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Preparing principles of schedule network for spacecraft development

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Preparing principles of schedule network for spacecraft development

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FOREWORD

The standard is translated from the Chinese version of Standard on GB/T 29073-2012 released by Standardization Administration of China (SAC) under the management of State General Administration of Quality Supervision and Inspection and Quarantine. TC 425 is responsible for the translation. In case of any doubt about the contents of English version, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with rules given in GB/T 1.1-2009.

This standard is proposed by China Aerospace Science and Technology Corporation.

This standard is under the jurisdiction of National Technical Committee on Space Technology and Operation of Standardization Administration of China (SAC/TC 425).

INTRODUCTION

This standard belongs to the National Standard System of China Space. The National Standard System of China Space is applicable to the formulation, revision, and management of national standards in the field of space, covering three sectors of space management, space technology, and space application and services and serving as the basis for guiding spacecraft and launch vehicle project management, engineering, space launch services, and in-orbit satellite applications.

Schedule network is one of the most important core content in the spacecraft development schedule management, and also the executive plan of schedule coordination and control of all development technologies and management activities (design, analysis, manufacturing, test, product inspection and acceptance, and project management). This standard is hereby formulated to standardize and guide the preparation of spacecraft development schedule network and schedule management, and actively promote the completion of spacecraft development tasks as scheduled.

Preparing principles of schedule network for spacecraft development

1 Scope

This standard specifies requirements of terms, principles, basis, system, contents, steps etc. in preparing the schedule network for spacecraft development (hereinafter referred to as schedule network).

This standard is applicable to the preparation of schedule network for the spacecraft system, subsystem, equipment and work items (including software) classified based on the level, and also to the preparation of the whole process, phased and annual schedule network of spacecraft development classified based on time.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 29072 Preparing principles of technical network for spacecraft development

3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB/T 29072 and the following apply.

3.1

schedule network

executive plan used for coordinating schedule of all spacecraft development activities (technical and management activities).

3.2

schedule network diagram

schedule network expressed in diagrams.

4 Preparation principles

4.1 Schedule network shall be prepared to meet users' requirements.

4.2 Schedule network shall be prepared based on the technical network by considering project management elements or requirements of schedule, quality and risks, or other constraints, such as personnel allocation, equipment capability, field limit, budget, purchased parts or outsourcing parts properly. Schedule network may adjust and optimize the technical network to a certain degree.

4.3 Schedule network shall be prepared based on different levels or periods. Schedule network at all

levels shall meet the time limit stipulated by schedule network of upper level.

4.4 Duration for work items in schedule network is generally determined with certain margin.

4.5 Preparation of schedule network shall minimize sequenced work items on the main line and shorten the working cycle of the main line. When resources permit, the work of auxiliary line may start earlier to wait for the work of main line.

4.6 Terms, symbols, codes, methods and tools used shall be unified.

5 Preparation basis

Preparation basis is as follows:

a) System specification or schedule requirement stipulated in contract;

b) Sub-goal derived from the overall goal is the basis for preparing the schedule network of the next lower level;

c) Technical network corresponding to the schedule network;

d) Project development management requirements;

e) Historical empirical data;

f) Resources constraints.

6 System of schedule network

6.1 General

System of schedule network comprises all schedule networks classified based on the work breakdown structure level and time. Schedule network commences from concept demonstration and ends with the spacecraft in orbit delivery for use (such as communications satellite or meteorological satellite) or on ground delivery of items like payload to users (such as recoverable satellite or manned spacecraft). Schedule network at the top level is the one for the whole process of system-level development, and schedule networks at different levels or types can be derived from it. See Table 1 for the system of schedule network.

Table 1 System of schedule network

Level	Time	Name
System-level	Whole process	Schedule network of the whole process of system-level development, schedule network of system-level software, schedule network of the system-level ground test and schedule network of the system-level ground support equipment
	Phase	Schedule network of concept design phase, schedule network of detailed design phase and schedule network of the manufacture phase
	Annual	Annual schedule network

Level	Time	Name
	Monthly	Monthly schedule network
Subsystem-level	Whole process	Schedule network of the whole process of subsystem-level development, schedule network of subsystem-level software, schedule network of the subsystem-level ground test and schedule network of the subsystem-level ground support equipment
	Phase	Schedule network of concept design phase, schedule network of detailed design phase and schedule network of the manufacture phase
	Annual	Annual schedule network
	Monthly	Monthly schedule network
Equipment-level	Whole process	Schedule network of the equipment development, schedule network of the equipment-level software, schedule network of the equipment-level ground test and schedule network of the unit check-out equipment
	Phase	Schedule network of concept design phase, schedule network of detailed design phase and schedule network of the manufacture phase
	Annual	Annual schedule network
	Monthly	Monthly schedule network
Note 1: prepare the weekly and daily schedule networks at all levels if necessary. Note 2: prepare the schedule network of the work items at all levels if necessary.		

