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Diagnostics of materials and structures of heating system as a component of ecological management in a modern city

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Abstract. The maintenance of materials and structures of the underground space in modern cities which contains many engineering structures is considered in the article. It is claimed on the example of quantitative data that the underground structures exert a great influence on the ecological situation of the city. The matters of the research included the analysis of the main heating systems as the most responsible city structure; the conclusions obtained can be also used for smaller heat pipelines. The article includes the comparisons of modern technical methods of diagnostics of materials and heating systems structures according to the results of experiment, as well as the characteristic of norms of control of the materials condition at the stages of construction and maintenance applied in the developed countries. On this basis, the author has developed and presented a system of diagnostics taking into account the alternation of measures during the heating period as well as the season when heat supply is not required. For an effective ecological management in modern cities, it is suggested to create the automated data base of materials and structures of the heating systems on the basis of the developed scheme of their conditions and events, which needs to be used for forecasting of environmental risks and planning of recovery works with consideration of special features of the maintenance processes. The direction of the further research is defined: it is the expansion of the stated approaches on other types of underground communications in modern cities.

1 Introduction

The extensive discussion of the problem of changes of the ecological situation in the world to the deterioration which is being carried out in the expert community raises some questions of ensuring efficiency of functioning of structures in the city infrastructure in a new aspect and defines the new trends in the search of reserves for providing these processes. The transition of the economy from the resource-and-raw type to the resource-and-innovative type, which has begun according to the provisions of the "Concept of the Long-Term Social-and-Economic Development of the Russian Federation till 2020" is the

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incentive to providing modern decisions on high characteristics of environmental friendliness of structures in the Russian Federation [14]. In order to solve the problem of reduction of the environmental risks in the ecological management complex it is important to consider that the underground space of modern cities has many engineering structures which have significant effect on the ecological condition in the city. From this point of view the heating systems, considered in the completed research, are the most dangerous. In the ecological aspect the main danger, produced by the heating systems for the urban development consists in the possibility of obtaining unorganized industrial emissions in the case of emergencies, when the heat carrier comes directly to soil in the form of streams of hot water (heat carrier), which is under pressure, without any cleaning. Scales of this problem in the Russian Federation are considerable and the experience of overcoming of these problems on a scientific basis can be useful to other countries which urban development has underground communications with the hot heat carrier of industrial or civil purpose. In the Russian Federation more than 17 thousand plants of heat supply work in the city settlements where heating systems have general extent of 172 019.3 km in two-pipe calculation (the direct giving pipe and the return one) [8]. While characterizing this problem more particularly it is necessary to provide the following data, defining its technical and economic aspects in the scales of the Russian Federation: according to Rosstat, in 2014 the quantity of the heating and steam systems, demanding repair, made up 49 738.1 km, that is more than one third of the general extent. At the same time during one year the considerable number of emergencies with the accompanying ecological damages has been noticed (6 782 cases), as the result 3 812 km of heating systems have been replaced in 2014. Taking into account that the estimated cost of replacement of 1 running meter of heating systems makes 10 thousand rubles, it is possible to estimate the total cost as 38 billion rubles. The similar quantitative assessment of "the generalized character" can be directly projected on any enterprise's activity in a modern Russian city in which the underground space has heating systems. At least one tenth of the heating systems property demands urgent repair and comprises some environmental risks; costs of their localization within the correct organization of the city management, according to the author, could be reduced by the size of about 30 percent. In the aspect of ecological management of the modern city existence of such risks supposes the promotion of measures of preventing character for diagnostics of heating systems which main elements are the diagnostics of technical condition of the structures of the heating systems under maintenance and the control of carrying out the measures for ensuring the efficiency of their functioning.

2 Methodology

For the definition of the directions and forms of the environmental risks related with the decrease in the properties of materials as well as with the failures of the heating systems structures, which need to be considered in the organization of the modern city management the conditions of the operating systems, methods of diagnostics of the technical parameters and the organization of their maintenance have been analyzed in the research. It is suggested to distinguish the conditions of the operating structures and the events, changing them:

- serviceable, at which the structure conforms to all the requirements of the specifications and technical documentation (STD);
- defective, at which the structure does not meet all the requirements of the STD;
- efficient, at which the values of all the parameters characterizing the ability to carry out the set functions; conform to requirements of the STD;.
- inefficient, at which the value at least one parameter characterizing the ability to carry out the set functions does not conform to requirements of the STD.

