Saimaa University of Applied Sciences
Technology, Lappeenranta
Double Degree Programme in Civil and Construction Engineering

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Lift scheduling organization

Lift Concept for Lemminkäinen

Thesis 2015

Abstract
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Saimaa University of Applied Sciences, Lappeenranta
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The purpose of the work was to make a simple schedule for the main contractors and clients to check and control workflow connected with lifts. It gathers works with electricity, construction, engineering networks, installing equipment and commissioning works.
The schedule was carried out during working on the building site Aino in Saint Petersburg in Lemminkäinen. The duration of work was 5 months.

The lift concept in Lemminkäinen is very well controlled in comparison with other building companies in Saint-Petersburg. Lemminkäinen provide KONE lifts prepared shafts as soon as possible. It always stays in touch with them and assures working conditions.

On the other hand, Lemminkäinen is overthinking the safety on the site. This is a European way of working, but it is hard to cooperate with Russians in such a way.

It is believed that KONE was not the best option for a company installing and maintaining lifts. Anyway, because of the agreement between KONE and Lemminkäinen, KONE was chosen to be the lift contractor.

As a result of the work the schedule was realised in Microsoft Project Software. It is simple to use. The schedule allows to change dates, name and quantity of works but shows the main duration and order of workflow.

Keywords: vertical transport, schedule, workflow organization.

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1. Introduction

1.1. Relevance

Necessity for vertical transport increases with time. Elevators become mandatory in Russia for buildings with five stories and more (according to SNiP 31-01-2003(3)). Unlike using stairs, this kind of transport is not only a way of economy time and effort, it is the only way for disabled people to get to the desired height.

Designing and installing elevators is very difficult, time and money consuming. The designing phase consists of designing of the lift equipment according to the given lift shaft, design of HVAC and electricity of the elevation system, selection of cost-effective elevator depending on the necessary waiting time and gross floor area.

The work is concentrated on the installation phase, which is described in details in paragraph 5.

Therefore during the construction phase some delays may appear, which leads to a later building commissioning, which results in a money leakage. It can also badly affect the company image.

1.2. Aims and Objectives

Delays can be avoided by a good schedule of construction of elevator shafts, installing equipment and all works related to vertical transport. Also regulations and order of work flow are necessary to be worked out.

The building site Aino belonging to Lemminkäinen Company in Saint-Petersburg is the example for the project.

2. Description of the building site

2.1. General information about the site

The building site for construction of a multi-storey residential house with underground parking and built-in premises in total amount of 1.445 hectares is situated on Vasilevsky Island in Vasilievskiy district of Saint-Petersburg, on KIMa Street 1.