6.2 Classification by spacecraft breakdown structure level

6.2.1 System-level schedule network: Schedule network describes spacecraft system development and relationship between the system and other relevant systems or between the system and subsystems. System-level schedule networks generally include schedule networks of the whole process of system development, system software, work items such as system ground test.

6.2.2 Subsystem-level schedule network: Schedule network describes spacecraft subsystem development and relationship between the subsystem and the system or between the subsystem and equipment. Subsystem-level schedule networks generally include schedule networks of the whole process of subsystem development, subsystem software and subsystem ground test, etc.

6.2.3 Equipment-level schedule network: Schedule network describes spacecraft equipment development. Equipment-level schedule networks generally include schedule networks of the whole process of equipment development, equipment software, equipment ground test and unit checkout equipment, etc.

6.2.4 Work items schedule network: Schedule network describes a work item development during spacecraft development process. Work item schedule network may be prepared at the levels mentioned above.

6.3 Classification by time

6.3.1 Schedule network of the whole process of development: Schedule network describes the whole process of spacecraft development.

6.3.2 Phased schedule network: Schedule network describes the spacecraft development at certain development phase (such as detailed design phase).

6.3.3 Annual schedule network: Schedule network describes the spacecraft development process in certain year.

6.3.4 Monthly schedule network: Schedule network describes the spacecraft development process in certain month.

6.3.5 Weekly or daily schedule network: Weekly and daily schedule networks may be prepared based on the monthly schedule network.

7 Contents of schedule network

7.1 General

Schedule network consists of schedule network diagram and statements. Schedule network contains all work and nodes within the scope stipulated by this schedule network and information concerning logic relationship, logistics and responsible organizations.

7.2 Schedule network diagram

Gantt chart or network diagram may be used for the schedule network diagram. Preparing tools shall be unified. See Annex A for an example of schedule network diagram.

7.3 Statements

7.3.1 Statements of schedule network include the title and contents of schedule network.

7.3.2 Title of schedule network consists of product name (including spacecraft code), scope name (such as subsystem name or equipment name), period name (such as phase or year) or work item name. Version number should be added when necessary.

Example 1: Schedule network of CE-1 control subsystem for the year of 2006 (06-2 version).

Example 2: Schedule network of SZ-8 thermal vacuum test at the manufacture phase.

7.3.3 Contents of schedule network are as follows:

a) Goals:
   1) Describe the goals that shall be realized for the schedule network, main work items and specific requirements needed for realizing the goals;
   2) Describe the basis for preparing this schedule network (document name and number);
   3) Describe product matrix and document list corresponding to this schedule network.

b) Critical and schedule risk items: identify critical path of the schedule network, conduct necessary analysis and take corresponding measures.

c) Main milestones: for schedule network involving many work items, several milestones shall be established and several subgoals shall be formed. They are generally the starting point or crossing point of concurrent work of several work items as well as the point of intersection of design, manufacturing and testing.

d) Control point: determine the review or inspection point according to requirements in product assurance management documents.

e) Logistics: specify logistics that are not yet fixed or still undergo the study and describe the conditions from the five aspects of personnel, equipment, materials, methods and environment.

f) Management measures: to ensure the proper implementation of schedule network, management regulations and measures shall be described from the aspects of plan, organization, command, coordination and control.

g) Others: description of the adjustment to technical network in the schedule network.

7.3.4 See Annex B for an example of statements of the schedule network.

7.4 "Schedule network of the documents preparation" may be prepared in the form of table, which shall at least include number, document name, time of delivery, number of copies, name of work item for documents used (such as for the mechanics test) and drafters.

8 Preparation steps

Preparation steps of schedule network are as follows:

a) Divide the overall goal of the project into corresponding subgoals.

b) Analyze the technical network corresponding to the schedule network:

1) Determine the work items suitable for the schedule network by combining or decomposing work items of technical network;

2) Add the management work items that shall be included to the schedule network.

c) Estimate the most possible duration for each work item.

d) Optimize the relationship between input and output of work items based on rationality of technical network.

e) Input relevant data, such as name of work item, planning duration and logic relationship of work items and generate the preliminary schedule network diagram automatically.

f) Analyze the schedule network diagram generated preliminarily:

1) Analyze its conformance by comparison with goals given in the schedule network of upper level;

2) Considering personnel, equipment, site, task arrangement of other projects and budget support, take relevant measures such as adjusting the sequence of work items, subcontracting and improving conditions without violating technical rationality;

3) Adjust input data and generate new schedule network diagram;

4) Report existing problems, investigate and work out solutions;

5) Complete the preparation of schedule network diagram.

g) Complete the statements.

h) Carry out coordination and assessment, adjust and determine the final schedule network based on coordination and assessment results.

i) Review and submit for approval.

j) If necessary, go through relevant approval formalities for updating the schedule network in accordance with relevant provision.