Full exhaustion of properties of materials and structures during the heating system maintenance is characterized by the achievement of its limit condition. The limit condition is the condition of a structure, when its further use according to its purpose is inadmissible or inexpedient, otherwise the restoration of its serviceable or working condition is impossible or inadmissible. The sign or the set of signs established by the STD act as the criteria of the limit condition of the heating system.

From the point of view of the assessment of materials and structures of the heating system some concepts were differentiated on the basis of observing the maintenance processes: the concepts "serviceability" and "defective" are wider than the concepts "efficiency" and "inefficiency". The maintenance of a heating system in the presence of dot corrosion on the metal surface of the pipeline or fittings which do not cause any considerable leakages of the heat carrier and not reducing the mode of its transportation, but which is already interfaced to damages of the ecological condition of the surrounding underground space can be an example. Defective condition of a heating system is seen, for example, in the violations of heat- and waterproofing layers of the pipeline, partial destruction of seams of reinforced concrete structures of channels and chambers.

But at the same time the heating supply system is efficient as it carries out its main function - which is the transfer of heat and no harmful ecological effects on the environment emerge. The transition of the system under maintenance from one condition into another results from some changes - damages and failures which are presented as environmental risks of different types. The events, consisting in the violation of the serviceable condition of the structure at the preservation of its efficiency, are considered to be damages. The events, breaking the efficiency of the structure, are considered to be failures.

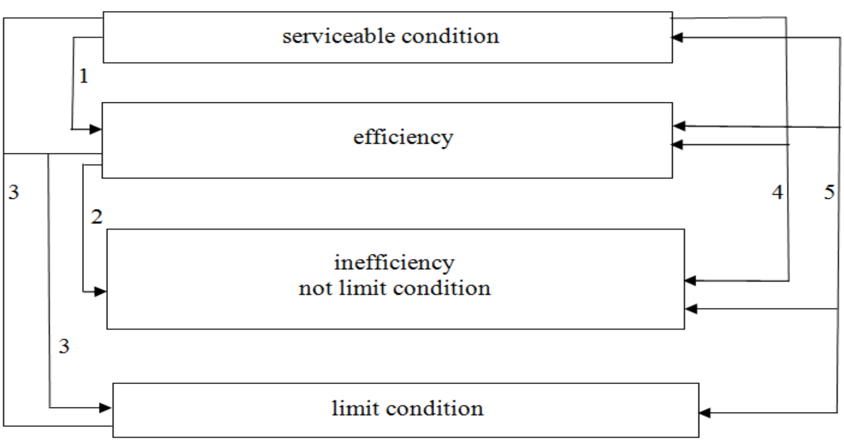

Fig. 1. Scheme of the main conditions and events of a heating system.

Deterioration in operational properties (event 1-3)

I - damage, 2 - failure, 3 - ineradicable violation in the heating supply maintenance (discrepancy to safety requirements, obsolescence, etc.);

Restoration (improvement) of the system properties:

4 - service and maintenance, 5 - repair.

The main difference among the aforesaid events is the extent of the influence on environmental of the underground space surrounding the structure and, respectively, the importance of the consequences for the managerial decisions making. It is considered, that the most serious consequences have the violations in the heating system maintenance, related with the metal corrosion of the pipeline - that makes up to 80 percent of the total number of failures in the practice of heating system maintenance in the Russian Federation.

Along with the corrosion processes the decrease in the maintenance properties of the heating systems happens because of the reasons of not corrosion character related with the deformation of elements, defects of metal, etc. The article includes the results of the author's research aimed on the introduction of the quantitative indicators, characterizing failures and damages of the heating system, which depend on the quality of their construction. At the same time the results of main heating systems survey of the city of Moscow, which due to the carried out functions cause the greatest environmental risks, were used. As a result of the completed analysis it was proved that the direct sites of the pipeline are the most common subject of failures. Fistulas in the material of the pipe and its gaps, which make up to 75-90% of the total number of failures of the heating systems, belong to the failures of corrosion character. They can be noticed on all the elements of the systems, which were produced from metal: pipelines, fittings, compensators, etc.

