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IMPLEMENTATION OF THE EUROCODES IN TEACHING PROCESS AND DESIGN PRACTICE IN LATVIA

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Abstract

The paper presents the history and current situation of implementation of Eurocodes in Latvia. The specific challenges of using Eurocodes in the structural design industry and academic education are highlighted in the work. Based on examples of application of Eurocodes, some essential differences are analyzed that have **to** be considered by the National Technical Committee during the National Annexes development process. In close collaboration with the Ministry of Economics of the Republic of Latvia, a new Eurocodes National implementation plan has been developed for years 2013 – 2014.

Key words

Civil engineering, Eurocodes, higher education, Latvian Building Codes, structural design.

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1 INTRODUCTION

In the last few years the Latvian construction industry, manufacturing of construction products and the structural design industry are experiencing a shortage of qualified workers corresponding with the market requirements, and there is also a reduction in the number of students choosing the field of construction. This can be explained by the overall economical tendencies — reduction of demand in construction, as well as an overall reduction in the number of students caused by the decreasing population and the low birth rate in the beginning of 1990s.

In construction education and training the most significant shortage of specialists is evident in mastering the modern technologies. Introduction of contemporary practices and their development is hindered by obsolete professional qualification requirements and deficiencies in legislation, which, in contradiction with the EU policy guidelines and the practices implemented by other countries, fail to take into consideration the issues of competitiveness, work force mobility and public interests.

One of the main aspects related to the improvement of construction specialists' competitiveness and the quality of education, is a full and well-implemented transfer to the design methodology specified in Eurocodes that involves all parties connected with the construction process: state institutions, designers, manufacturers of construction products and education institutions [1].

The Eurocodes are a series of 10 European Standards, EN 1990 - EN 1999, providing a common approach for the design of buildings and other civil engineering works and construction products. Each Eurocode consists of several parts. There are 58 parts in all. They are the recommended means of giving a presumption of conformity with the essential requirements of the Construction Products Directive for construction works and products 2003/887/EEC that bear the CE Marking, as well as the preferred reference for technical specifications in public contracts. [2]. The Eurocodes are expected to contribute to the establishment and functioning of the internal market for construction products and engineering services by eliminating the disparities that hinder their free circulation within the Community. Further, they are meant to lead to more uniform levels of safety in construction in Europe [1].

The work with the Eurocode started in 1957. The first publications came in the mid 1980s. By 2006 the EN Eurocode parts were expected to be published. The Eurocodes were expected to be fully implemented and to replace all national standards by 2010 (Fig.1).

Some of the aims and benefits of the Eurocodes are: to provide common design criteria and methods; to provide a common understanding of construction products; to facilitate the exchange of construction services; to serve as a common basis for research and development; to allow the preparation of common design aids and software; to increase the competitiveness of the European civil engineering firms, contractors, designers and product manufacturers in their world-wide activities [3].

The basic standards of the Eurocodes are designed to be easily adapted to the legal framework of the member state by providing the recommended values that ensure a sufficient safety margin for structural design in all Europe. In the Eurocodes, many parameters and even some calculation methods are left in the competence of the member states. These parameters are called Nationally Determined Parameters, or NDP. When adopting a Eurocode, it must be supplemented with a National Annex that has been developed and legally introduced in the specific member state and that includes the NDP values and other nationally applicable conditions not in contradiction with the standard.

The aim of the National Annex and the determination of NDP values is to adjust the Eurocode to the national conditions of each separate member state so as to avoid a decline of the structure safety level and a significant increase of construction costs, as well as to take into consideration the national construction traditions and local climate conditions once the structural design industry transfers from the national design regulations to the Eurocode system [1].

The draft National Annexes are prepared by a technical committee of standardization (TC), which then adopts the standard into the national system of standards. When developing the National Annexes, the Nationally Determined Parameters must be selected from the parameter range provided in the standards and in conformity with the national territorial (climatic) characteristics and construction traditions. The values, classes, symbols and the applicable methods of calculation (analytical design and testing methods) must be determined in such way as to not lower the level of structure safety and to avoid substantial increase of construction costs in comparison with the existing structural design requirements.