Annex A
(Informative)
Example of schedule network diagram

A.1 Example of schedule network for the whole process of system-level development

See Figure A.1 for schedule network for the whole process of a satellite system-level development.

No.	Mission	Duration
1	XX satellite	1705 workdays
2	Concept design phase	305 workdays
3	Coordinate technical indexes with users	277 workdays
4	Preliminary coupling analysis for launch vehicle to spacecraft	126 workdays
5	Sign project development contract	305 workdays
6	Satellite concept design	137 workdays
7	Satellite system concept review	21 workdays
8	Determination of international cooperation items	148 workdays
9	Negotiate import contract and sign import contract	180 workdays
10	Development, monitoring and acceptance for imported parts	450 workdays
11	Detailed design phase	745 workdays
12	Preparation of satellite design specifications	30 workdays
13	Issuance of subsystem development requirements	35 workdays
14	Detailed design and review of the satellite platform	65 workdays
15	Development of electrical model product on the satellite platform	180 workdays
16	Test of electrical model subsystems on the satellite platform	90 workdays
17	Concept design and review on the payload subsystem	45.5 workdays
18	Development of electrical model products on payload subsystem	105 workdays
19	Submit the procurement list of electronic components on qualification and/or flight model	60 workdays
20	Concept design and review of antenna and HF box	16 workdays
21	Detailed design and review of antenna and HF box	60 workdays
22	Development of antenna and HF box	180 workdays
23	Assembly and test of antenna	37 workdays
24	Transportation of antenna and its arrival at Beijing	3 workdays
25	Design and review of cylinder	50 workdays
26	Development of cylinder	120 workdays
27	Static test of cylinder	60 workdays
28	Dynamic test of cylinder	61 workdays
29	Mechanical test of cylinder, antenna and HF box	30 workdays
30	Development of communication module panels and thermal simulation parts	180 workdays
31	Thermal test of communication module panels	40 workdays
32	Development of antenna and HF box thermal simulation parts	231 workdays
33	Thermal test of antenna and HF box	60 workdays
34	Antenna qualification test	322 workdays
35	Concept design and review of satellite ground test	30 workdays
36	Development of ground test equipment	300 workdays
37	Development and delivery of technical communication module and its arrival	212 workdays
38	Integration of communication module of electrical model	20 workdays
39	Integrated test of payload subsystem	90 workdays
40	Integrated test of communication module and acquisition/tracking subsystem	30 workdays
41	Integrated test of satellite-satellite-ground in closed loop of satellite	30 workdays
42	Integrated test of antenna, HF box and acquisition/tracking & control system	30 workdays
43	Transportation of communication module and its arrival at Beijing	3 workdays
44	Development and assembly of structural parts on electrical module	212 workdays
45	Acceptance and delivery of electrical model platform	20 workdays
46	Integration and test of service module	150 workdays
47	Assembly of two modules, integration of electrical model	20 workdays
48	Integrated test of electrical model	60 workdays
49	Joint test of satellite-and-ground TT&C	30 workdays
50	EMC and ESD tests of electrical model	5 workdays
51	Satellite-satellite-ground test	20 workdays
52	Joint training in launching site	40 workdays
53	Ordering, acceptance and screening of electronic components for flight model	450 workdays
54	Development of qualification products on platform	300 workdays
55	Development of payload qualification products	300 workdays
56	Development summarization of engineering model	10 workdays
57	Design review from detailed design phase to manufacture phase	14 workdays
58	Manufacture phase	904 workdays
59	Issuance of flight model development requirements	30 workdays
60	Design review of subsystem and units of flight model	30 workdays
61	Development and test of service module subsystem	270 workdays
62	Delivery of service cabin subsystem products	10 workdays
63	Development of payload subsystem products	210 workdays
64	Development and delivery, and transportation of payload module and its arrival	200 workdays
65	Assembly of flight model structure	60 workdays
66	Integration and test of communication module	150 workdays
67	Integration and test of service module	60 workdays
68	Assembly of two modules, and model integration	20 workdays
69	Model test	80 workdays
70	Joint test of satellite-and-ground TT&C	30 workdays
71	EMC and ESD tests of model	5 workdays
72	Satellite-satellite-ground joint test	30 workdays
73	Mechanical environmental test of model	10 workdays
74	Thermal vacuum test of model	20 workdays
75	Leak detection, calibration and mass property test of model	15 workdays
76	Aging test of model	30 workdays
77	PSR	15 workdays
78	Preparation of shipment	3 workdays

