grounding:

Grounding of the SC is secured through the mating plane of the PLA assembled to the fairing. Grounding of the fairing is conducted and guaranteed by the LV organization. Grounding during transportation from the spacecraft processing facility to the VAB is not conducted.

(2) Weather judgment for transportation:

Go/no-go of transportation to the VAB is determined based on the regulation shown in [Table A.4](#).

Table A.4 — Weather judgment regulation

	Regulations
Temperature	(TBD)C - (TBD)C
Humidity	(TBD)C < Due Point < (TBD)C
Wind speed	< (TBD)m/sec
Rainfall	< (TBD)mm/hour
Lightning	No-risk of lightning for a time duration compatible with the transfer

(3) Toxics monitoring:

Toxics monitoring is conducted by the LV organization. Toxics monitoring is not conducted while the fairing is lifted at the VAB prior to mating to the upper stage.

(4) Environment monitoring:

Environment monitoring inside the fairing during transportation is conducted by the LV organization. Records of monitoring can be reported to the SC organization

7 Operations at Vehicle Assembly Building (VAB)

7.1 Overall description