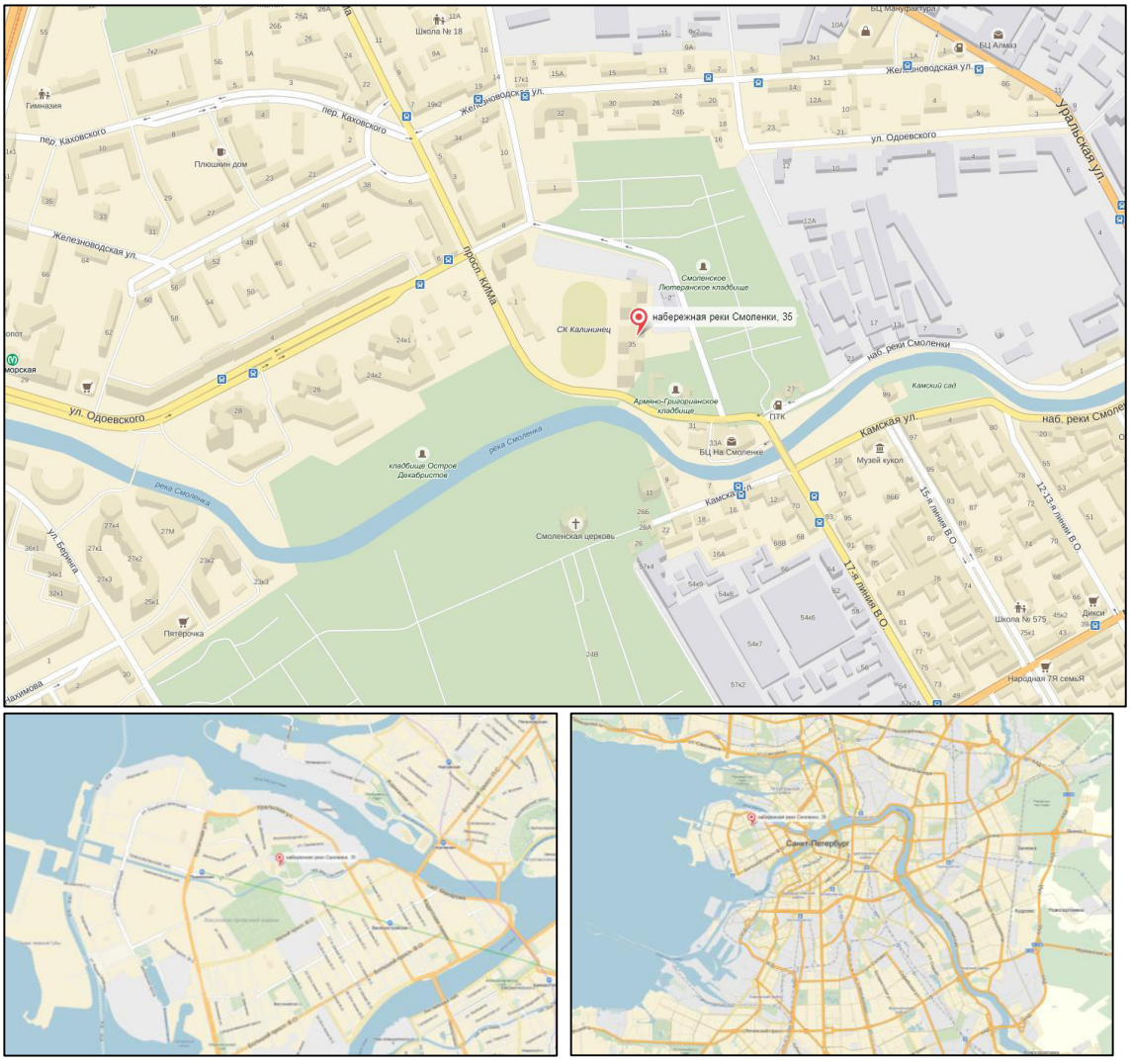


Figure 1. Building site on maps.

The building consists of 6 sections. It has an underground parking. Part of it is a technical floor under the 1st section. Parking is estimated on 156 parking spaces and has 1 entrance and 1 exit.

On the ground floors there are built-in premises. In the 1st section there is a kindergarten. Residential floors are from 2 to 13. The height of the building construction is not more than 40 m.

Disposition of passages and pavements provide accessibility for fire brigades around the building. An approach using fire stairs is provided. The distance from the building site to the nearest firehouse is less than 3 km (3).

The foundation of the building is a pile foundation with a monolithic reinforced concrete grillage. The walls and columns of the underground floor and ground floors are made of monolithic reinforced concrete and aerated concrete. The facing of walls of the ground floor is made of brick with insulation layers. The exterior load-bearing walls represent sandwich panels with different thickness made of prefabricated reinforced concrete and insulation materials. The interior load-bearing walls are made of prefabricated panels of reinforced concrete. The floor slabs are monolithic reinforced concrete. The roof is made of surfacing roll waterproofing.

2.2. Technical and economical parameters of the building

№	Name	Unit	Amount
1	The area of the land within the boundaries of land use	sq. m	14450,0
2	Build-up area	sq. m	6324,4
3	Density of build-up	%	43,8
4	The area of landscaping	sq. m	3069,7
5	Density of landscaping	%	21,2
6	Asphalt pavement area	sq. m	3307,7
7	Pedestrian paving zone area	sq. m	1881,9
8	Outside parking area	sq. m	181
9	Asphalt pavement area (outside build-up area)	sq. m	214,9
10	Paving zone area (outside build-up area)	sq. m	45,3
11	Restored landscaping area	sq. m	3577,4

Chart 1. The main parameters of the building.

The number of floors is 14. The building is 1 floor underground and 13 floors above the ground.

- Six residential units;
- The height of buildings, structures and facilities is 39,9 m;
- Total apartment area of 35 303.9 m^2;
- Built-in premises area is 2 312.4 m;
- Kindergarten area is 751.50 m^2;
- Total area of the building is 51,609 sq. m;
- Total parking area is 4862 m^2;
- 156 parking spaces in the underground car park;
- Up to 1018 shareholders in total;
- 466 apartments;
- Estimated area for 1 person is up to 35 m^2.

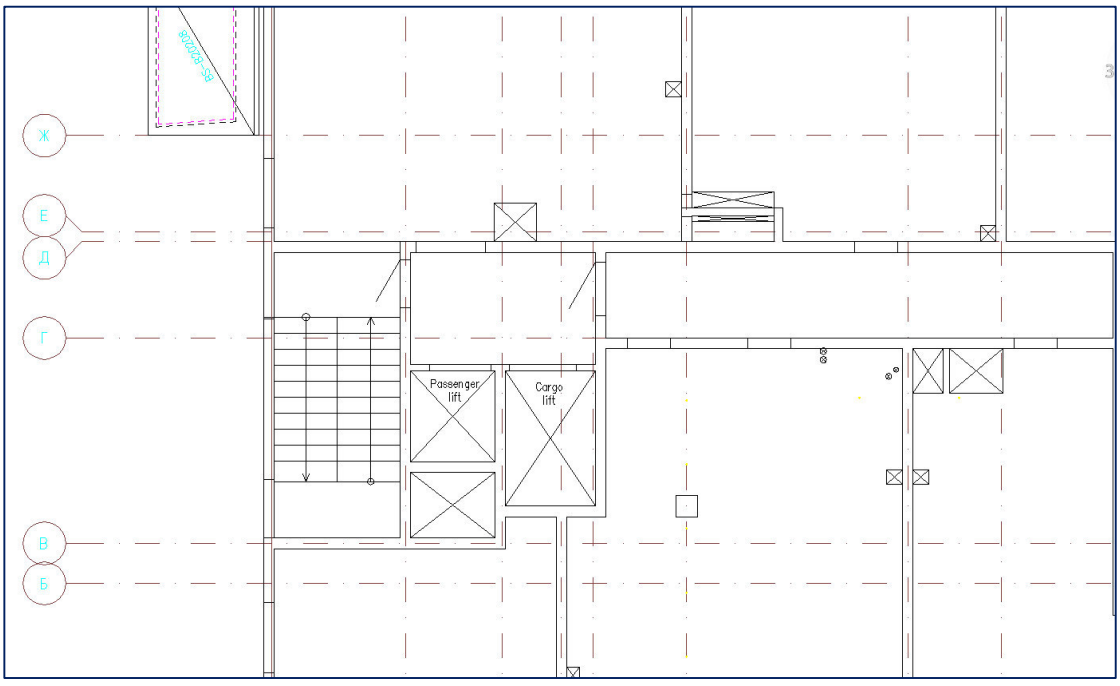


Figure 2. Plan of the 2nd floor (5).