2 THE HISTORY OF IMPLEMENTATION OF EUROCODES IN LATVIA

In accordance with EU Commission Recommendation 2003/887/EEC of 11th December 2003 on the implementation and use of Eurocodes for construction works and structural construction products [2], in 2003 the competent authorities in Latvia started the implementation of structural design requirements corresponding with the Eurocodes. Several Cabinet Regulations were issued and a dual approach transition period was started in the design industry — a parallel application of Latvian construction standards and the Eurocodes.

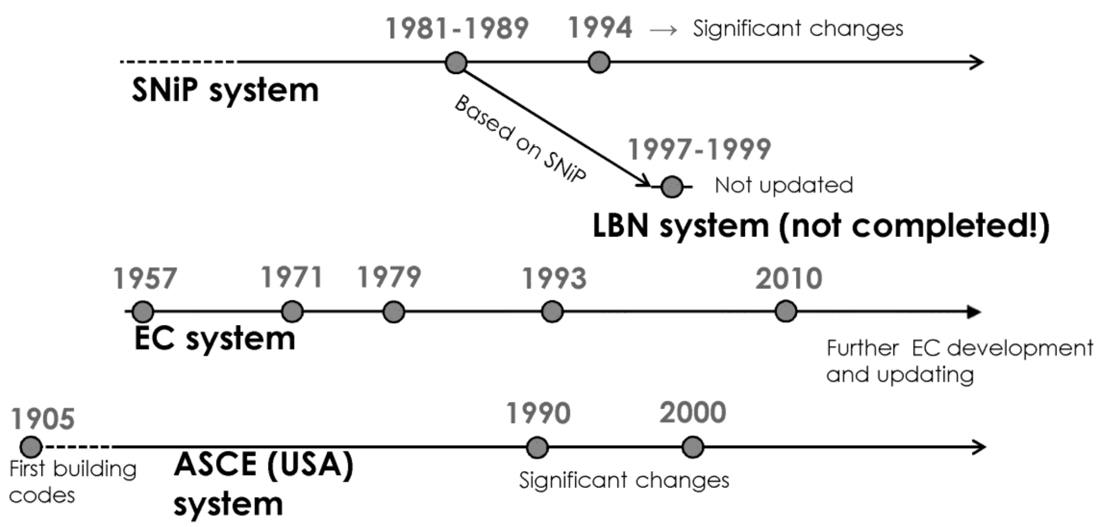

Fig. 1) Development of different building code systems

The Eurocodes' dual approach transition period will continue in Latvia until the Eurocode design standards are adopted and Cabinet Regulations determine that design works in the particular field must be carried out in compliance with only the Eurocode standards. Until then the customer of the building project and the author of the design can choose whether to design the structures in accordance with the currently applicable Latvian construction standards (in case of metal structures — in accordance with the former Soviet SNiP system), or to apply Eurocodes.

It's necessary to note that the procedure for loads statistical analysis in Eurocodes is different from the procedure proposed in the SNiP system, which is the basis of the Latvian construction standard. Therefore, it is not permissible to use one method for determining the results of separate interim calculations if the basis is determined using the other method.

The next step in the implementation of Eurocodes was the Twinning project LV/2005-IB/EC/01 financed by the European Transition facilities funds. The Project was put into effect in June 2006 and carried out by one of the leading European applied research institutions – Deutsches Institut für Bautechnik (German Institute of Construction Technology). The project included training of Latvian experts by the leading German experts, preparation of methodological brochures and drafting of the first national annexes to the Eurocode standards. The following phase was training of the Latvian structural designers by the Latvian experts trained by the German experts. Next, practical training built on lectures prepared by the Latvian experts for Latvian structural designers took place. Detailed information about results of this project is available on the Ministry of Economics' homepage [4].

In order to ensure the adoption of the Eurocode standards in the regulatory enactment system applicable to construction, to support free movement of design services within the European Union and to improve the national construction standards system of Latvia, the Cabinet of Ministers issued a decree No. 455 "Regarding the national implementation plan of Eurocode standards for 2008-2011" of 29th July 2008, which supports the national implementation plan of Eurocode standards for 2008-2011 [5].

Due to an emergency with the state budget and lack of funding, on September 30th, 2009 the Decree of the Cabinet of Ministers No.455 was amended and some implementation activities were cancelled.

