O‘ZBEKISTON RESPUBLIKASI

OLIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGI

FARG‘ONA DAVLAT UNIVERSITETI

FarDU. ILMIY XABARLAR

1995-yildan nashr etiladi
Yilda 6 marta chiqadi

1-2025
ANIQ FANLAR

НАУЧНЫЙ ВЕСТНИК. ФерГУ

Издаётся с 1995 года
Выходит 6 раз в год

MATEMATIKA

FIZIKA TEXNIKA

FarDU. Ilmiy xabarlar – Scientific journal of the Fergana State University

Volume 31 Issue 1, 2025-yil DOI: 10.56292/SJFSU/vol31_iss1/a96

UO‘K: 628.921:628.928

SOG'LOM YASHASH MUHITI SIFATIDA TURAR-JOY BINOLARINI LOYIHALASH UCHUN QUYOSH INSOLYATSIYANI TAHLIL QILISH VOSITALARI

ИНСТРУМЕНТЫ АНАЛИЗА СОЛНЕЧНОЙ ИНСОЛЯЦИИ ДЛЯ ЖИЛЫХ ЗДАНИЙ В ПРОЕКТИРОВАНИИ ЗДОРОВОЙ ЖИЗНЕННОЙ СРЕДЫ

SOLAR INSOLATION ANALYSIS TOOLS FOR RESIDENTIAL BUILDINGS IN HEALTHY LIVING ENVIRONMENT DESIGN

Azamatov Abdulaziz Irashevich
Turin Polytechnic University in Tashkent, Associate Professor

Annotatsiya

Ushbu maqolada inson sog‘-salomat yashashi uchun sanitariya-epidemiologik normalarga muvofiqlikni tahlil qilish orqali sog‘liq uchun zararsiz, energiya tejamkor binolarni loyihalash masalalari qisqacha ko‘rib chiqilgan. Talabalar, tadqiqotchilar, arxitektorlar va dizaynerlar tomonidan uyning passiv ko‘rsatkichlarini yaxshilash uchun loyihalash jarayonida samarali foydalanish mumkin bo‘lgan dasturiy vositalar muhokama qilingan.

Аннотация

В данной статье кратко рассмотрены вопросы проектирования экологически безопасных, энергоэффективных зданий путем анализа соблюдения санитарно-эпидемиологических норм для эффективного инсоляция жилых помещений. Обсуждается программные инструменты, которые могут эффективно использоваться в процессе проектирования студентами, исследователями, архитекторами и дизайнерами, чтобы улучшить их понимание аспектов проектирования пассивного дома.

Abstract

This paper provides a short review of current issues on conformance of sanitary and epidemiological rules, energy-efficient building design topics. Discussed the software tools that can be efficiently used during the design process by students, researchers, architects, and designers to improve their understanding of passive house design aspects.

Kalit so‘zlar: *Quyosh yo‘li diagrammasi; quyosh nurining tushishi; quyosh radiatsiyasi; quyosh insolytsiyasi; quyoshdan himoya qiluvchi qurilmalar; kunduzgi yorug‘lik.*

Ключевые слова: *Диаграмма пути солнца; солнечное излучение, солнечная радиация, солнечная инсоляция; солнцезащитные устройства; дневное освещение.*

Key words: *Sun-path diagram; solar irradiance, solar exposure, solar radiation, sun shading devices; daylighting.*

INTRODUCTION

Planning healthy and green buildings is a challenging task for urban planners, architects and other involved professionals. The construction and operation of energy efficient and resilient residential and commercial buildings can significantly mitigate the environmental impacts of the building sector. In the past decade, designers, builders, and engineers have made great strides in improving the ways that buildings are designed and built. High performing heating, ventilation, and air conditioning (HVAC) equipment, better insulation, smarter design, and occupant awareness of energy efficiency and renewable energy are becoming part of mainstream building practices and operations [1].

An important criteria is access to the sun in dense urban areas. Sunlight due to its spectrum and high intensity is utilized in therapeutic applications and in dermatology supporting the production vitamin D and its UV-C component has bactericidal effects [2, 3] while suppressing development of bacteria purifying environment. Exposing skin to sunlight may help to reduce blood pressure, cut the risk of heart attack and stroke. Production of this pressure-reducing compound - called nitric oxide - is separate from the body’s manufacture of vitamin D, which rises after exposure to sunshine UVA irradiation of human skin vasodilates arterial vasculature and lowers blood pressure independently of nitric oxide synthase [4]. This suggests that the cardio-protective effects of sunlight might be due to the nitric oxide released by UVA photolysis of nitrite rather than the UVB induced vitamin D synthesis [5].