3. Vertical transport designing

3.1. Initial data for designing

The decision of elevator facilities (number, speed of rise and lift capacity) depends on a number of interrelated factors: the amount of residents in the building, staff and visitors of commercial premises, floors, number of stops of the elevator, the opening and closing of doors (2). Due to the fact that the calculations required for the correct designing are extremely complex, you can use the design table for possible options along with empirical data, and the designer should rely on the opinion of an experienced consultant (2).

Basic requirements and recommendations are specified in GOST 52941-2008 (ISO 4190-6: 1984).

3.2. Architectural part

Each section is equipped with two passenger lifts, one of them, passenger carrying capacity of 480 kg, without getting in the underground parking. Another cargo lift 1000 kg is designed to carry fire-fighters in each residential section, corresponding to the requirements of GOST 53296-2009 has a stop in the underground parking lot. This eliminates the need for the entrance of vehicles directly to the entrance of the residential part of the sections.
Lifts, diving into the parking lot are equipped with air locks with air overpressure in a fire at the level of the car park (2).

Elevators do not have the engine room, all the equipment is in the elevator shaft. Such design slightly increases the cost of installing the elevator, but is advantageous in terms of space occupied.

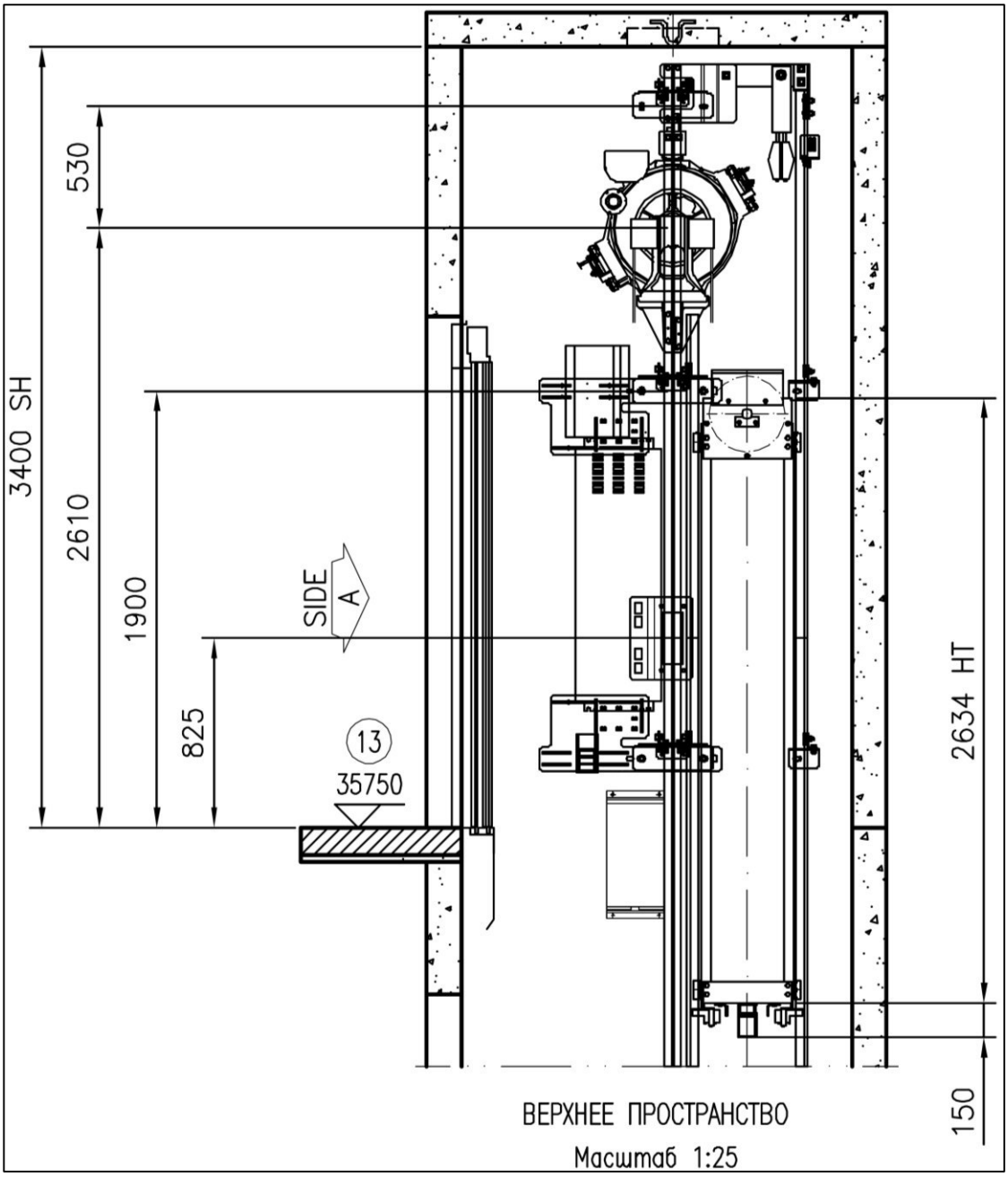


Figure 3. Section of lift shaft with equipment (5).

