

Saimaa University of Applied Sciences

Technology, Lappeenranta

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# **COMPARISON OF FINNISH AND RUSSIAN SYSTEMS OF CONSTRUCTION TIME SCHEDULING**

Bachelor's Thesis 2011

## ABSTRACT

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Comparison of Finnish and Russian Systems of Construction Time Scheduling, 36 pages,  
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The purpose of the study was to define and compare main principles of time schedule of all phases of construction in Finland and Russia. Comparison is presented in a tables form convenient for viewing. These tables show comparison of the main points like software, types of schedules, scheduling methods, used norms and standards. The detailed description of schedule types is presented in separate tables.

The main source of information is Finnish Ratu Production Planning and Management on a Construction Project. The main data sources used for describing Russian scheduling are Russian standards, norms and printed book Organization of the Construction.

The research findings can be presented in the form of a brochure. They can be applied as guidelines on time scheduling in further construction planning.

Keywords: planning of construction, time scheduling

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# 1 INTRODUCTION

The implementation of the construction objectives depends on successful production planning, control and production management. The main part of production planning is time scheduling and control on which success of other parts of planning depends. It also allows the designer to reveal the shortcomings, delays and deviations from the plans.

The phases in a building construction project are definition, project planning, construction design, construction and commissioning. Production planning on a construction project aims at the most advantageous selection of working techniques and resources, as well as at the timing of activities. Projects and activities are planned so that an individual project can be completed according to plans and contracts.

Time scheduling is an integral part of organization of all phases of building production. The normal course of construction is possible only when the sequence of work will be thought through in advance. The amount of machinery, equipment, tools, workers and other resources required for each kind of work also have to be considered in advance. Bad quality of scheduling would entail the lack of coordination of performers, interruptions in their work, delays and therefore more expensive construction. To prevent such situations a detailed schedule should be made.

According to the content of the plan, production planning on a construction project can be divided into: time planning, e.g. interior work phase schedule and the preparation of the resource plan that is connected with it; economic and financial planning, e.g. preparation of the budgetary objectives; general production planning, e.g. preparation of the site plan.

The principal purpose of the thesis is to describe and compare main principles and deviations of the building project schedule in Finland and Russia. The focus is to make some kind of a guideline for Russian and Finnish customers.

## **2 SCHEDULING IN RUSSIA**

### **2.1 Construction planning principles**

In general, the main objectives of planning are analysis, anticipation, scheduling, resources determination, co-ordination, control and production of relevant data. Good production planning ensures achievement of objectives and demands which are set in the beginning of the project. Production planning is a chain which sharpens and systematically goes forward. The project manager's power to influence the course of the project diminishes as the project progresses. As decisions are made, actions taken, designs completed and the contracts signed, the project takes a more definite shape and the opportunities to make changes decrease. It is clear that the early decisions have far reaching effects and so must be made in a well planned and objective way. (Neale 1989, p. 4.)

The main participants of the construction process are legal entity and natural entity, i.e. any state, public, private organizations and individuals. They are investors (depositors), developers, builders, customers, users, operators, designers, contractors, managers, project managers, suppliers, transport organizations, banks and research organizations. The main phases of construction are:

- pre-design phase (idea, business case, investment and contracts)
- design
- contracts (contracting agreement, delivery agreement, implementation of the delivery agreement)
- construction/ installation activities
- operational commissioning
- occupation. (Дикман 2006, p.25.)

### **2.2 Scheduling**

Time schedule is a project document which defines the sequence and timing of individual works, establishes their technological relationship with the nature and quantities of work to be done. The schedule is designed taking into account the validity period of the agreements on the temporary use of another's territories (СНиП 12-01-2004 2005.). A consolidated schedule of construction is developed as a part of the project of the construction organization, while a schedule of works on individual facilities is developed in the project of work performance. There are four types of schedules, depending on the size of task and type of documentation to which they belong (Table 2.1). All kinds of schedules should be closely linked with each other. (Технология и организация строительных работ.)

Table 2.1 Types of schedules

Type of schedule	Type of documentation
Aggregate (master) schedule	Building Site Organization Scheme (Project of Construction Organization)
Facility schedule	Site Work Execution Programme (Project of Work Performance)
Construction schedule	Operational planning
Hour (minute) schedule	Flow Sheets

### 2.2.1 Aggregate (master) schedule

Aggregate schedule as a part of the Building Site Organization Scheme determines the sequence of construction sites which includes the beginning and completion dates of each facility construction, the duration of the preliminary period and the whole construction period. As a rule for the preliminary phase the separate schedule is made. The construction of the facility should be divided into stages, start-up facilities and production

units on the stage of aggregate schedule. The project engineer signs the schedule and is legally responsible for its implementation.

The purpose of scheduling development of the project for construction are: justification for a given construction duration of the planned facility or identification of possible construction duration of the planned facility; the timing of construction and commissioning of individual parts of the facility, as well as the timing of some major works; the definition of the capital investments size and the number of separate construction stages; the timing definition of delivery of basic construction materials and equipment for buildings under construction; the definition of the required amount of major equipment as well as the number and time of personnel (Технология и организация строительных работ.)

Initial information for the schedule creation includes materials of the project (master plan, construction details and cost estimate, etc.); standard or given construction duration of the facility; conditions of construction; the list of the basic and auxiliary buildings and structures; the amount and cost of work; data about availability of the building industry in the vicinity and possibilities of its use; information on conditions of delivery and transportation of pre-fab structures, finished articles, materials and the equipment; information about the number of personnel; decisions concerning methods of the construction organization and production methods of the main works; projects analogues and evidence of their implementation; descriptive data of the contractors' capabilities and material-technical base of construction; standards, methodical literature, reference books. (МДС 12-81.2007.)

### **2.2.2 Facility schedule**

The facility schedule determines the sequence and timing of each activity for a particular facility from its construction start to its commissioning. Typically such schedule is broken down on months or days depending on the size and complexity of the facility. The facility schedule is compiled by prime contractor or invited design organization. Scheduling involves the development of the following:

- An integrated network schedule for the construction of a complex object or its part in which the sequence and timing of works to their best possible combination as well as the standard time of construction machinery are defined, a demand in the labor force and mechanization are determined, milestones and work packages are highlighted, quantity, professionalism and qualification of the team are determined.
- Schedule of works for the construction of residential or cultural and community building or its parts. Stages and types of work are allocated in the schedule. This work is entrusted to the complex and specialized teams; the number of employees, their professionalism and qualification are determined as well.
- Schedule of works for a preliminary period of construction which includes a schedule of works in a linear form or in the form of cyclorama or a network schedule. (МДС 12-81.2007.)