Climate change and resource depletion are the main challenges that mankind has to face in the 21st century. Through its impact on ecology, rainfall, temperature and weather systems, global warming will directly affect all countries. Nobody will be immune to its consequences. However, some countries and people are more vulnerable than others [6]. Mitigating and adapting to climate change are key challenges of the 21st century. At the core of these challenges is the question of energy – more precisely, our overall energy consumption and our dependence on fossil fuels. To succeed in limiting global warming, the world urgently needs to use energy efficiently while embracing clean energy sources to make things move, heat up and cool down [7].

Developing countries are going to play a decisive role in the future world energy scenario, as a consequence of their economic development. Industrial energy consumption will grow, and a dramatic increase in energy consumption for transport can be expected, with the growth in the number of vehicles on the roads - if the currently accepted worldwide approach to mobility does not change. The increase in energy consumption in the building sector can be expected to be even more dramatic, not only because air conditioning will spread and the number of domestic electric and electronic appliances will grow, but also because of the increase in the number of buildings [6].

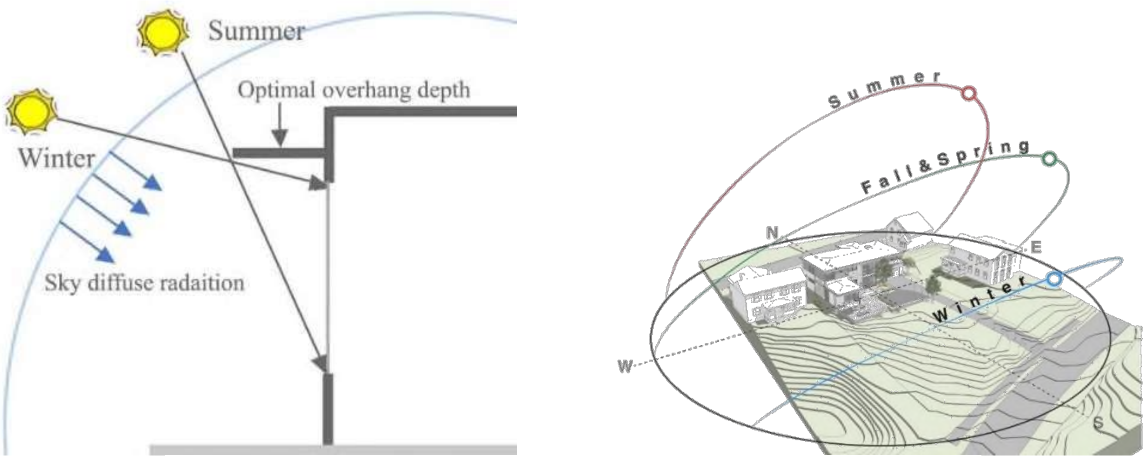

Figure 1. Main features of sun altitude angle regard to seasons

Nowadays, the needs for energy and for the reduction of conventional energy sources in the building sector are high. Shading devices (SD) can be considered as valuable machines of energy balance. Their geometric characteristics are a result of the avoidance of incident solar radiation in the interior, reduction of cooling, thermal and electricity loads and the maximization of energy production through the integrated (photo voltaic) PV. The way that SDs are used to be designed has to be changed. It is a new parameter that should be developed further on by buildings' industries, PVs' industries and research institutes, in order to enter the building market [8].

The use of shading devices (Figure. 1) is essential for south oriented facades, especially in hot climates. Fixed shading devices can reduce increasing thermal loads during summer and at the same time control intense summer daylight, improve vision and reduce glare [9].

SANITARY AND URBAN PLANNING NORMS

These rules and regulations apply to the design of new and reconstruction of existing urban and rural settlements and include the basic hygienic requirements for their planning and development. The sanitary rules and regulations are intended for the sanitary and epidemiological service bodies as a guide in drawing up a sanitary assignment for design, drawing up a sanitary characteristic of a settlement being designed, built or reconstructed, as well as in carrying out preventive and current sanitary supervision. These rules and regulations are also intended for specialized design institutions of the Committee for Architecture and Construction, technical workers involved in the design and construction of settlements in the republic [10].

