

# Toward Practical Application Of Factor Method For Estimating Service Life Of Building

T Nireki\* T Inukai\* & K Motohashi#

\*Tsukuba Building Test Laboratory, Centre for Better Living Japan

#Building Research Institute, Tsukuba City, Japan

**Summary:** Estimation of service life is a prominent important phase in the process of the service life planning. Among various available estimation methods for a whole building and building components, the Factor Method, modification of reference service life by factors to take into account of the specific in use conditions defined in ISO (ISO 15686-1), would be one of the realistic and practical method at present stage until the another alternative methods would be improved.

In view of the fact that relatively small amount of information has been reported on the principle of this method and also few works conducted pertaining to the applied results of this method, this paper investigates into the necessary performance data to establish the reference service life, the way and measures for preparation or classification of each factor, and it also shows some details that have been worked out in the performance based service planning system in Japan. The paper also points out that further investigation of the factor method could contribute to quantify and categorize the relevant items taken into consideration of service life, that would be foreseeable and unavoidable process in any other prediction system, and the factor method could be expected to apply for the stock management system as the estimation of residual service life of existing assets as well as their maintenance planning.

**Keywords.** Service life planning, Service life estimation, Factor method, Durability, Degradation

## 1 INTRODUCTION

At the beginning, to ensure that key terms in this paper are understood, the following are presented;

**Durability:** Capability of a building or its parts to perform its required function over a specified period of time under the influence of the agents anticipated in service (ISO 15686-1). <Ability of a building, its parts, components and materials to resist the action of degrading agents over a period of time AIJ (1988) is commonly accepted in Japan>

**Service life:** Period of time after installation during which a building or its parts meets or exceeds the performance requirements (ISO 15686-1)

**Service life planning:** Preparation of the brief and design for the building and its parts to achieve the desired life, for example in order to reduce the costs of building ownership and facilitate maintenance and refurbishment (ISO 15686-1). <Period of time during which all essential performance characteristics of a properly-maintained item (product, component, assembly or construction) in service exceeds the minimum acceptable values, Frohnsdorff & Nireki (1944) >

**Design life:** Service life intended by the designer (ISO 15686-1). <Service life that the designer intends an item (product, component, assembly or construction) to achieve conditions and maintained according to a prescribed maintenance management plan, Frohnsdorff & Nireki (1944) >

In practice, the service life planning is still not easy work for designers if they could understand the concept of it and wishes to introduce it into their building design. Though information on durability and degradation of building components or materials are provided in scientific documents for limited objectives, the necessary information for service life planning is rather hard to extract from those documents and usually they do not include a clear guide for the designer.

To cope with this situation, various domestic and international systematic approaches to service life have been made, and in fact interest in the possibility of predicting the service life of building and/or components has grown, as has the interest of designers in the necessity of providing service life planning.

These interests would assuredly foster progress towards making reliable service life prediction systems and towards the goal of providing service life planning as performance-oriented design system – setting a target (design life) at the first stage, then detailed design, work execution and maintenance planning follow to achieve it.

## 2 DURABILITY AS PROMINENT PERFORMANCE OF BUILDING

Durability is an important factor that could not be ignored when considering the performance of buildings. Durability has previously been stressed by the requirements, effective use of natural resources and saving energy, however, these requirements have turned to more wider and critical ones due to the recent social needs or requirements to the construction industry; not mere requirement for each building or a project but as nation-wide and global requirements such as saving energy at production of building materials leads to preservative use of global resource, to reduction of environmental loads then prevention global warming.

## 3 SERVICE LIFE PLANNING

The service life of buildings is influenced by the conditions throughout all the stages from planning, design, contract, construction, running, maintenance to demolition. Thus, the effectiveness of service life planning cannot be assured unless all conditions taken into account at design stage would be realized throughout whole life of a building from planning to demolition. The other prominent factor enable to realize the service life planning would be full understanding of this design system among all the persons concerned with a building in question as such planner, architect, designer, owner, property manager, caretaker, auditor, constructor, product manufacturer, user and occupant. In other words, the service life planning could be accomplished on the basis of mutual agreement among all sectors concerned and also the design life would be an indicator of consensus.

From the viewpoint of practical access to take service life or durability into the design of a certain building project, there are various so-called guides or rather huge amount of academic and technical documents for detailed technical issues, however very few of them are applicable for design of as a whole building or a part of it.