The initial information for development of the facility schedule includes aggregate schedule, standards of construction duration or directive task, construction drawings and cost estimate, information about organizations participating in construction (which includes information about the availability of the skilled personnel provided for major activities, industrial-technological equipment and transportation of construction materials as well as data of available mechanisms and opportunities for obtaining the necessary material resources), schedules of works on the annual program of the installation company. (МДС 12-81.2007.)

### **2.2.3 Construction schedule**

Usually the construction schedule is compiled by operation and technical department of a construction organization. Rarely the schedule is compiled by linear personnel during building and construction works. Such schedules are designed for a few months. The most widely used are weekly and daily schedules. The construction schedule is an element of operational planning which should be consistent throughout the construction period. The purpose of the construction schedule is to divide the facility schedule into smaller items



and to react on possible changes on site. The construction schedule is the most widely spread type of schedule. As a rule it is compiled very fast and often has a simplified form. This means that the schedule is not always optimized properly. However, the construction schedule usually takes into account the actual situation on site better than other types of schedules, as it is compiled by persons directly involved in this construction. This especially applies to the integration of weather conditions, features of subcontractors' interaction, realization of various innovations, i.e. factors which are difficult to calculate in advance. (Технология и организация строительных работ.)

#### **2.2.4 Hour (minute) schedule**

Hour (minute) schedules are compiled by developers of flow sheets or workflows sheets. Generally these schedules are carefully designed, optimized, but they are focused only on the typical (most probable) conditions. In specific situations they may require significant adjustment. (Технология и организация строительных работ.)

The hour schedule is drawn mainly for the installation of prefabricated buildings and structures. The timing and the sequence of individual precast elements installation in the design position are determined in the schedule. In accordance with ENiR the composition of installers' teams and the machine time are indicated in the schedule. This is the time needed for installation of each element. (Строим домик.)

Flow sheets are compiled for individual (complex) types of work and work performed using new technologies. Each flow sheet consists of the following items: field of application, general provisions, organization and technology of work, material and technical resource requirements, safety and labour protection norms, technical and economic performance. (МДС 12-29.2006.)

### **2.3 Scheduling phases**

The following description of schedule phases' preparation has been done for scheduling. The order of schedule development includes 10 main stages.

The first step in time scheduling is collecting the initial information which includes standards of construction duration or directory task; flow sheets for construction works, erection works and special works; construction documents and cost estimate; database about organizations (participants of construction, composition and qualification of work teams or groups, machinery and equipment, resource capacities). The next phase is preparation of the list of activities. The list of activities describes the technological sequence of various types of work and their duration. Works should be combined and amalgamated in order to make a concise and readable schedule. It is important to remember that combining of works performed by different teams is impossible. In case when one team performs different kind of works, it is necessary to identify and show separately the portion of the work that opens up the front of work for the next team. (Дикман 2006, p.142-143.)

The bill of quantities is determined according to the designed list of activities. The quantities is determined by the construction documents and cost estimate. The quantities should be maintained in the units adopted in The Integrated Complex Norms (UKN in Russian) or in The Uniform Norms and Quotations (ENiR in Russian). (Дикман 2006, p.144.)

The methodology of MDS 81-35.2004 describes the way for determination of the construction cost estimation in Russia. The current system of pricing and estimate rationing in building sphere includes the state itemized construction estimates and other estimation documents necessary for determination of construction cost. (МДС 81-35.2004.)

After this phase it is time to choose the main work methods and operation methods of the main machinery and then to calculate a labour input and operation time of the machinery. The labour input and operation time of the machinery are calculated by the following norms: norms and quotations, calculations, standards for budget calculations (SNiP, part IV), Integrated Complex Norms, specific development in m<sup>3</sup>/person-days, RUB/person-days, person-days/storey or person-days/apartment. (Дикман 2006, p.144-145.)

The next step is to determine the composition of a work teams and groups, a technological sequence of works, work shifts. Then it is necessary to calculate the duration of separate activities and linking them together; at the same time adjusting the composition and number of work teams and work shifts. By this time the production methods of work should be identified and machinery should be chosen. It is necessary to provide an intensive exploitation of the main machines by using them in 2 to 3 shifts without interruptions and unnecessary moving. Duration of the mechanized operations should be calculated only on the basis of machines productivity therefore the first step is to calculate the duration of mechanized operations and then the duration of the manual works. The quantity of machinery depends on the amount and nature of construction works and the timing of their implementation. When using the basic equipment (assembly cranes, etc.) it is need to take at least two work shifts. As a rule works without the use of machines should be conducted only in one shift. The number of workers per shift and the team structure are determined according to the labour input and duration of works. The calculation of the team structure is based on the fact that transition from one work zone to another should not cause changes in the quantity and qualification of the team. The further task is to compare the calculated and the normative work duration. (Дикман 2006, p.145-147.)

The following phase is to design the schedule of resources requirements. Scheduling should begin with the basic work or process that affects the overall duration of construction. It is possible to reduce the duration of main process by increasing working in shifts and amount of machinery of mechanized operations or the number of workers in the manual works if it is necessary. Timing of the other processes depends on the main ones. (Дикман 2006, p.150.)

## **2.4 Scheduling methods**

There are four most common scheduling methods: Gantt bar chart, Budnikov's cyclogram (line-of-balance chart), network diagram, combined diagram. The choice of the method depends on size and type of the task which it reviews.

Gantt bar chart is schematically presented in Figure 2.1. Benefits of the bar chart are simplicity and clarity, a simple design of workers' moving chart. Weaknesses of this chart are: the place of works' performance is not emphasized; it is difficult to trace the technological links between activities, it is not clear whether all conditions of the flow-line method of construction organization are executed. (Колчеданцев 2010, p. 6-7.)