Nevertheless, in October 2010 the Eurocodes Subcommittee was established at the technical committee LVS/TC30 "Construction" of the Latvian national standardisation body. The main tasks of this Subcommittee are the drafting of National Annexes to the Eurocode standards, as well as a revision of Latvian texts of some of the previously translated Eurocode standards.

3 CURRENT SITUATION OF EUROCODE IMPLEMENTATION IN LATVIA

At the moment, 28 of 58 Eurocodes are translated, adopted and included in the system of the Latvian national standardisation body (LVS). Within the scope of procurement contracts, 12 standards were translated in 2011 but were not registered. One translated standard not registered by LVS is being clarified in the Eurocodes Subcommittee of LVS/STK 30 "Construction". A contract has been signed for the translation of three more standards in 2012.

In addition to the primary standard documents, 47 corrections and seven amendments have been issued in the last few years and adapted in the status of a Latvian standard. Of these, four corrections and one amendment have been translated and registered in LVS, and 12 more corrections and one amendment have been translated within the scope or procurement contracts but have not been registered in LVS yet. A contract has been signed regarding the translation of three corrections in 2012.

According to the Latvian Law on Standardization, the application of standards is voluntary, and the Cabinet of Ministers can establish which Latvian national standards are mandatory. Therefore, a standard must be adopted in the status of a Latvian national standard. From the requirements of the Law on Standardization, as well as of the Latvian Constitution, the Official Language Law and the Law on Official Publications and Legal Information, it follows that when including the Eurocode standards into the regulated sphere and making their application mandatory, an obligatory requirement is translation of these standards into Latvian.

In order to provide full adoption of the Eurocodes into the system of regulatory enactments applicable in construction and to improve the national construction standardization system of Latvia by implementing the EU Commission Recommendation 2003/887/EEC on the implementation and use of Eurocodes for construction works and structural construction products [2], the Ministry of Economics in close cooperation with the Technical Committee for Standardization LVS/TC30 "Construction" has developed the new Eurocode national implementation plan for 2013-2014 [6], which provides for measures that have not been implemented during the previous Eurocode implementation period.

The plan stipulates that by the end of 2014 it is necessary to translate and register in the LVS system 17 standards, 31 standard corrections and 5 standard amendments, as well as to develop 26 National Annexes, to prepare amendments in legislation providing for design works in accordance with the Eurocode standards, and to inform the structural design specialists about the specifics of design regulated by the Eurocode standards. The current situation of development and implementation of NA in Latvia is shown in the diagram (Fig.2).

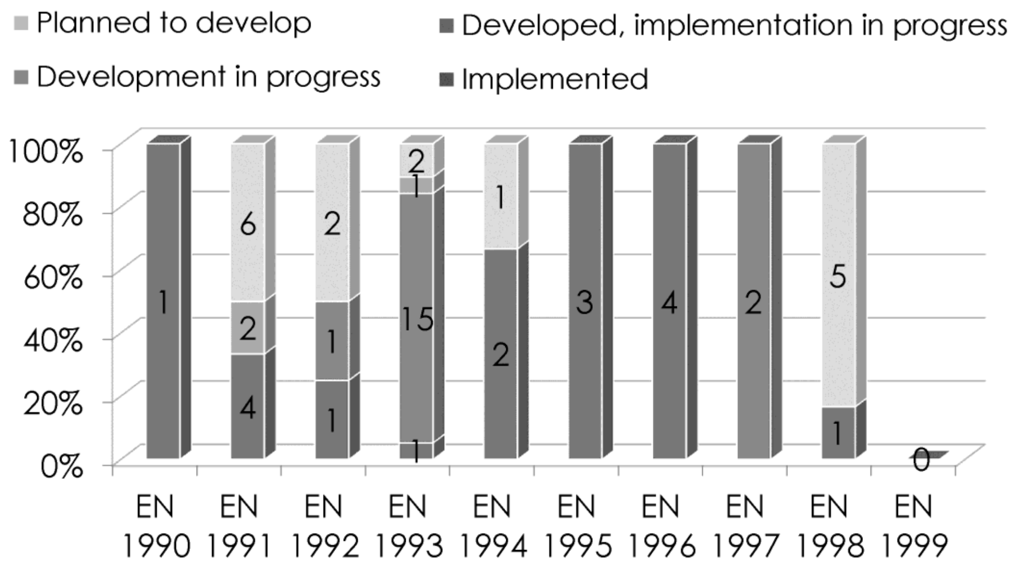

Fig. 2) Current situation of development and implementation of NA in Latvia

The national parameters of the Eurocodes developed by LVS/TC30 in compliance with the EU Commission Recommendation 2003/887/EEC must be entered into the JCR (Joint Research Centre) data base [7]. In addition, the National Standardization Authority must set up a contact point so that all interested parties could receive information and clarification about the Eurocode standards (provision of cooperation with JRC, CEN/TC 250 and the Technical Standardization Committee of Latvia).

