

## **Aging Management of Structures and Buildings**

While in the previous article the methods and results of the inspection of aging management programs necessary for the nuclear security licensing procedure of the service time extension were introduced concerning engineering technology, in this study the focus is on modifications and improvements due to the inspection mentioned above. The procedure is the same as in the case of engineering system elements and components. The license for service time extension is applied to those structures and buildings, which form part of the ABOS 1-3 class and those structures which do not belong to any security classes and whose deterioration endangers security functions.

The ABOS classification includes all technological aspects, while buildings and structures are responsible only for adequate environmental conditions (function 0) except for the reactor containment having a separate security function (function 1). Function 0 might cover providing appropriate spatial arrangement, division walls, etc. for the technological system elements. That is why anchoring, passages and even cable trays are regarded as supporting structures, so in a broad sense, they generally belong to class of structures and buildings. It is also provable by the fact that they are rather passive, long-lasting and reconstructable instead of being replaceable.

The lack of determining, listing and alphanumerically signing the structural and system elements, functional and possible types of buildings and structures as complex constructions causes serious problems, because the identification of commodity groups (groups of construction elements, such as certain types of armored concrete, requiring the same age management, made of the same material and placed in the same environment) is realizable with difficulty.

The large number of constructions which need treatment is also disadvantageous. Apart from office-blocks, all buildings and structures are involved in the service time extension licensing project that is due to the complexity and organic development of VVER-440/213. In accordance with the earthquake-proof building program, almost every separate element with no supporting structural function, such as brick walls in the earthquake-proof building project, increases the range of structures and buildings.

It can be stated that the buildings of the PNPP are rather complex, heterogeneous structures as far as their forms, materials, building and their contribution to safety are considered. The reactor building is an extreme example for all this.

The above statement projects that we have to take an untrodden path regarding the aging management of the buildings and structures, despite the fact that our company have carried on condition control activities in several areas regularly for years and that there are also some positive experiences from other WVER-440/213 power plants.

The GALL Report, a reference book of universal validity summarizing the general aging management experiences of the USA, includes eight aging management programs in the field of buildings and structures. These are the technological examination programs of the containments and covers made of steel, of the precast concrete containments, and of the pipe supports and anchoring, the compactness examination, the brick wall program, the program of water structures, the program of protective covers and the general building and structure monitoring program including all the other structures and mechanisms. With these eight programs – plus the planned preventive and corrective maintenances and the scheduled

renewal programs depending on the conditions – the aging of the buildings of any PWR power plants can be managed. Some absolutely local characteristics such as the control of the effects of the chemically aggressive soil on the foundations mean an exception about which an NPP-specific program can be prepared.

We have realized during the examination that our case is specific from many aspects – because of the above mentioned characteristic of the scope of buildings and because of the structural and functional complexity of each structure neither the practice followed till now nor the adaption of the PWR-model is successful. The practice followed till now have been based on an overall architectural condition control program which have been supplemented by activities that have a special role in the conception of Paks: integral and local compactness examinations, the building subsidence examination and the attempt for the condition control of the reactor support. The overall condition control program included the control of several important aging processes well-known from local and international experiences such as the control of the covers that can be decontaminated.

At the same time, exactly because of its overall nature, this program have not met the adequateness criteria of the aging management programs mentioned in the previous article. The scope of the buildings under the management of the program is not specified exactly. The typical structural groups, aging mechanisms, effects and parameters are not defined in details. The detection of the effects of aging is superficial, the exact definition of the adequateness criteria is lacking, the monitoring and analysis of the trends, the preventive and repair measures and the qualitative aspects of the program have not been worked out. We have found that the individual programs (for example the building subsidence examination) are incomplete as far as the attributes of the related aging management programs are considered, but they can be supplemented.

We have found that the existing practice does not manage consistently and exhaustively either the scope of structures and buildings that should be included in the aging management program related to service life extension, or the relevant effects of aging and their safety consequences. With certain modifications a small part of the existing program can be transformed into an aging management program but the full scope of structures and buildings and the effects of aging relevant from the aspect of safety can be handled basically by the preparation and introduction of new programs. The elements of the architectural condition control program which has been regarded as the most important program hitherto must be integrated to the relevant parts of the new aging management programs and the maintenances depending on the conditions must be referred to as measures of repair.

On the basis of the findings, the scope of structures and buildings, the complexity of each building, and the international (USA PWR) practice we have come to the conclusion that we have to find our own way and have to work out the hierarchic system of the aging management programs of the structures and buildings. This system defines three levels of the programs:

The first level, which is the basis of the system, consists of so-called type A programs that define the aging management of a certain type of structure. The type A aging management programs have been worked out for the different types of structures and structural elements that make up the buildings, considering the rules for the creation of commodity groups for aging management, i.e. following the logics that creates groups according to type, safety function, material, environment, aging mechanism and effect.

Type A programs refer to structures and structural elements as parts of a system that make up a building, e.g. foundations, steel structures, ferroconcrete structures and hermetic covers. We were preparing the type A programs considering the structural elements that are necessary for

the realization of a safety function. There are some categories of type A programs that serve for the management of typical mechanisms or effects that are present in several buildings, such as the aging management program of the subsidence and motion of buildings. There are 25 of type A programs.

The structures and buildings falling under the scope of licensing in connection with service life extension consist of various types of structural elements or system units. Because of the structural heterogeneity and complexity the safety function can be kept and the effects of aging can be managed if several of type A aging management programs are adapted properly to the structure given. The requirements containing the exact conditions of the accomplishment of type A programs adapted to the structure in question are called type B programs. We must take into consideration the logistic aspects of the accomplishment of type A aging management programs that make up a given type B program. Type B programs were worked out for the aging management of the reactor hall, the turbine hall, the hermetic cover and of the ferroconcrete structure of the containment. There are also 25 of type B programs. (Of course it is a coincidence that there are same number of type A and B programs.)

Actually, we might define a high level program above the former two types of programs. The type C program offers a comprehensive evaluation of the aging and the effects of aging on the safety functions of a complex building e.g. the reactor main building, based on type B programs and by this means on type A programs, too. Thus, the type C program is the comprehensive evaluation of the activities of the operator on the area in question which must be carried out at stated longer intervals. Its accomplishment is inevitable as part of the general examination carried out during the preparation for service life extension (ie. the work in progress at the present) and as part of the regular safety examinations.

In summary, it can be stated that in the future type A programs will be the basis of the aging management of the structures and buildings of Paks NPP, type B programs will prescribe and define the ways and conditions of the application of type A programs for complex buildings that have their own functions and the type C program will evaluate aging in a comprehensive way.

In the field of the aging management of structures and buildings – considering the specific culture and conventions of the field – we have to cope with a considerable drawback in comparison with the field of engineering where the system of tests, technological examinations and control programs has been existing for a long time and the preparation of the programs has been helped by the clear identification of the systems and the elements of the systems. Despite its significant traditions in our company, the architectural condition control could not form the basis of the new practice because of the scope of the structures and buildings, their structural complexity, i.e. because of the specificities of WWER-440/213. It was not possible to follow the PWR practice of the USA for the same reasons. Instead we have created an absolutely new system on the basis of our own experiences and in the spirit of the USA practice which was chosen as a model. This is a significant result even if there will be many things to be improved during the application.

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Dr. Katona Tamás