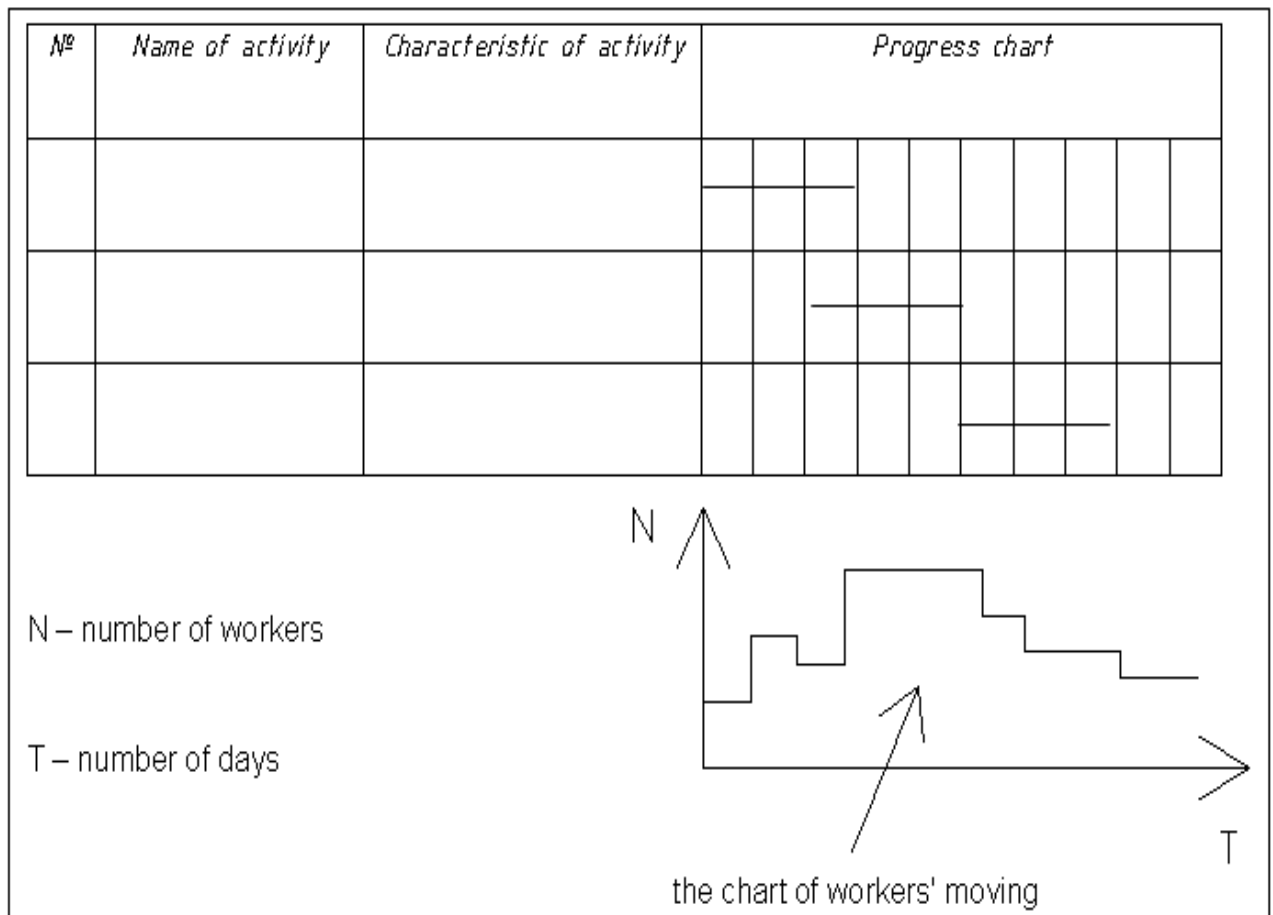


Figure 2.1 Gantt bar chart

Budnikov's cyclogram is presented in two coordinates: the horizontal one - calendar time of works' performance, the vertical one - the fronts of work. Each activity is presented in the form of a sloping line. Horizontal projection of this line corresponds to the duration of its execution; its vertical projection indicates the place of work. Budnikov's cyclogram is schematically presented in Figure 2.2. (Колчеданцев 2010, p. 7.)