In order to find out the interrelation of the corrosion failures and the quality of construction the analysis of the reasons of emergence of failures was carried out. Seven groups of the reasons causing corrosion failures, four of them are the consequence of low-quality completion of construction works at the heating systems, were distinguished. The quality of such works as waterproofing of walls and seal of seams of channels and chambers (up to 62% of the total number of failures) influences most sufficiently. The second and the third places are held by the works on the passing drainage, sandy basis. The violation the requirement to the quality of welding works also influences emergence of corrosion failures, as the tightness is not provided [15].

Studying of allocation of these failures throughout the term of heating systems maintenance (25 years in the Russian Federation) has shown process of loss of opportunities of resistance of materials of metal elements of a thermal network of corrosion and, respectively, increase of risks of ecological damages. The first corrosion failures appear in 5-6 years from the beginning of the heating system maintenance. This results from the fact that the speed of corrosion processes averages 1 mm a year therefore at a thickness of a side of pipes ranging from 5 to 12 mm emergence of corrosion failures happens in the range from 5 till 12 years. It is noted that during from 5 to 16 years of value of an annual increment of a stream of corrosion failures constantly, i.e. the period of normal operation of a thermal network is observed. At this time corrosion failures are the consequence of poor quality of construction. Since 16 years from input of the heating system maintenance, a stream of failures increases in process of "aging" of materials of heating systems. From this age dominating in development of corrosion of materials of the heating systems there are maintenance factors - the period of wear and increase of environmental risks begins. Therefore owing to the nature of course of negative processes hidden from the direct survey, there is the following question, important for ecological management in the modern city – the organization of diagnostics of the condition of materials and structures of the heating systems.

3 Standards

In the methodical aspect the starting point of the diagnostics, which is presented by the standards, used for carrying out control measurements is important. The comparative analysis of the standard requirements imposed for this type of technical structures in the Russian Federation and abroad, which was carried out by the author and covered 322 standard documents, is interesting [10]. According to the results of the comparison of the STD on the nondestructive control of pipelines with those on the direct access to the pipelines (availability control of the pipeline is provided from all the directions), the essential difference was not revealed. Many Russian standards on the nondestructive control just are the foreign standards accepted for the use in Russia, since according to article 13 of the Federal Law "On Technical Regulation": "Documents in the field of standardization used in the territory of the Russian Federation include: the international standards, regional standards, regional sets of rules, standards of the foreign states and sets of rules of the foreign states registered in Federal Information Fund of Technical Regulation and Standards." [2, 5, 8] In the STD studied there are more than 40 types of nondestructive control of the main part of the heating systems, (i.e. the welded pipes material), carried out by the means of the instrumental methods and visual survey. That is a rather detailed study of possible options of control, use of them theoretically allows to exclude risks of emergencies during the heating systems maintenance and the accompanying environmental risks. At the same time, according to this list, the main part of nondestructive control is presented by the processes of pipes production (the automated technologies), and to a lesser extent by the check and acceptance of structures during the construction. Both foreign and Russian STD make the main accent on materials and that consists in the following fact: the pipes arriving on construction site are to already have some data on the completed control in their accompanying documentation. For example, according to the American standard. ASTM (ASTM A 106 Standard Specification for carbon Steel Pipe for High-Temperature Service) [3]. That means that both in foreign and domestic STD the priority of the safe maintenanse of the structures consists in meeting the strict requirements to the quality of structure. The only difference is that in the USA and EU the quality of installation is controlled by the independent expert (inspector) [3], and in the Russian Federation it is controlled by the commission of representatives of the operating enterprise, the contractor and Rostechnadzor. Formally the organization of control at this stage appears to be approximately equal, but the further maintenance of the structures of the heating systems proves that in the Russian practice more defects of structures are detected at this stage than in other countries. It was the very subject of the further analysis according the assumption that the revealed causes of failures will promote the development of more perfect materials, structures and methods of technical diagnostics.