Sanpin rules related with the sun insolation are as follows [10]:

"… 22. One of the important hygienic requirements for planning and development of residential areas is compliance with sanitary standards for insolation:

22.1. For the geographical zone of Uzbekistan, the optimal efficiency of insolation is achieved with continuous solar irradiation for 2.5 hours for the period from March 22 to September 22 indoors and at least 0.5-1 hour in the local area.

22.2. In conditions of multi-storey buildings (9 storeys and above), a one-time intermittent insolation of residential buildings is allowed with an increase in the total duration by 0.5 hours during the day, respectively.

22.3. In residential buildings of the meridional type, where all rooms are insolated, the duration of insolation can also be reduced by 0.5 hours.

22.4. Standardized insolation must be ensured: in at least two rooms of 4-5-room apartments and in at least one living room of 1, 2, 3-room apartments. Orientation of windows of living rooms of apartments and bedrooms of dormitories to the western part of the horizon within 200-290° (for all regions of Uzbekistan) is not permitted.

22.5. Requirements for limiting excessive thermal impact of insolation on humans and the environment apply to: living rooms of apartments, bedrooms of dormitories, oriented with light openings at azimuths within 90-290° for all regions of Uzbekistan. **…"** [10].

Urban development codes (ShNK 23.12.2009 № 2.07.01-03) set the following rule [11]:

"… 26. The placement and orientation of residential and public buildings must ensure continuous insolation of residential premises for 2.5 hours per day during the period from March 22 to September 22, and of bedrooms, playrooms and study rooms of children's rooms for 3 hours. In the event of reconstruction, it is permissible to reduce the duration of insolation of premises by 0.5 hours. …" [11].

INSOLATION ANALYSIS METHOD USING LOCATION BASED INFORMATION

Sun path diagrams or sun charts are projections of the sky dome onto a surface. Sun path diagrams are a metric for designing a home and act as a visual aid to convey the architect's design decisions to the homeowner. Great tools for creating these diagrams are readily available online. For example, suncalc.org, anrewmarsh.com and shadowcalculator.eu provides the solar data of a site and tracks the sun as it moves across the sky from dawn to dusk (Pic. 3, 4). The length of shadows can be determined for any specific day and time (Pic. 6), simulated and analyzed.

Understanding the position of the sun allows us to build passive measures into the design of a home. Passive measures for sun control include a consideration of the proper placement, orientation, and shape of a home. Architectural features like sun shading and overhangs are likewise established early, during the planning stage of design. The goal is to shade the home during the hottest days of the year while allowing receive enough sunlight to warm the home during colder, shorter days (Pic. 1).

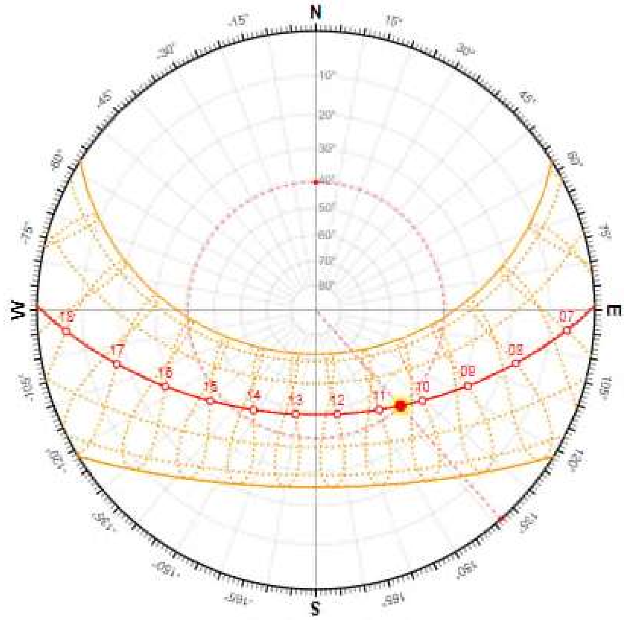

Figure 2. Stereographic sun path diagram for specific location
(Tashkent LAT: 41.350382219° N LON: 69.219778776° E)

The Stereographic (or Polar) Sun Path Chart is used to represent the angle of the sun at various times (a month during the year, hours during the day) of the year (Pic. 2-4).