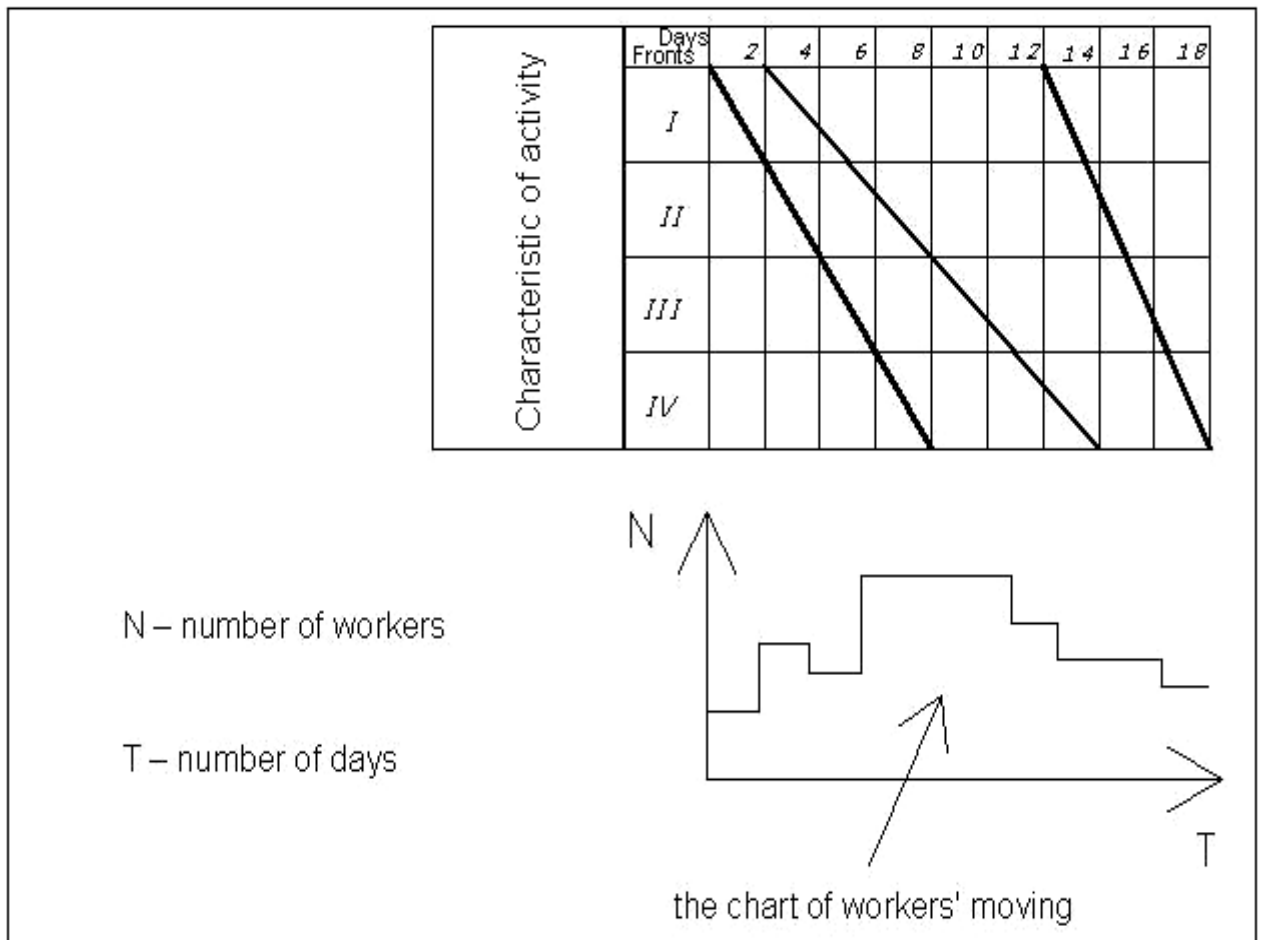


Figure 2.2 Budnikov's cyclogram

The cyclogram allows the best observance of conditions of the flow-line method of construction organization: combination of polytypic works in time, the maximum rapprochement of separate kinds of works, a work's continuity of teams or a development's continuity of fronts. The chart of workers' moving can be plotted under cyclogram. Partitioning scheme of the facility to the work fronts should be specified on the sheet. Characteristics of the work can be located on the left, below; they are not connected graphically with lines of work. (Колчеданцев 2010, p. 8.)

Network diagram is presented in the form of a network in which works are shown in the form of arrows with instructions of the work beginning and the termination. This method allows the fullest considering of all technology requirements by an establishment of relevant links. It is possible to display all the technological links and to identify top priority work which is lying on the critical path and do not has a reserve of time (critical path

determines the duration of the construction). The scheme of the network diagram is depicted in Figure 2.3. (Колчеданцев 2010, p. 8.)

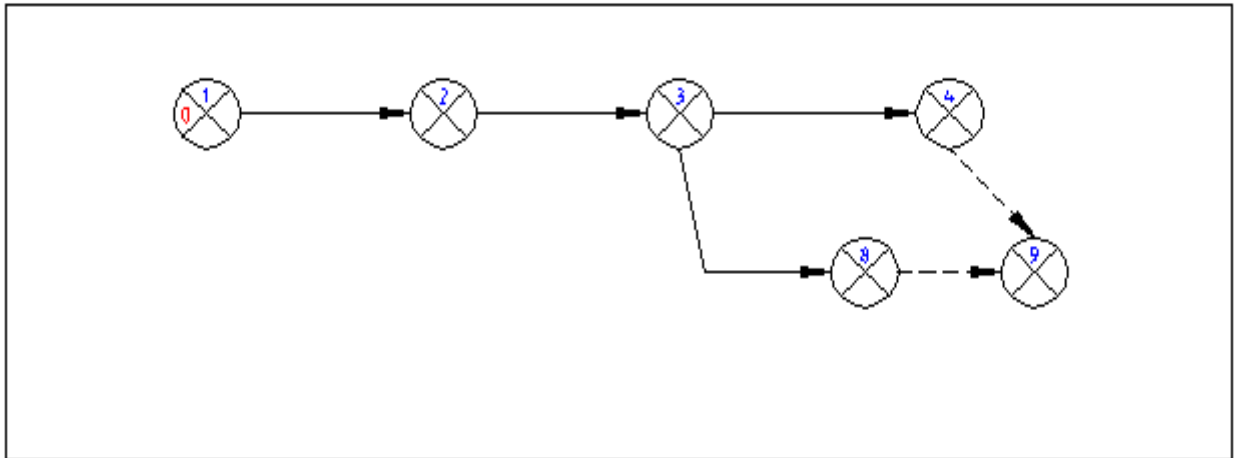


Figure 2.3 Network diagram

The combined diagram method was developed by professor Afanasiev. In this method the main types of activities are shown as a cyclogram but preparatory works, other activities and an accomplishment are presented as Gantt bar chart. The main works are performed on fronts. (Колчеданцев 2010, p. 9.)

## 2.5 Example of Russian time scheduling

The company for writing the thesis is YIT Lentek and the project is residential complex Vita Nova. The territory of the planned building with built-in and attached offices and underground car park is located in Saint-Petersburg on Mebelnaya street.

The construction process of the dwelling building with built-in and attached offices is drawn up in The Project of Construction Organization. Erection of the building is carried out in three stages. Stages of the construction are presented in the particle “Methods of works production”. The initial information for development of The Project of Construction Organization:

- Master plan, which is drawn up by ZAO “YIT Lentek”;

- Project of Construction Organization, which is drawn up OOO PKTB “Organization of the Construction”;
- Architectural project – AR, which is drawn up by Arkkitehtisuunnittelu Jukka Tikkanen Ltd.;
- Surveying materials, performed in 2009.

In developing of The Project of Construction Organization Russian norms and standards were used. There are:

- SNiP 12-01-2004 “Organization of the Construction”;
- Russian Federation Government Resolution № 87 "On the part of sections of project documentation and requirements for content";
- MDS 12-46.2008 "Guidelines for the development and the execution of The Project of Construction Organization and The Project of Organization of demolition (dismantling) works, The Project of Work Performance” (ZAO “CNIOMTP”);
- SNiP 1.04.03-85\* “Normative duration of construction and groundwork in the construction of facilities, buildings and structures”;
- SNiP 23-01-99 “Construction climatology”;
- SNiP 3.02.01-87 “Earthworks, bases and foundations”;
- SNiP 3.03.01-87” Bearing and enclosing structures”
- SNiP 12-03-01 “Safety in construction. Part 1. General requirements”;
- SNiP 12-04-01 “Safety in construction. Part 2. Construction performance”;
- SniP 3.01.03-84 “Surveying works in construction”;
- PB 10-382-00 “Rules of installation and safe operation of cranes”;
- PPB 01-03 RF “Rules of fire safety during construction and installation works”;
- SanPiN 2.2.3.1384-03 “Hygienic requirements for the organization of the construction performance and construction works”;
- “Calculated standards for developing The Project of Construction Organization”, which is carried out by CNIOMPT Gosstroy of USSR, RN-1. 1973.

The facility is planned to be completed in 3 years in the second half of 2013. The duration of the entire construction is presented in Figure 2.4.