3.3. Fireprotecting measures

Elevator hall is used as a fire-safe zone, separated by fire partitions (EI 90) and air overpressure in case of fire. The fireproof area designed for 25% of the capacity of apartments on the same floor, on the basis of the specific area of 1.0 m^2 / person per one rescued, but not less than 7 m^2 (3).

Timing of passenger elevator shafts, utility (2):

- Non load-bearing walls EI 45,

- Slabs REI 45,

Cargo elevator:

- Walls REI 150,
- Slabs REI 120,
- Doors EIS 60

Doors in elevator halls (lobbies) EIS 30.

3.4. Technical information

The main information about the passenger elevator is showed in the chart below.

1	Capacity	480 kg
2	Number of passengers	6
3	Speed	1 m/s
4	Acceleration / deceleration	0.5 m/s
5	Doors width	800 mm
6	Doors height	2000 mm
7	Internal height of cabin	2100 mm
8	Internal width of cabin	1000 mm
9	Internal depth of cabin	1250 mm
10	Minimum weight of cabin	376 kg
11	Maximum weight of cabin	710 kg
12	Minimum total weight	856 kg
13	Maximum total weight	1190 kg

Chart 2. Passenger elevator main parameters

The main information about the cargo elevator is showed in the chart below.

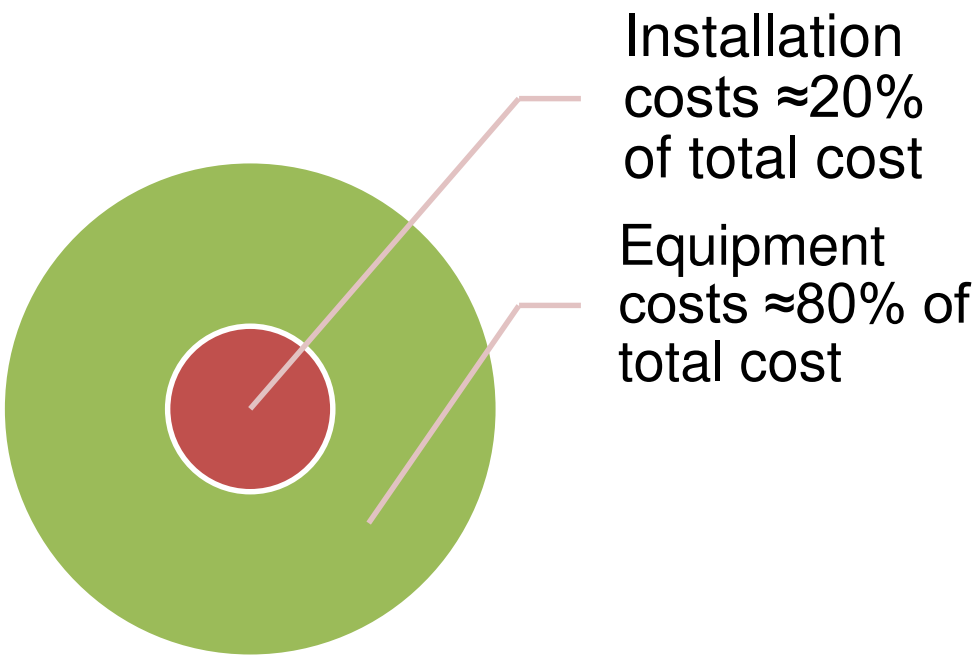
1	Capacity	1000 kg
2	Number of passengers	13
3	Speed	1 m/s

4	Acceleration / deceleration	0.5 m/s
5	Door width	900 mm
6	Doors height	2000 mm
7	Internal height of cabin	2100 mm
8	Internal width of cabin	1100 mm
9	Internal depth of cabin	2100 mm
10	Minimum weight of cabin	858 kg
11	Maximum weight of cabin	1150 kg
12	Minimum total weight	1858 kg
13	Maximum total weight	2150 kg

Chart 3. Cargo elevator main parameters

3.5. Prices

The total price consists of two parts (4):



At Aino, the total price was 811 500 Euros including 18% tax.

4. Project examination

4.1. General terms

Examination of project documentation aims at evaluating whether or not the specific project documentation meets the requirements of Russian legislation, the various building codes and other regulations and standards. It can be carried out by legal entities that are provided with a special authority.

During the examination compliance of project documentation is monitored in order to satisfy the source data, all kinds of specifications and individual requirements of the project or construction.

At the same time ensuring the following parameters in the design documentation is monitored (1).

- Safety and security;
- Structural reliability;
- Sustainability of projects under construction;
- High-level architectural decisions;
- Optimal use of natural resources;
- Efficient use of financial and energy resources.

According to Russian law, every new building, reconstruction, and major repair documentation has to be commissioned by authorities. The developer or technical customer has the right to choose whom to ask for examination of project documentation. So, it can send the technical documentation to state experts or contact a private expert organization.

Independent examination of project documentation implies the assessment of the documents submitted to the following criteria (1):

- Engineering research;
- National standards;
- Organizations standards;
- Technical regulations (including the requirements of fire safety, sanitary epidemiological requirements, standards of industrial safety, etc.)

- Cost estimations standards;
- Planning regulations;
- Project tasks.

Examination of projects is a full-scale study, the main goal of which is to verify compliance with various construction existing standards and regulations. The examination procedure is established by law - Decree of the Government of the Russian Federation.

Examination of construction projects takes place in several stages (1):

1. Filing;
2. Check the documentation;
3. Examination. Experts are checking documents for compliance with the various rules and regulations in the construction industry. If the customer is willing to fix defects, a further follow-up study;
4. Preparation of the results. Experts issue a document that gives a legal right to the start of construction.