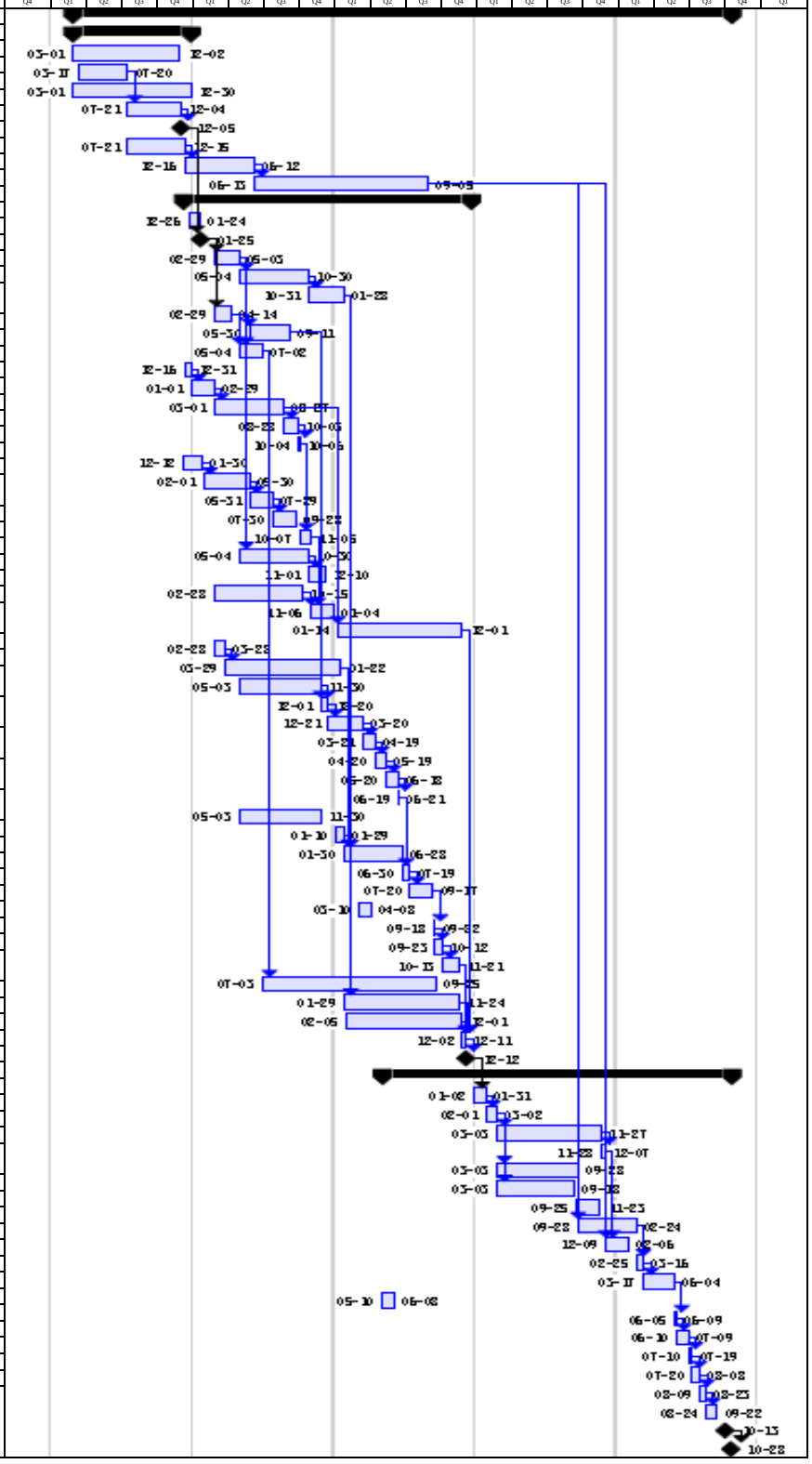

Figure A.1 Schedule network for the whole process of a satellite system-level development

A.2 Example of schedule network for manufacture phase

See Figure A.2 for schedule network for manufacture phase of a satellite.