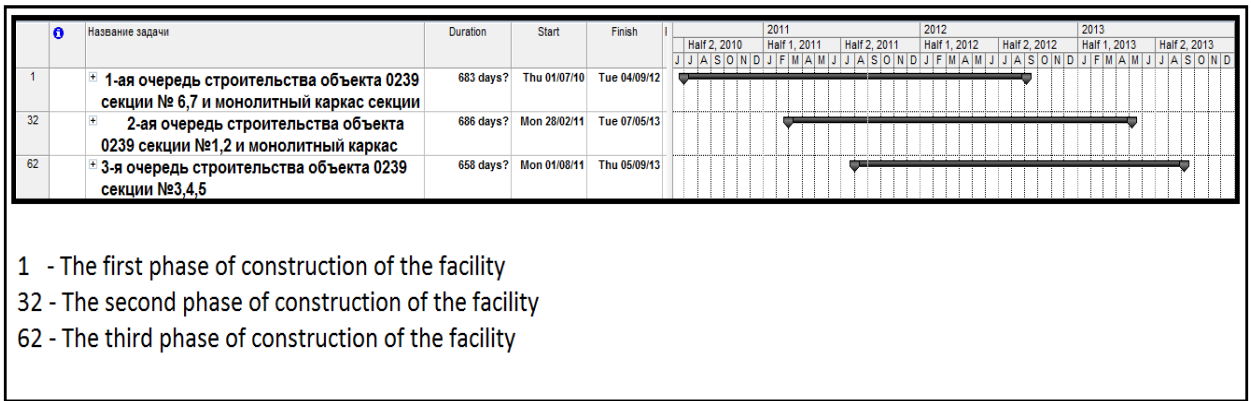


Figure 2.4 Duration of the construction

The time scheduling is divided in three stages. Figure 2.5 shows the first stage of the construction. The time scheduling was created in the program Microsoft Office Project.

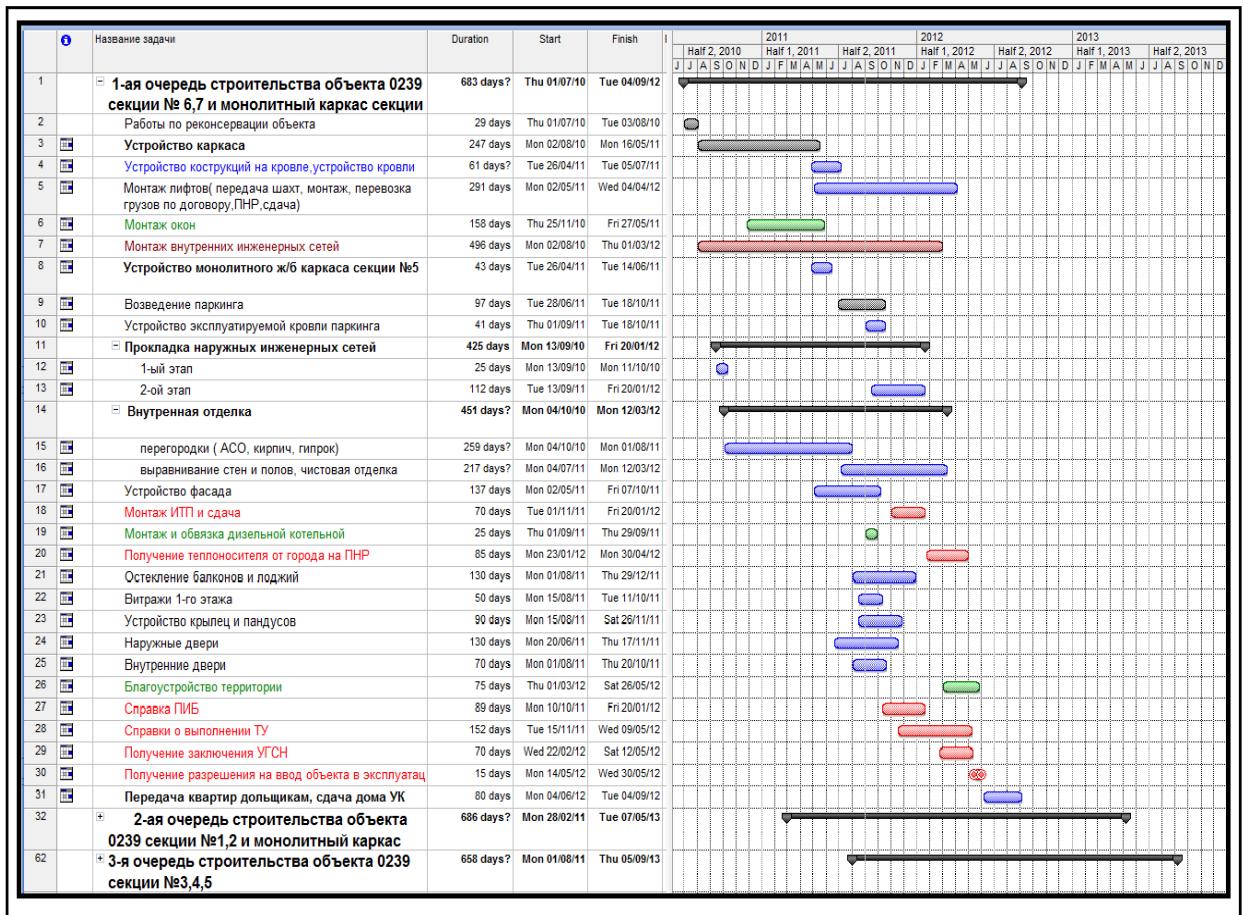


Figure 2.5 First stage of the construction



## **3 SCHEDULING IN FINLAND**

### **3.1 Construction planning principles**

Successful production planning, control and production management underlies the accomplishment of the construction objectives. The main part of the production planning is a time planning and control which determines not only the foundations of the success of other planning, but also allows to reveal the shortcomings and deviations from the plans. The schedule is a project's implementation model which defines the project goals and individual assignments. (Aikataulukirja 2008.)

The purpose of building production is the satisfaction of society's building needs. The buildings are divided into residential, industrial, public and other buildings. New building is implemented as a construction project. New construction starts when a decision to construct a new building is made and the project ends when the building can be commissioned in good condition. (Koski 1995, p. 8.)

Construction project involves many parties. Main parties are: building's users, developers, builders and public authorities. Depending on the project in general consultants, material suppliers and subcontractors may also participate. (Koski 1995, p. 8.)

The project starts with definition which includes project background, size and location, estimates of time, cost and finance. The next task is to make a project planning. Specification of needs, objectives, timing, space programme for the building, costs and location are established in project planning. The next phase is construction design. The purpose of construction design is to provide plans which accord with decisions in the earlier phases, so that the project can be undertaken successfully. For example, working drawings represent detailed technical solutions to structures and structural members. Activities of construction phase include production planning, project start-up, construction work, control, management, commissioning, handing over and finishing operations. In occupation phase arrangements for maintenance and servicing are made. Instructions are

given in the operation of technical systems; operation and service manuals are compiled; the preservation plan for the estate is defined. (Koski 1995, p. 8-9.)

Success of construction project is influenced by how well the building production management is steered to accord the schedules. If the temporal planning and control is not well performed, it leads to delays, to low quality and cost overruns. Successful scheduling reduces the risk of failure of the project. Projects and activities are planned so that an individual project can be completed according to plans and contracts.