During the implementation of the plan it is necessary to amend or replace the existing structural design construction standards (LBN and SNiP). The Cabinet of Ministers will issue regulations about the design of steel structures, wood structures, concrete, steel and concrete composite structures, masonry structures, seismic structures, aluminium structures, and geotechnical design to be performed in compliance with the Eurocode design standards. This would not only substitute the existing structural design requirements but also expand this regulation by covering several spheres of design that were not regulated before: steel and concrete composite structures, aluminium structures and seismic structures. In the previously mentioned Cabinet regulations there will be indicated essential requirements for each structural design procedure and references to the relevant Eurocode standards and their National Annexes that in accordance with the Law on Standardization have been adopted in the status of a Latvian National Standard. These regulations, however, will not provide detailed technical solutions and calculation methods that would duplicate or contradict the content of the Eurocodes. For cases specified in the Eurocodes, the regulations will determine requirements for quality control and market surveillance.

4 SPECIFIC CHALLENGES OF USING EUROCODES IN LATVIA

CEN standards are always issued in three main languages: English, German and French. The text is usually translated from the English version, sometimes from German. In text translation and practical application there often are problems related to the polysemantic nature of the English language: one term in English can have up to ten different meanings. For this reason, the practical implementation of translations requires technical editing by a design specialist.

Since the Eurocodes are based on relatively new scientific studies resulting in the new materials and calculation methods, many new terms are coined that cannot be found in the Latvian technical dictionaries. In order to provide a translation that is closer to the original language of the Eurocodes, the Technical Committee had to expand the Latvian terminology and to start compilation of a special glossary of technical terms used in Eurocodes.

Practice shows that the texts of the Eurocode standards can be difficult to interpret both for design professionals, and for the students, because the original text utilises different traditions or technical terminology. For example, two-way slab or slab acting in two directions — (slab supported by outline, [plātne balstītā pa kontūru] in Latvian), beams with tension/compression reinforcement — (beams with simple/double reinforcement [sijas ar vienkāršo/divkāršo stiegrojumu] in Latvian). Some terms cannot be translated at all and need additional clarification or even illustrations, because the relevant structures or technologies have been rarely if ever used in the Latvian construction industry until now. Such terms include, for example, “confined masonry”, “shell bedded masonry”, “cavity wall”, etc.

The verification procedures of the Eurocodes are based on the physical and mechanical properties of the used materials, and these properties are determined in accordance with harmonized EU testing standards. However, the majority of these standards do not correspond with the previous generation of standards, and it is not permissible to base calculations on testing data that has been obtained from still-existing LBN and SNiP standards. In addition, all these testing standards, same as Eurocodes, are available in the major European languages, therefore, to facilitate their application, they also need to be translated into the national language. The total amount of texts to be translated is much larger than the Eurocodes.

The problem with Eurocode 3 and Eurocode 9 is in consideration that there are no applicable Latvian construction standards on design of steel and aluminium structures. There are still former Soviet SNiPs applied in parallel to the relevant Eurocode standards. The new construction standards should replace the former Soviet SNiP codes.

Transition from the national LBN construction standards to the Eurocode will cause no conceptual problems in Latvia as both are based on the limit state method. The difference is in more detailed partial factors method and reference period of loads. In LBN system and in SNiP system used in the former Soviet Union the statistical reference period for snow loads is 10 years instead of 50 years in the Eurocode and for wind loads it is 5 years instead of also 50 years. Therefore, the nationally determined parameters (NDP) must be adjusted. A detailed comparison of all three codes is presented in author's earlier publication [8].