North

est

ast

South

Figure 3. New building's sun insolation analysis using google map data. The old buildings on back side will be demolished. (Tashkent LAT: 41.350623° N LON: 69.222024° E)

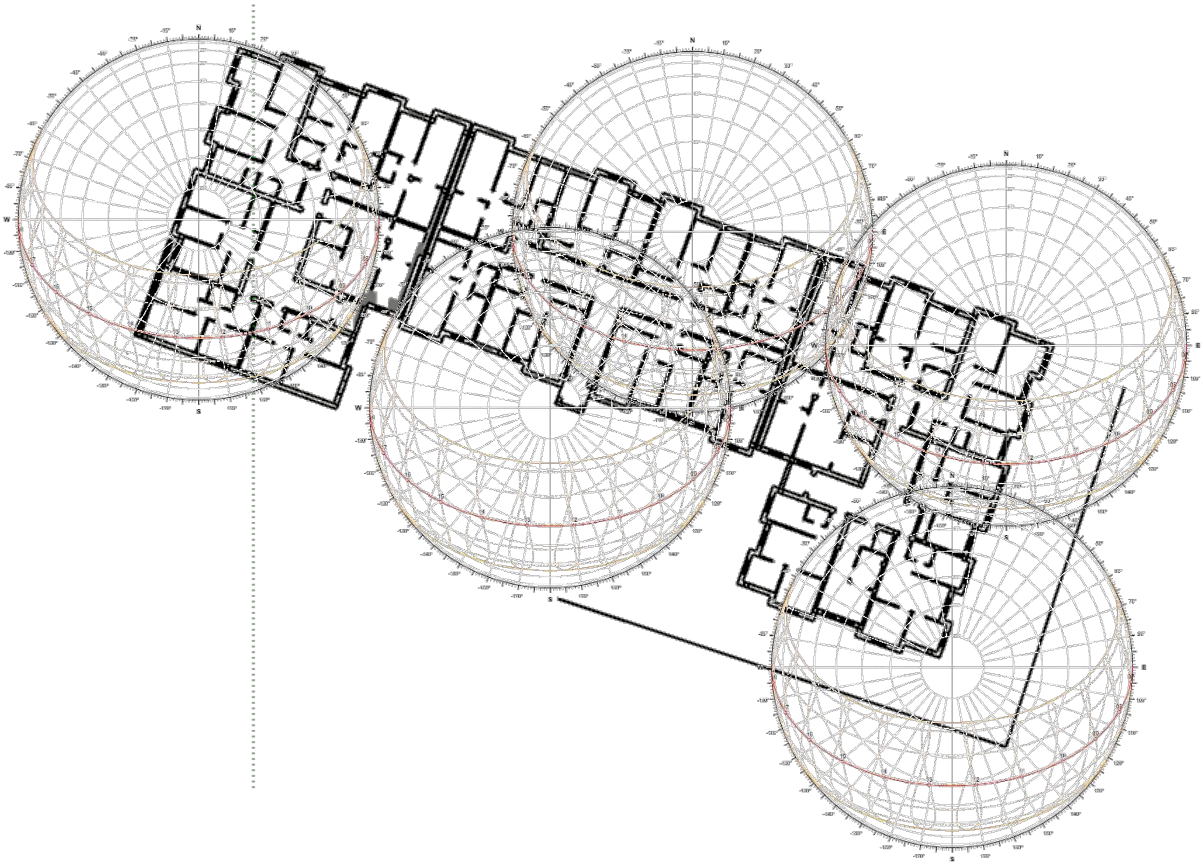

Figure 4. New building’s sun insolation analysis using stereographic diagram for specific time and location (Tashkent LAT: 41.350623° N LON: 69.222024° E)