Planning and management processes must be controlled. Construction project must succeed in time, cost and quality. Realization of only one part of these is not enough. Schedules are needed to work to be carried out on time as planned. All work can not be done at the same time, so the work and steps shall be staggered and execution order shall be specified.

The accuracy and timing of the production planning on a project activities divides the production planning into categories: preliminary production planning in the tender phase; general planning, before construction commences; production planning in phases during construction; weekly planning during construction. According to the content of the plan, production planning on a construction project is divided into: time planning, economic and financial planning, general production planning. (Koski 1995, p. 10.)

## **3.2 Scheduling**

Scheduling is initiated by the developer in the project planning stage, when a timetable for the project is drawn up. The project schedule allows compatibility between the planning schedule and a general timetable for the site. The planning and work phases have to be controlled and coordinated by the main implementer of the project management and collaboration with different contractors.

### **3.2.1 Preliminary general schedule**

Scheduling is an integral part of preliminary production plans which is one of the most important plans of production planning during the tender phase. The purpose of the preliminary production planning is to produce information on issues that are to be considered when preparing the cost estimate. This information is provided in the form of plans and schedules, one of which is the preliminary general schedule. (Koski 1995, p. 12-14.)

The preliminary general schedule is prepared during the tender phase, after measurement, but before the preparation of the cost estimate. This schedule is used by cost estimator, work planner, procurement manager and project manager. The purpose of the preliminary general schedule is to check that construction time is realistic and to determine the main working techniques and resources needed. Thus, the project is presented, in which such information as construction time, milestones established in the contract programme and phasing of construction through the seasons of the year can be used in the preparation of the cost estimate and general schedule. (Koski 1995, p. 24.)

The content of the preliminary general schedule usually is presented in the form of a bar chart with 10 to 30 coded items. The items include activities that are important from the viewpoint of cost estimating and project management. The preliminary general schedule is compiled by work planner and project manager. (Koski 1995, p. 24.)

The necessary preparations have to be done before the start of the preliminary general scheduling. Technical information on the project and previous experience of the scheduler serve as the basis for choosing the 10 to 30 items for inclusion. Activity durations are affected by the quantity of work and capacities of work teams or groups. Activities are scheduled on the basis of their duration and order of execution, taking into account: forecast weather conditions (rain, cold), general holidays, critical supplies. The achievement of milestones and total time are checked. Activities are scheduled to meet the established objectives, which is possible, for instance, by changing the quantity of resources. On large and demanding projects the construction phase plans are worked out before the preliminary general schedule. Initial information: construction documents, bills of quantities, general production files (Ratu), as well as the company's own production files provide information on pricing (preparation of cost estimate) and work planning. Project

manager is the person responsible for the preliminary general scheduling. (Koski 1995, p. 24.)

### **3.2.2 General schedule**

The preliminary plans produced during the tender phase are used in preparing time and resource plans. They are updated and refined during the general planning phase of the project according to the conditions, contracts and other factors that affect the work.

The users of the general schedule are employer, designers and contractors. The general schedule is necessary:

- To guide the construction process
- To provide basic information to lower level schedules and plans
- To inform project participants
- To act as a binding document once approved in a site meeting. (Koski 1995, p. 44.)

The general schedule is presented in the form of a bar chart with 20 to 60 coded items. The activities are chosen from the viewpoint of project implementation. The minimum time division is one week. Work planner, site manager, site engineer or project manager compile the general schedule. The date of preparation is just after formalizing the contract. (Koski 1995, p. 44.)

The necessary preparations have to be done before the start of the general scheduling. The project's characteristics and, for instance, the requirements established in the contract documents (e.g. construction time and milestones) are carefully studied. Schedule items are chosen on the basis of technical information. Durations are based on the quantities and pace-setting work that are generally used for similar activities. The order of performing the tasks, possible overlaps and timing are planned to take into account critical supplies and disturbances. Milestones and the overall duration of the project are verified. The objectives are to be met even if the timing of the activities is changed. Changes may be necessary in working methods, sequence of working and resource quantities. At the same

time, the cost estimate (for instance, in terms of working hours for pace-setting resources) is verified. On large and demanding projects, the construction phase schedule is prepared before the preliminary general schedule. (Koski 1995, p. 44.)

The person in charge for the general scheduling is site manager or project manager. The general schedule is controlled for 2 to 6 weeks (depending upon the site). The plan is changed or renewed under exceptional circumstances only, due to its binding nature. Background information is used to create the general schedule (points in common with other plans, which provide initial information for scheduling of construction phases and, for instance, in preparing of drawing schedules and the procurement plan):

- preliminary general schedule
- bills of quantities
- cost estimate
- specifications
- drawings
- contract documents
- production files
- information on available resources. (Koski 1995, p. 44.)

### **3.2.3 Construction phase schedules**

Construction phase schedules, or so-called period schedules, are more accurate than the general schedule. The schedules are prepared on the basis of plans that have been developed earlier.

Construction phase schedules are used by project manager, foremen, procurement manager, sub-contractors and prime contractors. Purposes of construction phase schedules are:

- To act as an implementation model in the construction phases

- To ensure the economical and balanced use of resources at a level more accurate than in the general schedule
- To provide initial information and objectives for weekly planning and special plans in the particular construction phase. (Koski 1995, p. 70.)

Construction phase schedules consist of a bar chart in which the 20 to 200 coded items (List of activities by location) represent the most important tasks of a given construction phase. The accuracy level is one work shift. The use of a particular main resource across different activities is also included. Construction phase schedules are compiled by work planner, site manager, site engineer before each construction phase.

The general schedule and list of activities by location serve as the means for choosing items to be included in construction phase schedules. The dependencies between the tasks are defined before this phase. Work arrangements are prepared and task durations are calculated by the same time on the basis of work shift times and the required quantities with their related resources. These take into account the objectives in the general schedule, available resources, selection of methods and other production plans. In winter time the effects of cold weather have also to be forecast. (Koski 1995, p. 70.)

The person responsible for construction phase schedules is the site manager. Construction scheduling is controlled every 1 to 2 weeks, discussed in schedule meetings. It must be updated if the deviations (expected/actual performance) are significant, that is at least 15 - 20 % of the duration of the construction phase. It is necessary to use initial information construction scheduling, such as: general schedule, bills of quantities, budgetary objectives, work specifications, drawings, contract documents, production files, information on available resource, special plans, initial information for weekly plans, special plans and other construction phase schedules. (Koski 1995, p. 70.)