For the determination of NDP, EU member states may consider their existing design practice and design rules in order to maintain their traditional level of safety. Latvia as a member state has the advantage that the partial safety factor system for the design of structures has been already in use for many years by using SNiPs during the Soviet time. These standards were later incorporated into the LBN system. The disadvantage, however, is that the existing LBN system is not exactly fitting to the Eurocode partial factor system, which makes the adjustment of the LBN system to the new one somewhat difficult. Further in this article there are highlighted some essential differences that have to be considered in the process of adoption of Eurocodes when discussing the values of NDPs at the responsible technical committees.

Among design professionals that have started becoming acquainted with the Eurocodes or to apply them, there is some discontent due to the "recommending" nature of the Eurocodes, which is unusual for the experienced users of the mandatory LBN and SNiP standards. This "recommending" nature can be explained by the fact that, first of all, the Eurocodes are meant for all member states of the European Union, the traditions of which in some cases can be very different, therefore, the Eurocodes were agreed by way of coordination. Another reason is that, in the member states of the European Union, the final responsibility for the overall safety of the structure usually remains with the designer, even if the solutions have not been covered by Eurocode procedures. The tradition of the Soviet SNiP system is different: the designer is no longer responsible, if all requirements of the applicable standard have been observed.

Some difficulties in the introduction and application of the Eurocodes, as well as in the development of NDP, are related to the fact that Eurocodes were developed later than SNiP and LBN standards. As a result, the information to be processed by the designers is much broader and extensive than the one included in the previous standards. For several specific materials, procedures and phenomena, there are no direct analogies in the LBN and SNiP standards, for example, "shade air temperature", "shear lag", ect.

Some materials, structures and methods, on the contrary, were considered non-effective by the Eurocode designers in the initial stages of standard development, and as a result, they have not been included in the final text of the Eurocodes. For example, the Eurocodes do not provide verification procedures for such structures as rubble natural stone masonry and masonry reinforced by horizontal steel mesh. However, such structures are widely used in Latvia, and the lack of appropriate verification procedures causes significant problems during inspection and reconstruction works.

It is also worth noting that the Eurocodes mostly use more complicated structural analysis calculation models than LBN and SNiP, which causes difficulties during the studies, as they require advanced knowledge of mathematics and strength of material, for example, plates, shells and subframes instead of the simple or continuous beams widely used in LBN.

When applying the Eurocodes more extensively, it becomes evident that part of the verification procedures cannot be executed without the use of special computer software. For example, even medium-complexity buildings have such a high number of load combinations, that it is physically impossible to use manual calculations. The design rules for the joints of steel structures are also so time consuming that it is not possible to execute the calculations by hand.

In structural design, the procedures, same as terminology, are based on the traditions and experience of other countries (not Latvia), which means different approaches to the build-up of the structures. For example, rolled sections for steel structures are made according to different criteria and requirements, which in turn result in joint design principles and calculation methods that are completely different from the ones specified in the LBN standards and that are not familiar to the Latvian specialists.

Serious problems will be encountered when preparing the National Annexes to EN 1997 group of standards “Geotechnical design”. Eurocode 7 standards are very general and do not contain verification methods of serviceability (e.g. settlement of foundations), which is a determining criterion for the Latvian grounds, and in numerous cases allow application of national design and testing methods. The national annexes to the above standard will be drafted in parallel with the amendments to the Latvian construction standards LBN 207-01 “Building Foundations and Grounds”, LBN 214-03 “Pile Foundations and Grounds” and LBN 005-99 "Geotechnical investigation and testing" that will remain in force after implementation of the Eurocode standards. It means that the Geotechnical Eurocode (EN 1997) will be used together with the National Annex and the above LBN standards.

During the development of the National Annex, the Technical Committee for Standardization LVS/TC30 is closely cooperating with representatives of the industry and non-governmental organizations [9] by taking into account their opinion and practical experience.

In the main Latvian universities that prepare Civil Engineering specialists (Riga Technical University (RTU) and Latvia University of Agriculture (LLU)), the Eurocodes were fully incorporated into the study programmes and subjects starting from the academic year 2007/2008. When preparing the study materials, RTU professors are widely using the modern E-learning Management System system (Moodle), which allows the professors to conveniently create courses, prepare and upload tasks for the students, as well as to automatically test the students and process the results. For quality assesment purposes, an anonymous student questionnaire is organized at the end of each semester in relation to each study course and each professor. This allows quick incorporation of any necessary changes into the course programme.