In this regard the generalized characteristic of the pre-maintenance and maintenance processes concerning the equipment (including heating systems) in the foreign practice, minimizing the risks of the decrease in properties of materials, failures of structures and accompanying ecological damages, was prepared. According to the Directive PED, the equipment with the maximum admissible pressure of PS of more than 0.5 bars is the subject of obligatory certification. [15]. EU have no right to forbid or to limit commissioning of the equipment in the market of the EU on the basis of danger because of the existence of technological processes of work under pressure. At the same time, the interested parties are obliged to apply all the nesessary measures of control of allocation in the market of the products, which is meeting the requirements of the Directive and which has undergone the certification procedure with the right of drawing marking of SE. In the cases when the equipment, being the subject of action of the Directive, threatens the safety, the authorities of the EU are obliged to take the appropriate measures for the withdrawal of such products from the market of the European Union. The equipment has to be exposed to one of the procedures of control of compliance which can be chosen by the producer, depending on the category of the product.

As the result of the practical use of the rules, generalized above, the qualitatively constructed heating systems with polyurethane foam isolation, with the alarm system, warning about moistening of materials of structures, brought to the single automated control panel exist in the majority EU countries . Rigid control of the quality of the make-up water is also carried out and there are no heat exchangers which are "full of holes". All the arising cases of violation of properties of the materials of the pipes waterproofing are liquidated quickly and qualitatively, the pipelines serve on average 30 years. [8, 9] At the same time the temperature condition up to 130C is provided. In 30 years it is enough to open 2-3 sites and if the survey proves the materials and structures of the pipeline to be in good repair, that conclusion extends to all the heating systems of the same type. For the normal maintenance of the heating systems with the channel types of laying it is sufficient to provide the qualitative waterproofing of channels, the current maintenance of drainage systems and well-organized monitoring of the production processes of the transportation.

4 Results

The most exact information on the condition of materials and structures of the heating systems, their compliance with the considered STD can be obtained by the means of carrying out technical instrument diagnostics. [9, 13]. This type of diagnostics supposes the timely detection of places of thinning on the pipe side of the heating system because of external and internal corrosion, which makes up about 90 percent of the refusals of the system. The remote indirect methods became the basis for the analyzed technology of the technical diagnostics of the underground heating systems, which are inaccessible for any direct survey and measurements of parameters of maintenance. We should note that they do not reveal particular defects of the heating systems, but reveal certain abnormal zones, which are different from the standard values. Two methods which were considered in details are most perspective: they are the acoustic tomography (AT) and the method of contactless magnetic diagnostics (CMD) [3]. Their use allows to reveal the places of the heating system where there is increased metal tension on the metal side of the pipe. The method of thermovision infrared aerial photograph (TIRAP) is also interesting as a method, supplementing the aforesaid methods [3]. It shows the heat anomalies of the ground surface over the main heating system and that rather visually demonstrates the areas of an environmental risk on the city map.

For the formation of reliable data the check of the results received through the indirect methods is important for ecological management in the modern city. In this regard the analysis of the provided data on the basis of direct access to the separate sites of the heating system by the means of pitting. In general from 100% of the sites surveyed by the AT and BMD methods in 60 - 80% sites with anomalies have real defects of metal of pipes; the rest is the tension of metal without noticeable defects which can lead to loss of the heat carrier. Therefore such type of the result of these methods of diagnostics can be sufficient when for management requires to estimate the general reliability of a site, assuming a little extension of term of maintenance (till 1 year). As an additional condition of decision-making it is also necessary to consider the maintenance history, i.e. the previous repairs of small sites caused by the arisen damages.

In our opinion making such local decisions containing an environmental risk concerned possible leakages of the heat carrier cannot be applicable for all territory of the city. At the especially responsible territories of the city it is required to provide 100% reliability of maintenance, usually through traditional way of the full turn of a site instead of carrying out local repairs. Diagnostics of heating systems in this case can be carried out by the direct method on intra-pipe shells by the Norwegian firm, named “Breivoll”. [3] The measurement of thickness of a side of the heating system by the intra-pipe inspection device, which is in the water environment, is made by the means of technology of the acoustic resonance based on an ultrasonic method of nondestructive control.

Indirect methods of diagnostics are being developed and need an assessment of the results therefore for the comparison of one of the indirect methods of diagnostics with the IPD method the comparison of the results received through diagnostics of the same sites of the heating system was carried out. The specifications of application of the aforesaid methods are given in the Table 1.