Non-governmental or public examination of project documentation is necessary to achieve the following objectives:

- Identification of the correctness and completeness of design solutions in accordance with the signed contracts and agreements between the parties;
- Determining the level of compliance with project documents executed existing standards;
- Evaluation of the necessary activities related to drafting, as well as about their conduct. Taken into account the appropriateness of these measures, in accordance with existing rules and regulations (for the successful implementation of the whole range of installation and construction works, as well as the date of the building of the selection committee);
- The examination of the circumstances that led to additional work not provided for in the project (also revealed the desirability of these works).

The result of examination of project documentation is the conclusion of conformity (positive opinion) or otherwise (negative opinion) project

documentation requirements of technical regulations and the results of engineering studies, the content requirements of sections of project documentation provided in accordance with Part 13 of Article 48 of this Code, as well as compliance engineering research with the technical regulations (if the results of engineering surveys were sent for examination at the same time with the project documentation). If the results of engineering surveys were sent for examination to the direction of the project documentation for examination, the result of the examination is the conclusion of conformity (positive opinion) or otherwise (negative opinion) engineering research with the technical regulations.

Often carrying construction expertise reveals discrepancy particular object climatic and other conditions in which it will be built. For example, investors or customers, little versed in construction techniques, often offer to purchase the building, designed to operate in a favorable and mild climate of Europe. It does not take into account that in the conditions of the Russian winter to exploit such property is not economically feasible: the building will require frequent repairs, and the overall service life will be negligible. To rid themselves of unpleasant surprises, which are often presented to investors their partners, it makes sense to commission a building examination before the start of construction.

4.2. Subject of examination

The subject of the assessment is to assess the conformity of the project documentation requirements of technical regulations, including sanitary-epidemiological, environmental requirements, the requirements of protection of cultural heritage, fire safety, industrial, nuclear, radiation and other safety, as well as results of engineering studies, and conformity assessment results engineering survey requirements of technical regulations (1).

4.3. Required documentation

For the state examination papers are available (1):

1. Request for public examination of project documentation and (or) engineering research;
2. The credentials of the applicant to act on behalf of the builder (customer);

3. Positive conclusion of the state ecological expertise (for facilities, construction, reconstruction, major repairs that are expected to carry on the lands of specially protected areas, as well as related to the placement and disposal of waste hazard class IV);

4. Project documentation, including the original data and the conditions for the preparation of project documentation for the object of capital construction;

5. Normative legal act of the relevant executive authority, on the basis of which a decision on the development of project documentation;

6. Land use documentation;

7. Development plan of land provided for capital construction object allocation (except for linear objects);

8. A copy of the specification for the project;

9. A copy of the job to perform engineering surveys;

10. The results of engineering studies;

11. Specifications, if the operation of the proposed facility capital construction is not possible without connecting it to the network engineering and technical support of the public;

12. Special technical conditions (in case for the development of project documentation for capital construction object inadequate requirements for safety and reliability established by normative technical documents, or such requirements have not been established).

5. Construction, installing and commissioning

5.1. Schedule

The schedule of all works, connected with installing and commissioning of elevators, their connection and conditions is showed in appendix 1. The duration of processes is based on the Aino building site and may differ on other sites, because it depends on different circumstances. However, it can be used for estimating approximate date of the construction ending and work flow control.

Blue color indicates the operations of the organization responsible for installing, commissioning, getting a declaration of accordance and maintaining of elevators.

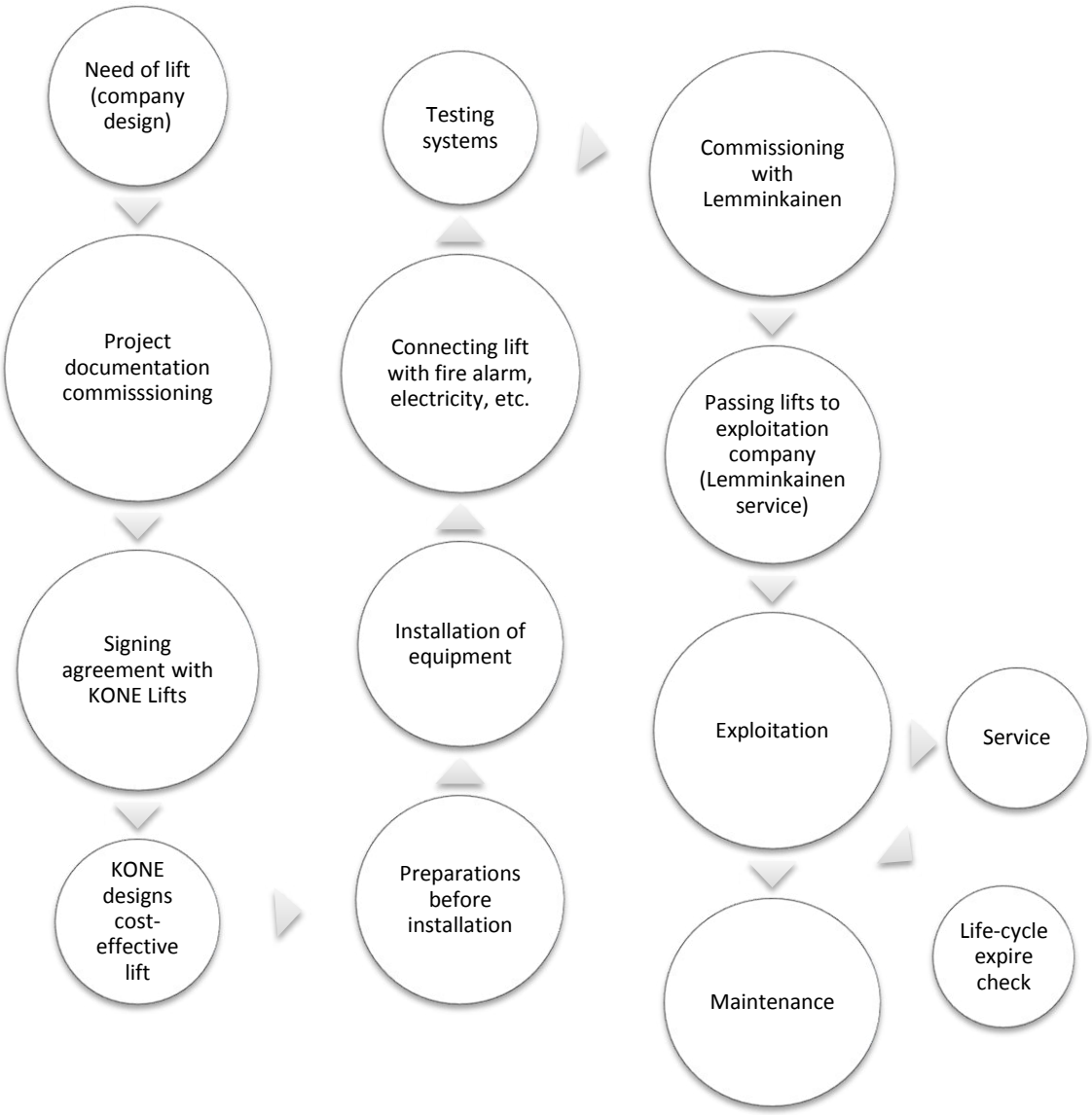
Orange color indicates the responsibility of the general contractor, in this case Lemminkainen Stroy Ltd.