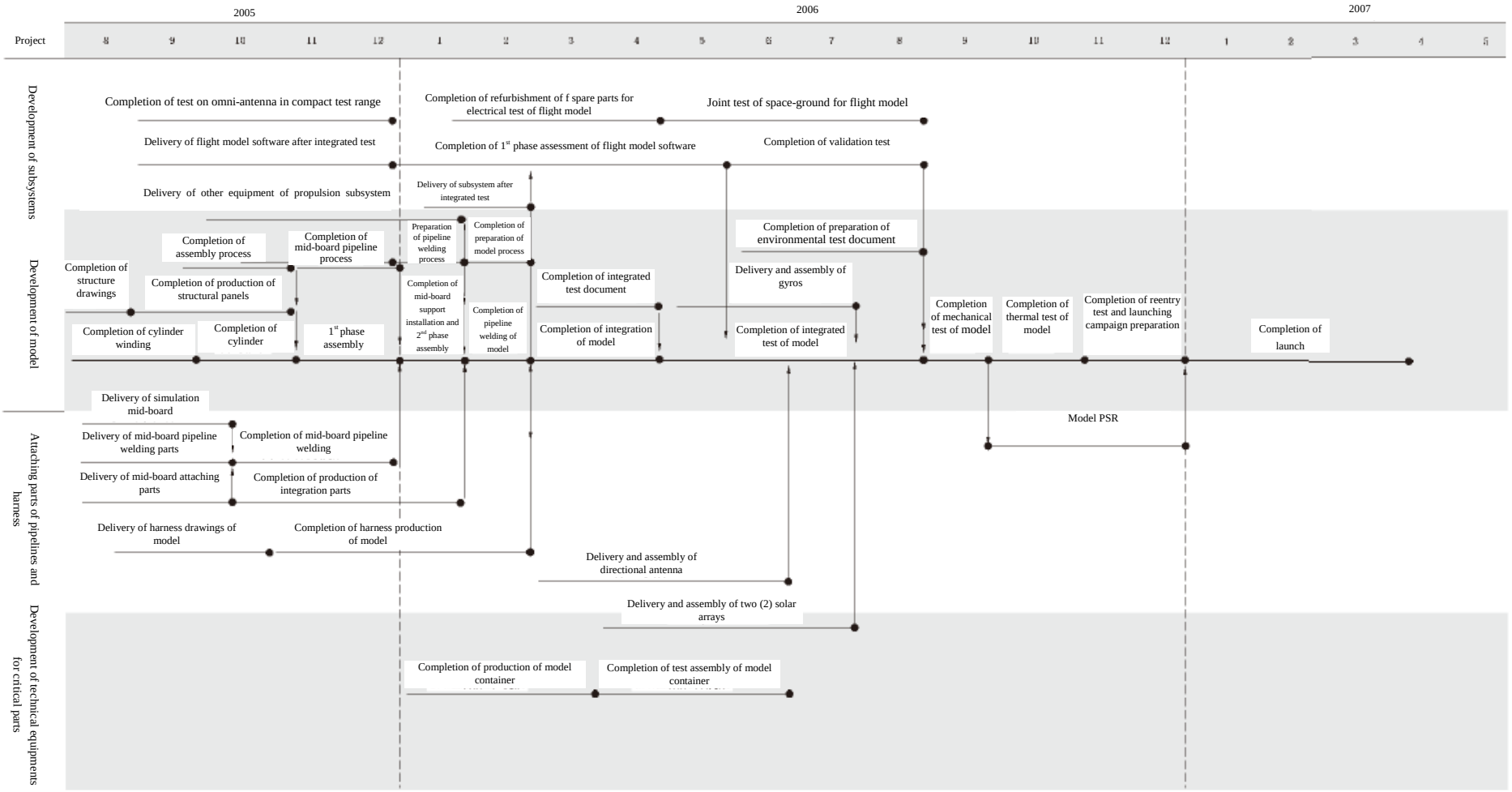

Figure A.2 Schedule network for manufacture phase of a satellite

A.3 Example of schedule network for manufacture phase of subsystem

See Figure A.3 for schedule network for manufacture phase of subsystem.