The authors would like to note that the initial, deceptive assumption of Eurocode advocates in Latvia — that a transition to Eurocodes would require only a change of element verification methods and that the rest would remain the same — has not come true. This assumption was based on the idea that the basic science of structural analysis cannot change (Strength of materials and Structural mechanics) and that the materials remain the same (steel, concrete or timber). However, the changes are much deeper. The Eurocodes require different building design methods and a deeper understanding of the behaviour of materials and structures [10]. In the last two years, the professors of structural engineering have had to change almost all visual aids used at the lectures, as well as to re-write the practical tasks.

In order to ensure more successful understanding of the Eurocodes, it is urgently necessary to expand the subject of Structural Mechanics, because the Eurocode procedures use calculation methods that are based on the laws of physics (plasticity, non-linear behaviour, second order effect), which have not received enough attention during the study process.

When analyzing the current position of the Eurocodes in the curriculum, the Committee of the study programme of the RTU Civil Engineering Faculty has recommended that in order to increase the competence of the new specialists it is necessary to increase the number of Structural Mechanics lessons in the Civil Engineering programme. This could be achieved by reducing the proportion of social subjects.

In spite of the fact that the introduction of the Eirocodes in Latvia is taking long time, some significant structures have already been designed in compliance with the Eurocodes, and these projects are currently under construction. Examples include the Latvian National Library project "Castle of Light" [11], the “Z-Towers” multifunctional high-rise building [12] and the reconstruction of Riga Motor Museum [13].

5 CONCLUSIONS

Considering the European harmonization trends, as well as the fact that for Latvia it would not be easy or even possible to maintain and update the LBN standards or to develop its own independent system of national building regulations. Therefore, Latvia has no alternative but to participate in the harmonized normative base of the European Economic Area.

In order to harmonize the construction industry, a more considerable financial and non-financial support is needed from the state institutions, not only for the translation of the standards, but also for their quicker and more intensive introduction in practice. It is necessary to support the development of clarifying methodology materials in Latvian. In Latvia there are no large structural design companies, manufacturers of structural elements, or computer software developers interested in it and ready to participate and sponsor the introduction of Eurocodes, like it was in the United Kingdom and Germany. Unfortunately, the last time book publishing in the field of structural engineering was supported by state, was during the Soviet Union period in the end of the 1980s.

The fact that the dual approach transition period has been so prolonged, negatively affects both the education process, and the students who are already graduating with knowledge of Eurocodes but are not yet saught after in the design industry, as the majority of the previous generation of specialists are using only the old LBN/SNiP system and are not familiar with the new system.

Despite the difficult economic situation in Latvia, the implementation of Eurocode standards according to the Latvian Eurocode National Implementation plan and the Recommendations 2003/887/EEC of the EU Commission from December 12th, 2003 with some delay is proceeding.

A step in the implementation of Eurocodes was the Twinning project LV/2005-IB/EC/01 financed by the European Transition facilities funds. However, this project did not fully reach the goal due to fact that the German colleagues were not properly introduced to the design traditions existing at that time in Latvia.

The Latvian construction standards of structural design (and SNiP) are not exactly fitting to the Eurocode partial factor system, which makes the adoption of the Eurocodes somewhat difficult in the sense of determination of NDP and elaboration of National Annexes.

Considering the fact that the design approach used in the Eurocode standards is different from the structural design methodology specified in the current construction standards, as well as the interest of structural design professionals regarding the application of the Eurocode design standards, it is necessary to organize workshops for the practicing specialists in order to clarify the specifics of design as determined by the Eurocode standards. Furthermore, in order to ensure public availability of information about the requirements and specifics of design according to the Eurocode standards, it is necessary to prepare and distribute informative materials about the specific features of design regulated by the Eurocode standards.

The introduction of Eurocodes serves as an impetus for expanding and developing the Latvian technical terminology. As a result of the activities of the Technical Committee, a glossary of Eurocodes' technical terminology will be developed. It will be used in their professional activities by both structural design specialists, and university professors preparing the next generation of specialists conforming to the contemporary requirements of the Latvian and European design markets.

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