Yellow color indicates the responsibility of a client and managing company, in this case Lemminkäinen Rus JSC and Lemminkäinen Service Ltd.

Green color indicates the responsibility of others, for example engineering systems contractors, shareholders and etc.

5.2. Regulations and order of work flow

This graphic shows the life-cycle of the lift designing and construction and work flow at Aino in Lemminkäinen.



Before installation of equipment elevator shaft has to be prepared and safe for working. The organization, responsible for installing, negotiates the terms and list of preparations with the main contractor personally, but the main positions are mentioned in *5.3 Preparations*.

After installing the equipment, contractors, responsible for engineering systems, should check connection between elevators and fire safety systems and dispatching room. Installing organization pass engineering system contractor signal leads and eliminates faults occurred during commissioning if needed.

Before signing the agreement about exploitation of elevators, it should be connected to permanent electricity. However, most companies ignore this rule and continue to use temporary electrical networks or diesel generators.

Getting the declaration of accordance in engineering center it is necessary to provide the project of vertical transport, describing everything about shafts, name and specification of installing equipment.

5.3. Preparations

The main contractor should provide the following conditions (5) for installing equipment (only mandatory points):

- ✓ Clean and dry elevator shaft covered with plaster;
- ✓ Fenced portals;
- ✓ Presence of ventilation holes, covered with lattices, proven by the main contractor mounting tabs installed in the ceiling of the shaft or lifting beams;
- ✓ Accordance of size of shafts to the project drawings. Door openings are fenced or closed to provide safety.
- ✓ The presence of 3-phase electricity power to the winch lift and mounting hardware;
- ✓ The presence of warehouse area not less than 30 m^2 on the main floor next to the elevator shaft. Free passages to the shaft from the room and back.

5.4. Construction and installing

In most cases installation and commissioning are provided by the supplier of the elevator equipment. Such an option is the most reliable, quick but cost expensive compared to others. Installation of elevator equipment consists of installation of:

- ✓ rails;
- ✓ shaft doors;

- ✓ the cab;
- ✓ counterweight;
- ✓ winches;
- ✓ speed limiter and tensioner;
- ✓ buffers;
- ✓ traction rope;
- ✓ rope speed limiter;
- ✓ compensating circuits;
- ✓ device elevator control, input device;
- ✓ cords, sensors, and other peripheral equipment;
- ✓ cables, wire harnesses, wiring.

As a result, equipment has to be installed correctly, readymade for electricity networks (dispatching, fire systems and etc.) (6).