Mission	Duration
Manufacture phase of subsystem	587 workdays
Subsystem	587 workdays
Preparing design report of subsystems in manufacture phase	15 workdays
Design review of subsystem for manufacture phase	2 workdays
Development of equipment	580 workdays
S- band TT&C antenna	165 workdays
Design of equipment (passive)	48 workdays
Design review of equipment	24 workdays
Procurement of components and raw materials	57 workdays
Issuing documents and drawings for production	11 workdays
Production preparation and parts manufacturing	82 workdays
Test of electric performance of antenna	10 workdays
Equipment environment test	5 workdays
Acceptance of equipment	10 workdays
C-band responders 1 and 2	181 workdays
Issuance of development requirements	2 workdays
Design of equipment	34 workdays
Design review of equipment	30 workdays
Procurement of components and raw materials	46 workdays
Issuing documents and drawings for production	10 workdays
Production preparation and parts manufacturing	31 workdays
Assembly and integration of equipment (active)	49 workdays
Commissioning of equipment	12 workdays
Equipment environment test	22 workdays
EMC test, equipment test, data analysis	2 workdays
Acceptance of equipment	8 workdays
Shunt filter	580 workdays
Design of equipment (passive)	61 workdays
Design review of equipment	24 workdays
Procurement of components and raw materials	6 workdays
Issuing documents and drawings for production	11 workdays
Production preparation and parts manufacturing	25 workdays
Commissioning of equipment (passive)	20 workdays
Equipment environment test	9 workdays
EMC test, equipment test, data analysis	2 workdays
Acceptance of equipment	9 workdays
Synthesizer	580 workdays
Design of equipment (passive)	61 workdays
Design review of equipment	24 workdays
Procurement of components and raw materials	6 workdays
Issuing documents and drawings for production	11 workdays
Production preparation and parts manufacturing	20 workdays
Commissioning of equipment (passive)	17 workdays
Equipment environment test	9 workdays
EMC test, equipment test, data analysis	2 workdays
Acceptance of equipment	8 workdays
Subsystem AIT	464 workdays
Document preparation for subsystem integrated test	15 workdays
Acceptance and assembly of equipment	3 workdays
HF cable sampling and manufacturing	4 workdays
Subsystem link test	2 workdays
Subsystem acceptance test	3 workdays
Document preparation of subsystem acceptance	32 workdays
Subsystem PSR	1 workday
Acceptance and delivery of subsystem	2 workdays