### **3.2.4 Weekly planning**

Weekly plans are developed by detailing the construction phase schedules. Usually weekly plans are produced on Fridays so that the following two weeks are described in detail and serve as a tool in managing daily working arrangements. (Koski 1995, p. 64.)

The purpose of weekly plans is to undertake the works according to the objectives established in the construction phase schedule for achieving the maximum benefit from available resources. Weekly plans are used by foremen, sub-contractors, prime contractors, team leaders. The initial quantities, resources to be consumed, labour input, quantities planned for specific weeks and timing to an accuracy of one half shift are incorporated in the plan and compiled by site manager, foremen, site engineer. The state (completed, unfinished, not started) of key activities is reported weekly (often on Thursday or Friday). The remaining quantities and, if needed, the labour inputs, are changed for the new weekly plan. A person in charge for weekly plan is the site manager. Initial information is needed for weekly plan: construction phase schedule, previous weekly plan, production files, procurement plan. (Koski 1995, p. 74.)

### **3.3 Scheduling phases**

The preparation method for schedules on different levels of construction is quite similar so that the description is suitable for general scheduling, construction phase and weekly scheduling. The following description of the phases of schedule preparation has been done mainly for general scheduling.

The first phase is to collect the initial information and to familiarize with the project. The initial information includes contract documents (drawings, specifications, contract programme, contract outline etc.), budgetary objectives (which show the resources that have been used in plans), the bill of quantities (which represents the description and quantities of the finished, as-built work), recalculation information and production files (which are used with public-domain production files, e.g. Ratu-file), information on available resources (e.g. the date that the structural frame erection work group is free to leave the previous site, is determined). After collecting the initial information, the project is studied using the available material. The following details are determined approximately:

main activities (e.g. erection of elements, brickwork for partition walls, etc.), milestones (e.g. heating completion, ventilation plant room ready for installation work), conditions (e.g. unusual site conditions). (Koski 1995, p. 98-99.)

The next step in scheduling is to divide the project. The project has to be divided into smaller parts when there are only few dependencies between the parts (e.g. from common resources). This always depends on the merits of the individual project and site conditions.

The preparation of the list of activities by location requires the division of the project into areas, work types and those activities which take place in them. The quantity surveyor ordinarily divides the project into areas and assigns codes to them. The Talo-80 coding system, previous experience of the surveyor and the project characteristics form the basis for the division. When dividing the project by work types, time is the essential matter of concern for the work planner. (Koski 1995, p. 20.)

The following phase is to calculate performance quantities. Performance quantities are mainly determined from the drawings. The bill of quantities, used for producing the cost estimate, can also be used. (Koski 1995, p. 99.)

At the next step it is necessary to choose work methods. Work methods are partly defined in the contract documents and also influenced by construction. The choice of the work method has influence on the performance quantity. Work methods depend essentially on project characteristics, available resources and conditions. (Koski 1995, p. 99.)

After choosing of the work methods, it is time to focus on choosing the resources for each activity. Previous experience of the scheduler makes it easier to choose the work groups to produce the right resource quantity. Production files can also be used in determining the right resource team. The resources should be chosen so that the teams could move from one activity to another with the same speed all the time, so that no waiting times will occur. If the transfer of resources were not quick enough, faster teams would have to be given other places in which to work. (Koski 1995, p. 100.)



The next step is to calculate activity durations, which are determined on the basis of work input and performance quantity. The further point is to plan the work order.

The purpose of the planning of the work order is to determine the most economical order for the project activities for the entire project. In this way the work proceeds according to the established milestones and objectives and the resources have a balanced loading. The dependencies between activities can be divided into four categories: natural dependencies are absolute dependencies that describe the possible technical working order; condition dependencies are defined on the basis of contracts, weather conditions, site arrangements and other similar factors; technical dependencies arise from factors in implementation, resource dependencies describe resource transfer from one activity to another. When planning the working order, the critical supplies have to be taken into account. (Koski 1995, p. 100-101.)

It is necessary to determine the effective work time. Activities have to be scheduled on available working days. This effective work time is achieved by taking out the days that work is not performed from all the calendar days during the planning period. The factors that reduce work time are weekends (Saturday and Sunday), annual holidays and general days off, days on which work time is reduced, caused by interruptions from adverse weather conditions.

When schedule activities have been determined and the durations and work order for them have been decided, the plan can be drawn up in the form of a schedule. The schedule contains the activity bars or lines and the following information:

- number, name and location for the item
- quantity and unit
- resources and pace-setting work input or work achievement
- activity duration.

The next task is to revise the schedule. It is necessary to check the resource loading, milestones and project time after having drawn up the schedule. The work order or

methods can be changed if the schedule is not good for implementing. After the corrections and making changes a new one has to be drawn up. (Koski 1995, p.101.)

### **3.4 Scheduling methods**

There are three most common methods of presentations of scheduling: bar (Gantt) charts, network diagrams and line-of-balance charts. The responsible person for preparation has to consider the available time and resources as well as the project size and characteristics.

On the bar chart the vertical axis represents the items and the horizontal axis is the time scale. The execution of an activity is a solid bar; the dependencies are marked with dotted lines. The bar chart it is readily understood and the most used method in all levels of scheduling. This method is more often used as representation of a plan than a scheduling tool though the line-of-balance chart has become popular in construction phase planning.

In the network diagram the nodes that represent the activities are joined with arrows to denote their order or sequence. This method is used as a planning tool but not in representing plans.

The vertical axis of the linear schedule is the axis for floors, sections or spaces. The horizontal axis is the time axis. The activities are represented with leaning lines that describe the planned progress of work. The following information is given in a line-of-balance chart work sequence (the line sequence from left to right), time between activities (the horizontal length between lines), production speed (line inclination). This chart is especially suitable for ensuring and controlling the prerequisites for production. It aims at planning the starting dates and speed of the activities. This is used to forecast, for instance, the availability of free locations for working and activities which require more resources in order to prevent problems. (Koski 1995, p.102.)

## 4 COMPARISON OF SCHEDULING IN FINLAND AND RUSSIA

Comparison of scheduling of the construction is presented in the table forms (Tables 4.1, 4.2, 4.3, 4.4, 4.5). Table 4.1 shows the comparison of main items such as software, types of schedules, scheduling methods, used norms and standards. As presented in the table in general the same methods are used in both countries. The only difference is the use of combined diagram in Russian scheduling.