Table 1. Specifications of application of IPD and AT-method.

Conditions of application of the method on the heating system	IPD - inspection shell, "Breivoll" firm, direct diagnostics	AT-equipment, "Rent Technologies", Ltd, indirect diagnostics
General description of the application conditions	The site of heating system without angles of rotation is chosen, taken out of service, cooled up to the admissible temperature. The laying is opened in one place before the access to pipes. In the top part of the surveyed pipe the window for loading of the device is cut out. The diagnostic shell is entered into the pipe filled with the cooled heat carrier. The shell with a cable of communication and a rope moves ahead until the end of a site and during the return pulling of the rope the diagnostic record is made.	The site of the heating system in working order in the maintenance mode is chosen. Acoustic sensors are fixed at the edges of the site in the access points (chambers, viewing hatches) at first on the giving pipe and then on the return pipe. The record is made separately for the giving pipe and for the return pipe. The record lasts 2 minutes for each pipe.
Data processing	By a highly qualified specialist using computer	By a highly qualified specialist using computer. In an operating mode is it usually done in 24 hours. In the emergency mode it can be processed on the site.
Removal after maintenance	Required	Not required
Temperature of the heat carrier	Not above +40°C at the stopped circulation	Up to +130C in the operation mode °
Length of the surveyed site for one work cycle	On direct sites on length only	40-300 metres irrespective of the scheme.
Nominal diameter of the pipe, mm.		50 - 1400
Data obtained	Side thickness on all the surveyed length with the exact binding on length	Abnormal zones with the increased metal tension with the binding on the site length on the ground surface

As the concrete example of comparison of methods the results of AT-diagnostics of the return pipeline with a nominal diameter of 600, 125 m long are presented in the form of the schedule (fig.1). The results of the detection of defects by the IPD method for this site are presented in the Table 2.

Table 2. Results of the diagnostics of a site of the heating system by IPD method.

№	Beginning of the interval, m	End of the interval, м	Length of the defective interval, m	Metal loss level, %	Result
1	5.1	6.5	1.4	29.5	External corrosion
2	69.7	71.6	1.9	48.2	External corrosion
3	71.6	72	0.4	39.7	External corrosion
4	87	90.8	3.8	27.2	External corrosion
5	99.5	100.3	0.8	27.5	External corrosion
6	109.2	111.5	2.3	39.6	External corrosion
7	117.0	117.7	0.7	39.6	External corrosion
8	59.6	60.2	0.6	Outgrowth up to 60 mm	Internal outgrowths on the structure

Similar diagnostics was also carried out by the AT-method, its results are presented graphically (Fig. 2). Axis "X" demonstrates the distance on a pipe from the initial point to final. Axis "U" demonstrates the energy of the signal of issue generated in the step-by-step analysis. The existence of defects is stated by signals above to the green line. The location of defect corresponds the position of "peak" (amplitude value) of the signal. According to the level of energy of issue, all the defects are divided into: subcritical (between green and red lines) and critical (above the red line).