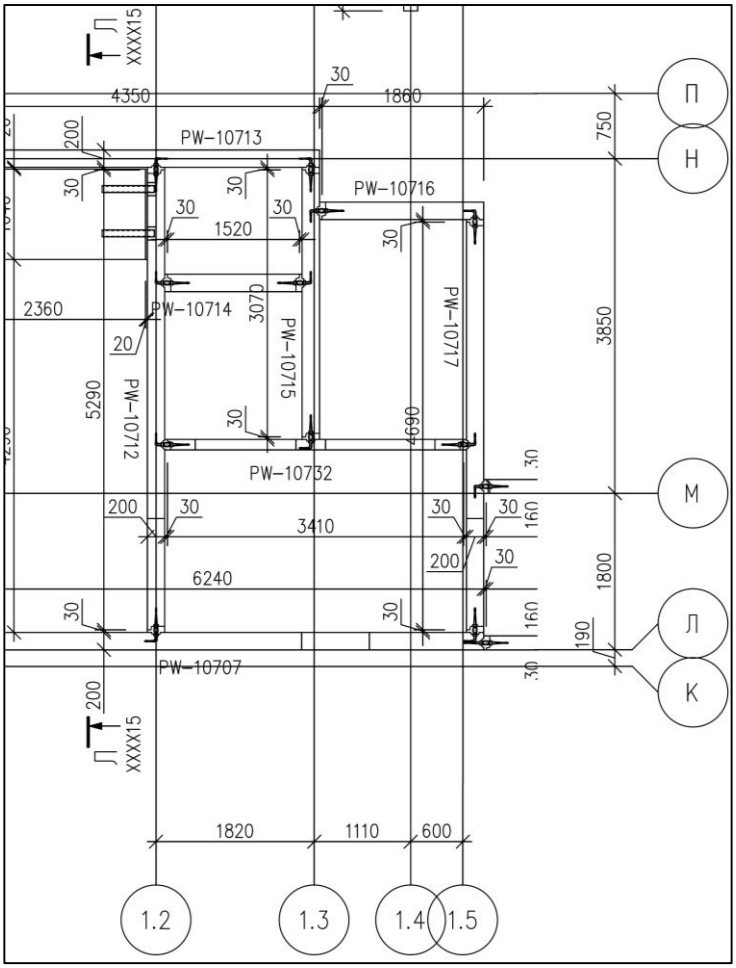


Figure 4. Lift shaft plan (5).

5.5. Commissioning

After the end of the elevator installation, commissioning of mechanical and electrical elevator equipment is held according to the technical description, and electrical circuits.

During the execution of commissioning it is checked that the lift, the interaction of its parts and mechanisms and the work of electrical equipment work properly. Setting works of electrical equipment must be carried out after the adjustment works on elevator equipment produced in the process of installation. Before switching on the input device properly connected motor, the wires connected to the control panel and motor, labeled terminal strips panel are checked (8).

Commissioning works include:

- testing of the equipment under load lift with adjustable parameters of the equipment;
- adjustment of automatic modes of elevator or group of elevators in qualitative and quantitative indicators;

At the beginning of testing it is recommended to carry out a full height test run of the cab which is done manually. If the cab was mounted with the installation at the top of the shaft, to facilitate efforts to move it, it fits a load equal to half the mass of the rated load. Commissioning of the equipment located in the mine is carried out from the roof of the elevator car. During the commissioning of the equipment, measurements of gaps that are regulated by the technical documentation of the manufacturer elevator are taking place. It is necessary to pay special attention to the reliability of all security and safety devices to ensure safe operation of elevators, proper execution of commands, accurate stops on all floors. In carrying out commissioning checks the balance of the "cab-counterweight" lift. Balancing the system is done by adding or removing counterweight. Adjustment of stopping accuracy is made downloading the cab without the motion in both directions. Upon completion of the installation and commissioning work on the elevator specialized organization will prepare protocol of operation check (8).

6. Setting to exploitation

6.1. General terms

Obtaining a permit for setting to exploitation is only possible after the receipt of the complete technical examination of the elevator. It can be obtained in the engineering center after the commissioning of the equipment, the invited experts from EC and correction remarks that were issued by it.

After completing the installation and commissioning work, lifting equipment is subjected to technical examination, issued a declaration of conformity of the lift equipment. Measurements, technical examination, preparation and verification of the documents on the declaration of conformity is carried out by an independent expert organization on the basis of the application of the Client, in the presence of its representative and the representative of the general contractor of a construction company.

After receiving the declaration of conformity of the lift equipment, according to the "Technical Regulations on safety of elevators" in expert organizations, lift passport and the declaration are transmitted to customer to be registered at RosTechNadzor and setting to exploitation.

7. Exploitation

7.1. Building purposes exploitation

After the installation and commissioning checks on its own construction readiness lift Engineering Center is called to conduct a full technical inspection of the elevator. As a rule, the first time Engineering Center provides comments to be eliminated, and only then, upon recall, elevator complete technical examination is drawn.

This act is included in the list of mandatory documents for obtaining permission for the facility to be set to exploitation.

Also act of technical inspection enables to sign the agreement on the exploitation of the elevator for transporting construction materials within

the allowable weights. This allows the developer to abandon the lift services earlier. In terms of the contract emergency maintenance service is included.

Before the transportation of goods and workers elevator cab must be protected from damage and contamination. As a rule, it is sheathed with wooden bars and sheets of hardboard.

7.2. Emergency repair and maintenance, warranty

In most cases, a company engaged in the installation of elevator equipment is engaged in the emergency maintenance.

At Aino KONE lifts gave a warranty that in case of accident, their service have to come and eliminate the problem. It has been prescribed in the warranty agreement signed after commissioning with the main contractor.

The emergency lift maintenance includes:

1. Run the stuck elevator (troubleshooting that does not require time-consuming activities) - around the clock, including weekends and holidays (except at night from 23:00 to 8:00, if eliminating the stoppage of the elevator requires noisy actions);
2. The adoption of urgent activities if there is smoke or ignition in the elevator equipment or shaft;
3. Turn off the elevators (within the agreement with the customer) when corruption is detected, preventing the safe operation of elevators, the removal of which is time-consuming and long-term repair;
4. Release of passengers from stopped elevators - around the clock, including weekends and holidays, within 30 minutes after receiving the information.

7.3. Regular inspections

Conformity assessment of elevators during the exploitation is carried out in the form of periodic technical inspection of at least once per year for the duration of the service term by the certification body. The sequence of technical examination (7):

- ✓ Verification of technical documentation and documentation of Exploitation elevator;
- ✓ Inspection of elevator;
- ✓ Testing of the elevator;
- ✓ Presenting of results of technical examination.