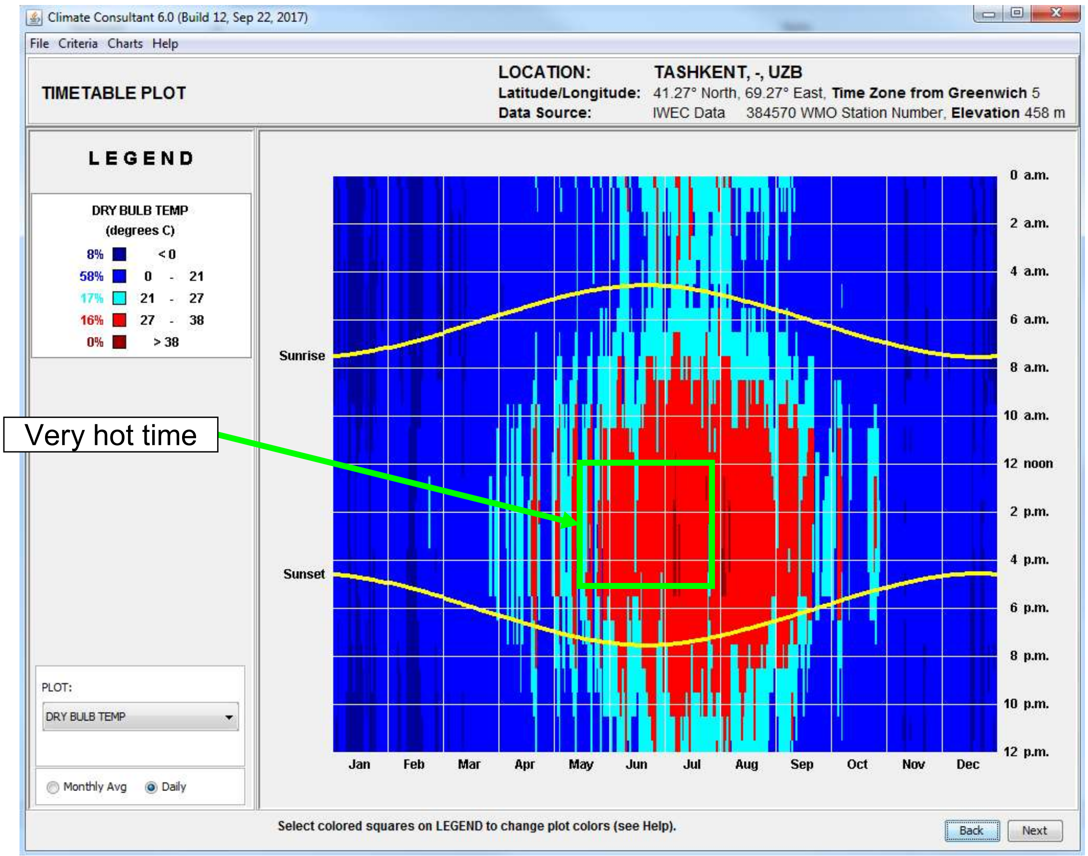

Figure 5. Timtable plot for Tashkent city [8].

The timetable plot is a graphic plot of average monthly temperatures based on Energy Plus Weather data [12]. In Pic. 5 shown timetable plot for Tashkent city, Uzbekistan. Very hot time recommended to have a shade is from 12:00 to 17:00, from 1-June to 15-August in summer season. The “Blue” times are too cold for thermal comfort, the “Red” times are very hot for thermal comfort and “Turquoise” color times are times which are comfortable.

Effective standalone software for solar radiation and shading assessment for architectural projects are used for analysis: Google SketchUp Pro with Extensions (Curic Sun, Sun Hours, Sun UV) shown in Pic. 6. Online based, free, open tools are available in the internet: Andrew Marsh 3D Sun Path Simulator, Andrew Marsh Dynamic Daylighting. Some performances are compared in Table 1.

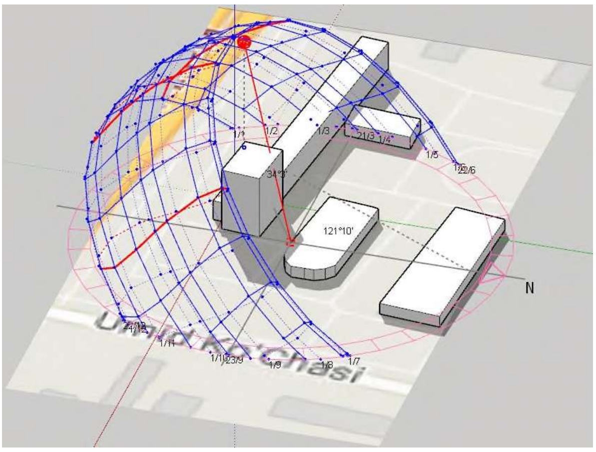

Figure 6. Sun path simulation in Google SketchUp Pro

Shading devices

External shading devices (Pic. 7) can reduce solar heat gain through glazing by up to 80%. By designing shading devices according to the sun’s seasonal path, both summer shading and winter solar gain can be achieved in climates with seasonal variations.