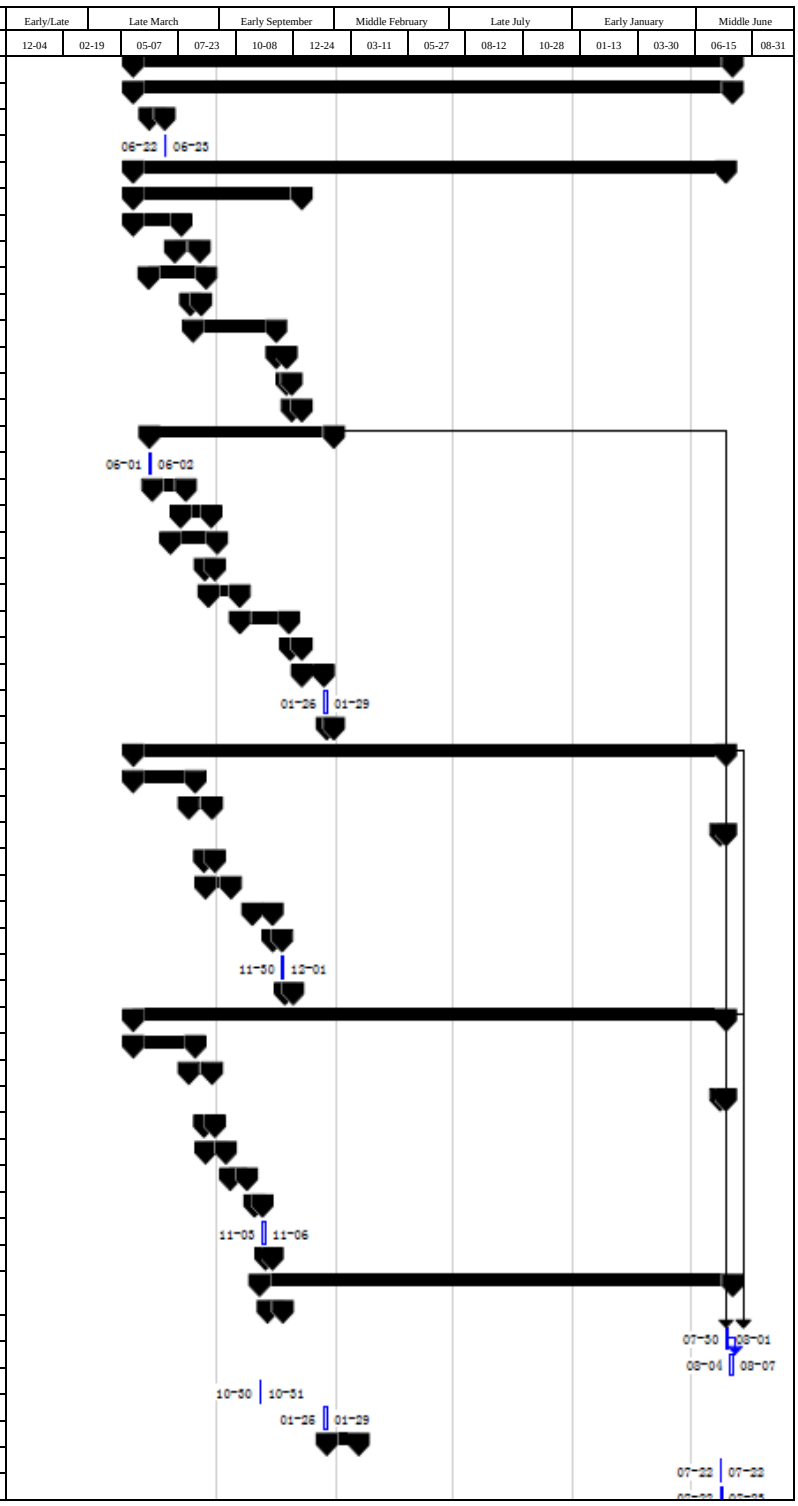

Figure A.3 Schedule network for manufacture phase of subsystem

A.4 Example of schedule network for subsystem-level work item

See Figure A.4 for schedule network for subsystem-level work item.

No.	Mission	Duration
0	Schedule network diagram of work item of joint vibration test for satellite and antenna	22.3 d
1	Specific test plan of joint vibration test for satellite cylinder and antenna	22.3 d
2	Transportation of antenna to the test hall, and get ready of antenna hoisting device and support vehicle	0 d
3	Test assembly of antenna and cylinder	1 d
4	Installing acceleration transducer of antenna	0.5 d
5	Handover of cylinder	0.2 d
6	Put cylinder onto vibration bench	0.3 d
7	Installation of antenna	0.5 d
8	Validation of technical configuration for test	2 d
9	X-directional vibration test, result evaluation and test validation	1 d
10	Preparation of Z-directional vibration test	1 d
11	Disassembly of antenna	0.2 d
12	Take down cylinder from vibration bench, and turn bench	0.5 d
13	Put cylinder onto vibration bench, installation of antenna	0.3 d
14	Z-directional vibration test, result evaluation and test validation	1 d
15	Preparation of Y-directional vibration test	1 d
16	Disassembly of antenna	0.2 d
17	Take down cylinder from vibration bench, and turn bench	0.5 d
18	Put cylinder onto vibration bench, installation of antenna	0.3 d
19	Y-directional vibration test, result evaluation and test validation	1 d
20	Disassembly of antenna	0.3 d
21	Disassembly of antenna and HF box	0.7 d
22	Take down cylinder from vibration bench	0.5 d
23	Remove balancing mass	3 d
24	Handover of cylinder and transportation to manufacture factory	0.5 d
25	Defection detection of cylinder	5 d