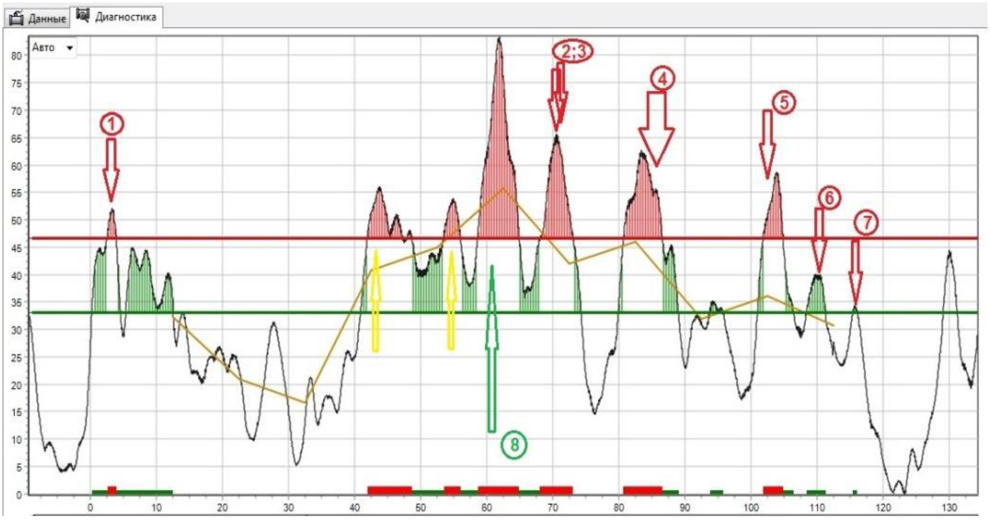

Fig. 2. Results of diagnostics of the site of the heating system by AT method.

The comparison of the results of diagnostics on this site shows that seven defects of external corrosion of the pipe metal, found by IPD were also found by AT-method. Besides, one interval with outgrowths inside the pipe was found by IPD (8 - green arrow in fig. 1). That indicates the existence of internal metal corrosion. This interval was found by AT-method too. In addition two more defective intervals of critical level were by AT-method revealed (yellow arrows in fig. 1). These defects are displayed in fig. 1 as arrows.

Total length of the heating system which is the subject of the comparison of results of the aforesaid types of diagnostics is 1958 running meter. 56 defective intervals were revealed by IPD method, 53 of them were revealed by AT-method. Besides AT-method indicates the existence of 15 more defective intervals which generally correspond to the heating system sites where the IPD method noted the existence of outgrowths inside the pipe, i.e. the internal corrosion. Thus, the coincidence of the results for IPD and AT methods makes up 82%.

5 Discussions

The developments, which basis is estimated for years of research activity in the field of management of the heating systems maintenance allowed to raise a question in such an aspect and to offer some methodical tools for ecological management in the modern city, concerning the activity of the heat supplying enterprises [10]. It is well-known that one of the main conditions of effective management of any process is the existence of necessary and sufficient data on the performance of the management subject at the moment of decision-making [4, 11] . Within the considered perspective the diagnostics of the performance of materials and structures of the heating systems on the basis of the standards and methods considered above in combination with the certain system of control measures makes up the basis for the formation of the automated data base at the operating enterprise. We will give the description of such data base in relation to the Russian practice which according to the official reports and the conducted research the performance of the heating systems is most problematic in the aspect of accident rate and has considerable environmental risks.

Considering the situation of making decisions on the existence of the environmental risk connected with the decrease in properties of materials and structures of the heating systems within the maintenance process it is possible to name the following parameters of obtaining of data: data have to be obtained within 10 minutes after the receipt of inquiry, and the relevance of data has to be no more, than 5 days after the date of inquiry. It appears very problematic to meet these requirements for the Russian heat supplying enterprises in the conditions of the modern city. During the construction, commissioning, repair works throughout rather long service life of the heating system data are fixed incidentally and irregularly. The main disadvantage of such accounting at the enterprises operating the heating systems is the significant amount of data which, despite the current possibility of automation of management, are still stored as papers or as the local databases separated on separate divisions (that is not less problematic). One more important aspect should be noted: in the case of the mixed "paper-and-electronic" data storage many doubts about the reliability of data exist, as it is impossible to compare them, in fact it is impossible to make any correct conclusions on the base of such data.

The most progressive enterprises operating the heating systems are guided by the use of the ready software which, is aimed generally on "drawing" of the heating system schemes on the electronic map of the city as well as on the hydraulic mode operation ("Zulu", "Stream", "Teploexpert") [3]. The existence of such data which are visually representing the heating systems in an electronic form is the step forward, however it is not exhaustive. Even in such circumstances in the particular situation of accident in the heating system decisions are made more intuitively, the wide range of options (from change of all the route to the local replacement of a separate site). In practice and as the extreme version the decision concludes the replacement of the damaged part of the heating system.

It is possible to correct this situation by starting permanent and consecutive work on the accumulation of the data acccording to the results of diagnostics using standard techniques of database formation [1, 7]. In various domestic STD there are general requirements about the need of fixing of these rounds, surveys, revealed defects, eliminated damages of heating systems. But in the case of the use of modern information technologies, it is necessary to develop some regular procedures of control and also some branch qualifiers of the performance of materials structures of the heating system on the basis of the received results [11, 12]. Domestic and foreign documents, despite the demands of management, do not include such qualifiers. It is suggested to use the performance and the maintenance events of the heating systems, applied earlier for the identification of damages and failures as the basis of such qualifiers.