In case of any problem the customer should contact Lemminkäinen service for help. If the problem cannot be solved by Lemminkäinen service, then KONE lifts is invited as a warranty company.

7.4. Expiration commissioning

Reaching the end of the elevator rated service life about 25 years shall be subject to a diagnosis, as well as examination of metal structures, which use non-destructive methods of control in order to determine the feasibility of the operation of the elevator in the future (7).

8. Conclusion

Planning and coordination of the work during installation of vertical transport is different for each object, therefore complex and unique. The general progress of the work, their relationship and the duration and conditions for the implementation are described in section *5.1 Schedule*. To begin installation of equipment it is necessary to carry out the preparatory work, their generic list is specified in paragraph *5.3 Preparations*. Signing a contract with the management company is only possible after receiving the declaration of conformity. And in the end, moving in of shareholders takes place after the end of the entire spectrum of the works referred in sections 5 and 6.

This work was done in the framework of object Aino construction company Lemminkäinen, and cannot be applied to any situation and claim to absolute truth, as much depends on the general contractor, the model of the elevator equipment and the construction organization. Most of the information was obtained empirically during communication and negotiations with qualified employees and recorded at the site.

However, all housing projects in St. Petersburg have common features and bugs, and, consequently, their decisions will be typical. In order for them to do so, I gathered as much information about the device of vertical transport as possible, analyzed and systematized it.

For convenience, sample dates are created in Microsoft Project, which can be used for the organization of work and changed during the process of construction.

In my opinion, the lift concept in Lemminkäinen is very well controlled in comparison with other building companies in Saint-Petersburg. The main contractor provides the lift contractor (which was KONE lifts in my case) prepared shafts as soon as possible without any delays. They always stay in touch with lift contractor and assure working conditions. If there is a problem on the side of the main contractor that does not allow KONE continue working (for example, with electricity or fire alarm) Lemminkäinen tries to solve it as soon as possible.

On the other hand, Lemminkäinen is overthinking the safety on the site. I understand that this is a European way of working, but it is hard to cooperate with Russians in such a way. There are a lot of conflicts concerning work safety.

Also it is believed, that KONE was not the best option for a company installing and maintaining lifts. Their prices are too high and the quality of the services does not suit them. Anyway, the headquarters had chosen KONE Company because of the annual agreement between KONE and Lemminkäinen.

References

1. Construction Code of Russian Federation, Chapter 6, Article 49 "Expertise of project documentation and engineering survey results, the state ecological examination of project documentation for the construction, reconstruction of which is supposed to be carried out in the exclusive economic zone of the Russian Federation, on the continental shelf of the Russian Federation, in the internal sea waters in the territorial sea of the Russian Federation, on the lands of specially protected natural territories ";
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APPENDIX 1

Ид.	Режим задачи	Название задачи	Длительность	Сторонние условия для начала	Начало	Окончание	Предше
1		Lift shaft construction	1 день		Пн 06.01.14	Пн 06.01.14	
2		Dedusting, plastering of the shaft walls	5 дней		Вт 07.01.14	Пн 13.01.14	1
3		Finishing lift halls	20 дней		Вт 07.01.14	Пн 03.02.14	1
4		Framing portals	5 дней		Вт 04.02.14	Пн 10.02.14	3
5		Installing equipment	20 дней		Вт 14.01.14	Пн 10.02.14	2
6		Connection control with the electrical systems contractors	4 дней	Commissioning of fire protection and dispatching systems	Вт 11.02.14	Пт 14.02.14	5
7		**Putting lifts into the operation**	**30 дней**		**Вт 11.02.14**	**Пн 24.03.14**	
8		Tests	10 дней		Вт 11.02.14	Пн 24.02.14	4;5
9		Commissioning by the main contractor	4 дней		Вт 25.02.14	Пт 28.02.14	8
10		Invitation of Engineering Center for complete technical examination of the elevator	3 дней		Пн 03.03.14	Ср 05.03.14	9
11		Identified comments elimination	5 дней		Чт 06.03.14	Ср 12.03.14	10
12		Repetition of invitation of Engineering Center	5 дней		Чт 13.03.14	Ср 19.03.14	11
13		Obtaining Act of technical inspection of elevators	3 дней		Чт 20.03.14	Пн 24.03.14	12
14		***Obtaining a permit for setting to exploitation***	0 дней		Пн 24.03.14	Пн 24.03.14	13;6
15		Signing an agreement for using lift for building purposes	3 дней	Switching to permanent electricity	Чт 20.03.14	Пн 24.03.14	13ОО
16		**Obtaining the declaration of conformity**	**35 дней**		**Чт 20.03.14**	**Ср 07.05.14**	
17		Preparation of documents for declaring lifts	3 дней	"Vertical transport" project	Чт 20.03.14	Пн 24.03.14	13ОО
18		Declaring lift by the Engineering Center	25 дней		Вт 25.03.14	Пн 28.04.14	17
19		Obtaining the declaration of conformity	5 дней		Вт 29.04.14	Пн 05.05.14	18
20		Passing documents concerning lift to the service company	2 дней		Вт 06.05.14	Ср 07.05.14	19
21		Signing an agreement for maintaining and examination of lifts	3 дней		Чт 08.05.14	Пн 12.05.14	20;15
22		**Clients move-in**	0 дней	Construction end	Пн 12.05.14	Пн 12.05.14	21