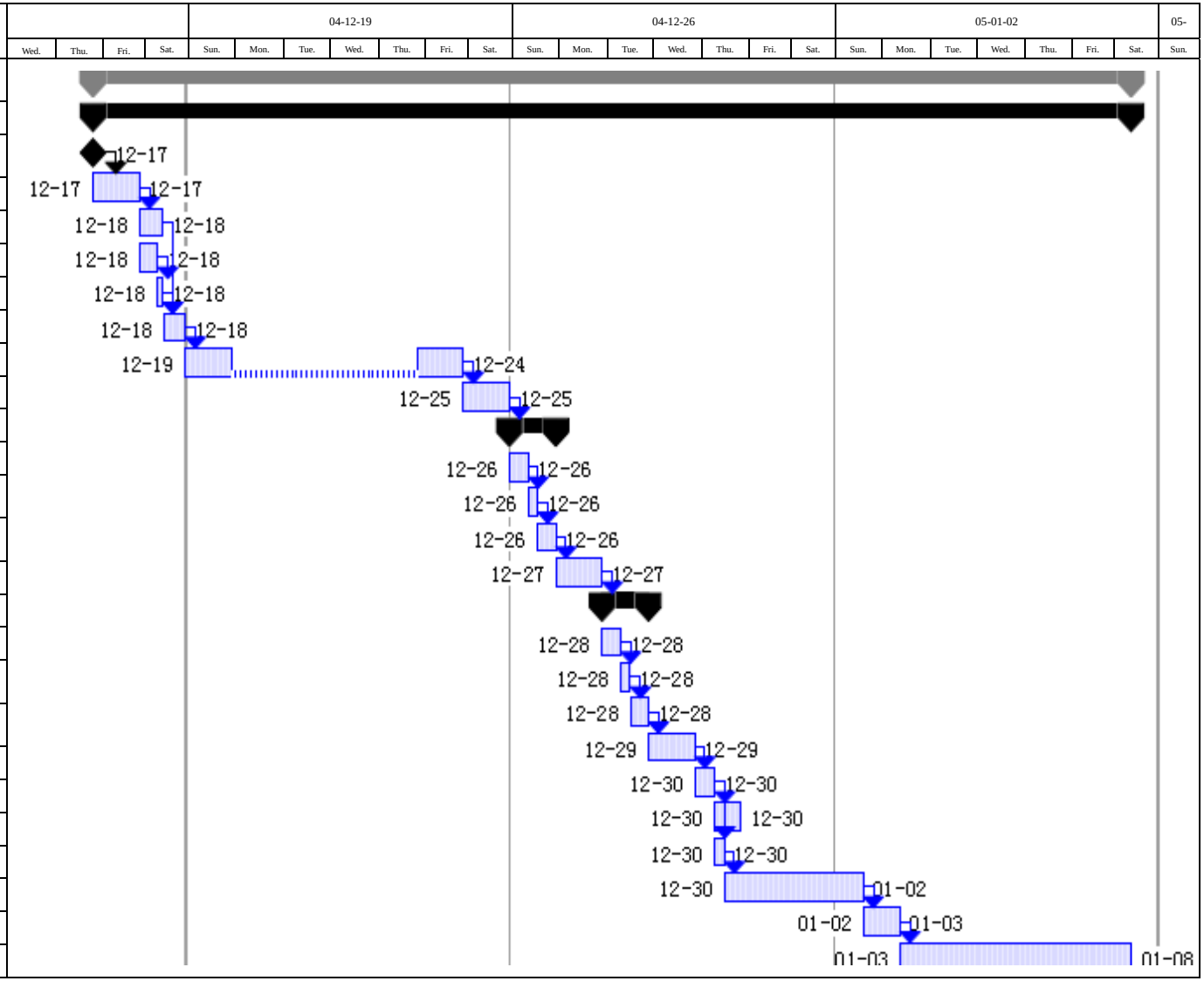

Figure A.4 Schedule network for subsystem-level work item

Annex B
(Informative)
Example of statements of schedule network

B.1 Goals

The goals of this schedule network are to complete the development of a satellite solar array and to provide qualified solar array.

Preparation basis of this schedule network includes:

a) Technical requirements of satellite on the mechanical part of solar array;

b) Preparation rules of schedule network for satellite development;

c) Design report on the mechanical part of a satellite solar array;

d) Technical requirements of the assembly of mechanical part of a satellite solar array.

Complete the product matrix of solar array developed and delivered.

B. 2 Critical (schedule risk) items

Critical (schedule risk) items of this schedule network are as follows:

a) Specifications and drawings for the base plate and connecting yoke;

b) Production;

c) Assembly;

d) Test and assessment;

e) Deployment test;

f) Delivery.

B.3 Main milestones

According to schedule requirements, environmental test and delivery of solar array shall be completed on XX(day) XX(month), 20XX(year). Therefore, the most important responsibility of solar array development personnel is to make sure that planned examination nodes are reached as required. See Table B.1 for a development schedule milestone.

Table B.1 Solar array development schedule milestone

No.	Work item	Date of completion	Notes
1	Drawings distribution	20XX-XX-XX	—
2	Mechanism acceptance	20XX-XX-XX	—
3	Acceptance of base plate and connecting yoke	20XX-XX-XX	—
4	Assembly acceptance	20XX-XX-XX	—
5	Mechanical environmental test	20XX-XX-XX	—
6	Delivery and review for pre-shipment	20XX-XX-XX	—

B.4 Control points

Set up the following mandatory inspection points and quality control points based on the design documents and previous development experiences or lessons. Designers shall track on site and control the production so as to ensure the quality control during the production process of solar array.

a) Approval and signature of design documents and drawings (quality control points);

b) Mechanical test of solar array (quality control point);

c) Delivery review (quality control points).

B.5 Logistics

B.5.1 Site and mechanical ground support equipment (MGSE)

According to the development plan of solar array, site and MGSE shall be coordinated and determined.

B.5.2 Conflicts of personnel

According to the development plan of solar array, core personnel A and B shall also undertake other development tasks at the same time at the phase, leading to the insufficient attention to this task. Application has been made to the research laboratory for the personnel demands and it will be confirmed with the research laboratory again on XX (day), XX (month).

B.5.3 Technical risks

This solar array is a mature product without technical risks.

B.6 Management measures

B.6.1 Prepare the operable, checkable and controllable schedule network.

B.6.2 Reinforce communication. All personnel involved shall know the schedule requirements and logistics to prevent the units taking part in the development from committing the negligence in the interface work.

B.6.3 Manage in advance. According to the schedule network, check and determine the preparations of personnel, equipment, materials, methods and environmental factors in advance, especially the availability of assembly tooling, site and personnel; for example, to investigate durations for subcontracts or procurement cycle, then to procure or put into production in advance based on the plan requirements.