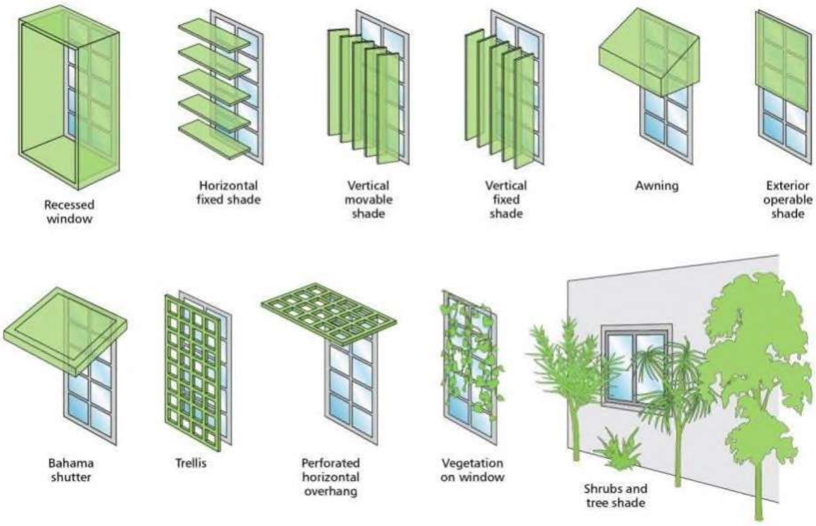

Figure 7. Types of external shading devices [13]

Incorporate the following shading strategies: (1) Horizontal overhangs or louvers for solar orientations (facing the equator); and (2) Vertical fins and egg-crate designs for other orientations.

Adjustable shading devices can be repositioned to allow for seasonal temperature variations or user control during unusually warm or cool periods. Additional shading strategies include recessing glazed openings, and incorporating porches, balconies, and mature vegetation to shade east and west walls as well as outdoor areas.

Table 1 Comparison of tools

Name of the tool	Commercial/Free	Weather statistics considered (Yes/No)	Sun insolation analysis	Energy analysis	Input file / information	Output file
Google SketchUp Pro	trial version	no	yes	yes	.3ds, .dwg, .dxf, .rvt, .stl	.3ds, .dwg, .dxf, .stl, .wrl
Climate consultant	free	yes	no	no	.EPW	.CSV
Design Builder	commercial	yes	yes	yes	.EPW, .DXF	.IWEC, .CSV, .IDF, .DXF, .CSV
Autodesk Ecotect	commercial	yes	yes	yes	.DXF, .IV, .WRL, .XYZ, .STL	ASCII (.MOD), .DXF, .IDF, .INP, .CFG, .RAD

CONCLUSION AND DISCUSSIONS

Various available through internet tools analyzed in this research. Passive solar heating in its simplest form requires no more than a good window facing the equator. An appropriate horizontal shading device could provide shading in specific time of the summer but allow the entry of required solar radiation in other time (see Pic. 1, 5). Adjustable shading could also be considered. The performance of such a system would also depend on the available thermal storage mass. In a lightweight building the solar heat input would overheat the interior, which may lead to discomfort, but also to a large heat loss [14]. An interactive result could be received, validated through solar radiation and shading assessment tools. These tools help to architects and designers to choose right decisions in order to design more efficient access to the sun, greener solutions.

The number of panes can significantly influence the performance of multi pane windows, meaning that increasing pane number results in more energy saving. In this regard, Julián et al. [15] claimed that replacing clear single pane windows with double-pane windows was reduced the heat flux by 50-72.6%. Painting exterior building envelopes with light-colored coatings also reduce the transferred heat remarkably thanks to the high reflectivity of these coatings against solar rays.

ACKNOWLEDGMENT

This research was supported by EU's ERASMUS+ programme DEBSEUz Project (ERASMUS-EDU-2023-CBHE).

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