We will present the procedures of control details. In the Russian practice of the heating systems maintenance (as compared with the heating systems in the EU) the technical performance of materials and structures of the heating systems vary much more. So, the heating systems, laid in channels according to the old technologies of construction has many unpredictable corrosion factors of failure. They include periodic flooding of the heating system, drops through the joints of overlapping plates, compensation violation, silting; that makes it impossible to define the performance of the heating system only by separate pitting as it has been described concerning the maintenance in EU. Thus the system of monitoring of the technical performance of the heating system is required to be more difficult. Rational allocation of diagnostic measures among the periods of the heating system maintenance (seasons) is important. The efficiency of survey by the indirect methods of AT and CMD is higher at full working loading of the heating systems, i.e. during the heating period, while control of metal in zones of the revealed anomalies (in pits or places of access) is better to be carried out in the summer period during shutdown of the site for pressure testing and repair. This obligatory requirement of the STD demands to carry out visually measuring and ultrasonic control only at the disconnected and emptied equipment [8]. The anomalies revealed by the indirect methods can be processed and verified by the means of thermovision aerial photograph, according to the production monitoring of the heating systems performance before the termination of a heating season. By the end of the heating season all the works within both AT and BMD methods have to be completed and the collection of data on the revealed anomalies has to be made for diagnostics by the methods of direct access – pitting and additional defect detection control on the pipe metal, purified of isolation. Intra pipe diagnostics is suitable in the summer, when it is technically simpler to switch-off the heating system for survey, the temperature of the heat carrier is lower and less time is taken to cool the water up to the acceptable temperature. All the control pit and additional additional defect detection control in them have to be completed before the following heating season begins. The actualized data on the performance of the heating system has to be prepared by then and the conclusion on the required measures for the localization of the detected environmental risks has to made on this basis.

6 Conclusion

Nowadays ecological management in the modern city has to be guided by objective data on the heating systems under maintenance, which materials and structures (as practice proves) are not always reliable and conclude risks of emergence of leakages of the heat carrier in the soil surrounding them. It is caused by the fact that they are operated in much more difficult technological environment than overland structures. The ground mass influences aggressively the heating system structures as compared with other engineering service lines due to the temperature conditions during their maintenance process [3]. Therefore for the minimization of this type of risks it is important to study the performance of the heating system during the maintenance period and to define which events, caused by the performance of materials and structures, lead to environmental risks. In the research the author defines the main type of failures of the heating system, related with corrosion of material of the pipeline, which causes the greatest number of the fixed heat carrier leakages. It is stated that violations of requirements of standard-and-technical documents both to quality of the materials used during the construction, and to the structure the heating system, when the standard maintenance conditions are not provided, are the reason of this type of defects. Therefore it is important to provide constant diagnostics of the performance of materials and structures of the heating systems under maintenance and to fix the obtained results in the data base which is specially created for this purpose. Obtaining objective data needs to be carried out on the basis of diagnostics which can be completed by the means of various indirect methods and methods of direct access to the materials and structures of the heating system, which are offered to be carried out according to a certain system taking into account alternation of the heating period and the season when the heat supply is not required. This approach to diagnostics will allow to save resources which are the important factor of management in modern conditions. In this aspect the options of diagnostics of materials and structures of heating systems related with the use of a certain type of technical means of diagnostics have been considered.

In our opinion, all the aforesaid results allow to reach systemic ecological management in the modern city concerning such material-intensive and complicated structure as heating system. The article proves that the importance of this matter in Russian and foreign countries differs. In the Russian Federation it is most acute, since in this country there are long-term traditions of the centralized heat supply in the cities on the basis of large plants, which were operating heating systems of considerable cumulative extent. However as the direction of the further research and practical measures the author considers the expansion of this approach on all the linearly - extended structures of the underground space in the modern city, to be very similar in the requirements to quality of materials, their use during the construction as well as similar in the character of the environmental risks related with unorganized industrial emissions.

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