Table 4.1 General comparison

Items	Finland	Russia
Software	PlaNet/PlaNet+; Vicosoft Control; PlanMan Project 2010; MS Project; MS Excel	MS Project, DefSmeta, PlanWIZARD, Primavera Project Planner (P3), Spider Project, MS Excel
Types of schedules	Preliminary general schedule, General schedule, Construction phase schedules, Weekly planning	Aggregate (master) schedule, Facility schedule, Construction schedule, Hour (minute) schedule
Scheduling methods	Bar (Gantt) charts, network diagrams and line-of-balance charts	Gantt bar chart, Budnikovs' cyclogram (line-of-balance chart), network diagram, combined diagram
Norms, standards	Talo-80, Aikataulukirja, Building 2000 Project Classification Talo 2000	The Integrated Complex Norms (UKN), The Uniform Norms and Rules (ENiR), SNiP 12-01-2004, Metodological guidlenes (MDS)

The following Table 4.2 contains the comparison of the bill of scheduling phases. The table is based on two sources: Production Planning and Management on a Construction Project edited by Koski Hannu, Organization of the Construction edited by Lev Dickman. As seen from the below table the main points of the content of scheduling phases are almost identical. The principal difference is in the order of implementation of scheduling phases.

Table 4.2 Scheduling phases

Finland	Russia
Collection of initial information and familiarization with the project	Collection of initial information and familiarization with the project
Bill of quantities	Preparation of the list of activities
Dividing the project	Quantities are determined for each type of work according to the nomenclature
Preparation of the list of activities by location	Selecting of the main work methods and methods of the operation of the main machinery
Calculation of performance quantities	Calculation of labour input and operation time of the machinery
Choosing work methods	Definition of work teams and groups
Choosing resources	Definition of technological sequence of works
Definition of work input	Definition of work shifts
Calculation of activity durations	Definition of the duration of separate activities and linking them together
Planning the work order	Adjusting the quantities of work teams and work shifts
Definition of effective work time	Comparison of the calculated and the normative duration
Drawing up the schedule	Designing schedules of resources requirements
Revising the schedule	Revising the schedule

Comparison of schedules types of time scheduling in both countries was carried out. The detailed description of each type of schedules is given in Tables 4.3, 4.4, 4.5. Their

comparison is presented in Tables 4.3, 4.4, 4.5. The description of the general schedule and aggregate schedule is shown in Table 4.3.

Table 4.3 Comparison of the general schedule and the aggregate (master) schedule

Items	Finland	Russia
Plan document	General Schedule	Aggregate (master) Schedule
Size	Entire project	Entire project
Objective	Timing for entire site, milestones	Timing and the sequence for entire site and commissioning; Capital investments size, the quantities; Personnel, equipment
Content	Main tasks approx. 20-30 of them, milestones, task dependencies	Main tasks approx. 30 of them, milestones, task dependencies
Exactness	Dur. from 0,5 weeks to 1 week	Long-term construction is shown by years; Less than two years - by quarters; Less than one year - by months
Initial information	Preliminary general schedule; Drawings and specifications; Quantity surveys; Resource limits; Work achievement or work input files (T4); Fixed dates	Project materials, analogues; Fixed dates; Conditions of construction; The list of the basic, auxiliary structures; Quantities, cost of work; Industrial base; Resource limits; Number of personnel; Methods of the organization, production; Literature
Need of preparation	Always	Always
Person in charge	Site manager	Principal project engineer

Items	Finland	Russia
Compiled by	Site management	Principal project engineer
Date of preparation	After signing the contract or after the decision to construct	After signing the contract or after the decision to construct

The type of scheduling described above presents the organization of the entire project. The comparison of the construction phase scheduling is done in Table 4.4. The analogue of the construction phase schedule in Finland is the facility schedule in Russia.

Table 4.4 Comparison of the construction phase schedule and of the facility schedule

Items	Finland	Russia
Plan document	Construction Phase Schedule	Facility Schedule
Size	Construction phase or chosen period	Each activity for a particular facility
Objective	Specification of timing or resources	Sequence, timing of a facility
Content	Main work types or works, grouped by resources	Stages and types of work
Exactness	Dur. 1 work shift time 0,5 weeks	Has breakdown on months or days
Initial information	General schedule; Quantity surveys (grouped); Available machinery and devices; Resource limits; Work achievement or work input files (T3)	Aggregate schedule; Standards of construction duration or directive task; Construction drawings, cost estimate; Information about organizations participating construction; Schedules of works on the annual program of the installation company

Items	Finland	Russia
Need of preparation	Industrial and business buildings and like: always, large residential building projects: frame work phase, finishes	Always
Person in charge	Site management	Prime contractor or invited design organization
Compiled by	Site management	Prime contractor or invited design organization
Date of preparation	1-2 weeks before the start of construction	After examination and approval of design documentation

A comparative table for the week schedule and construction schedule is made to determine the main differences of this schedule type. A determination of main items of the week schedule and the construction schedule is presented below.

Table 4.5 Comparison of the week schedule and the construction schedule

Items	Finland	Russia
Plan document	Week schedule	Construction Schedule
Size	1-3 weeks	Week, month, months
Objective	Detailed planning of tasks and resources	Separation of the facility schedule into smaller items; Reaction to possible changes on site
Content	Following week's tasks; Task dependencies	Week's tasks
Exactness	Dur. from 2-4 hours to 4-8 hours	Has breakdown on weeks or days

Items	Finland	Russia
Initial information	Drawings, specifications, construction phase schedule, work achievements from previous weeks, work achievement or work input files (T3)	Construction documents
Need of preparation	Always	Always
Person in charge	Site management	Operation and technical department
Compiled by	Site management	Operation and technical department
Date of preparation	On the previous week, for the following 1-3 weeks	On the previous week, for the following 1-4 weeks

The comparison is made on the basic parameters. Items of the description are: title of the plan document, size of the covered period, objective of the schedule, its content and exactness, necessary initial information, description of the need of preparation, information about the person in charge and the person who compiles the schedule, date of preparation.



## **5 SUMMARY**

Issues concerning the time scheduling are among the most important in the construction. This question should be well organized, controlled, managed. Only in this case the completion of the project will be successful. These issues should be perfectly designed from the preliminary period to commissioning.

There is a trend of increasing cooperation between Finland and Russia which means many joint projects and ventures. One of the main difficulties of cooperation between Finland and Russia is the lack of the relevant, required information, literature, and data in accessible language for both countries. All sources of information which describe the time scheduling in Russia are in Russian. The same situation is observed in Finland: all literature is in Finnish.

Therefore it is necessary to determine the main principles of time scheduling in Finland and Russia, to compare them on the main points such as: titles of schedules, used software for scheduling, existing types of schedules, scheduling methods used for planning, norms and standards accepted in both countries. The customers should be aware of the sequence and phases of construction, of needed initial information for starting the planning, of the person in charge and the person who compiles the schedule.

## **FIGURES**

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