### 3.1 Service Life planning system

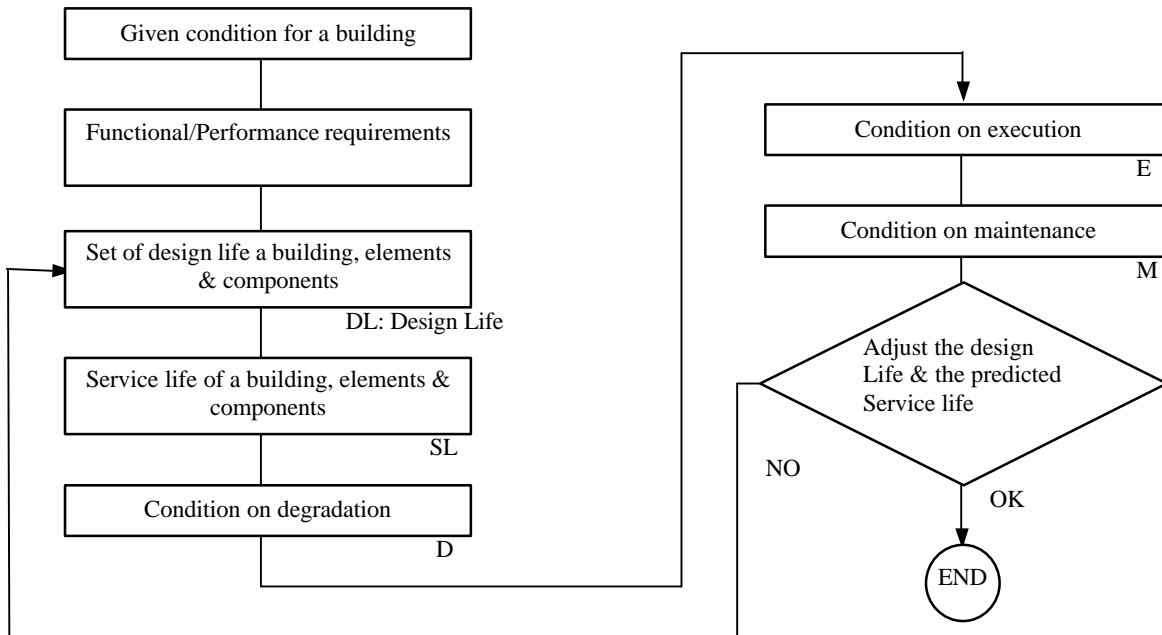
The followings are some typical approaches that intend to improve the service life planning for buildings and some of them are already standardised.

#### 3.1.1 Ministerial R & D for service life planning in Japan

Along with the interest of requirement on durability, the Ministry of Construction (MOC, Ministry of Land, Infrastructure & Transport, MLIT of present) started a five year R & D “Development of Techniques for Improving Life Time of Building. (Fiscal year 1980 – 1984)” This large scaled joint governmental research institute, university and relevant industry, total amount of member for technical committees and sub-committees reached to some 650 within five years, was promoted by Building Research Institute (BRI) and the research target could be summarized as below. Nireki et. al (1983)

<p>1 Maintenance for existing building Degradation agent &amp; Diagnosis Repair &amp; Upgrading</p>	<p>2 Improving service life of new building Requirements, design includes design criteria Higher-durability product - Structural - Non load bearing - Services Site works &amp; Management</p>
<p>3 Evaluation method Maintenance technology LCC / LCA Maintenance &amp; management</p>	<p>4 Improving service life Guide to Service Life planning Guide to Execution &amp; site work Guide to Maintenance &amp; management</p>

The guide for service life planning are proposed based on the research results obtained from the elemental projects? to? as in above, and the basic planning concept throughout all objectives could be outlined as shown in Figure 1. Nireki (1995)



$$SL \equiv SS \times D \times E \times M$$

SS: under normal use condition (equivalent to Reference Service Life in ISO 15686-1)

**Figure 1. Concept of service life planning in the Ministr R & D project**

The following guide to service life planning had been established.

- Reinforced concrete building
- Piping and plumbing
- Steel framed building
- Mechanical & electrical installations and equipments
- Wooden building
- Surface coating for external wall
- Masonry coating for external wall
- External wall tiling
- Cement mortar finishing for external wall
- Aluminum external cladding and window and door set
- Waterproofing for flat and gradient roof
- Sealing

In this concept, to estimate the service life of a whole or part of building, building element, component etc. should be one of the key process, then, a rather simple calculation method, service life could be obtained by multiplication of several conditions (factors) that would effect the service life of the objective in question, had firstly been introduced.

### 3.1.2 AIJ guide for service life planning in Japan

Architectural Institute of Japan (AIJ) decided to organize a technical committee on durability (Chairperson: Prof. Shirayama, Core member: T.Nireki, M.Sato) in 1979, aiming to systematize the concept of durability in the field of building engineering.

In 1989 the committee compiled “Principal Guide for Service Life Planning of Building” (referred to as AIJ Guide (Japanese) ) which was on the basis of the results of committee works for some nine years and referring the results from the Ministr R &

D project as describe above. The principle of service life planning in this guide was fundamentally on the almost same track as in the Ministr R & D project (1980 - 1984), as shown in Figure 1, and some service life estimation methods by applying the multiplication method for concrete, steel, wooden component etc. were compiled in the Appendix of the guide.

In 1993 AIJ Guide (Japanese) was translated into English as, “The English edition of Service Life Planning of Building (referred to as AIJ Guide (English))” and issued from the AIJ. After issuing the AIJ guides, the committee was reformed as a technical committee “Service life planning” (Chairperson Nireki) and active works have been done. Main works stressed in the committee were to make AIJ Guides much more practical taken the recent requirements and technical development into account and also to support the standardization of ISO 15686 series as one of the domestic group in Japan, then, the committee drafted “Service Life Planning for Building, Components and Materials” in 2000.

### 3.1.3 Service life planning in British and Canadian Standard

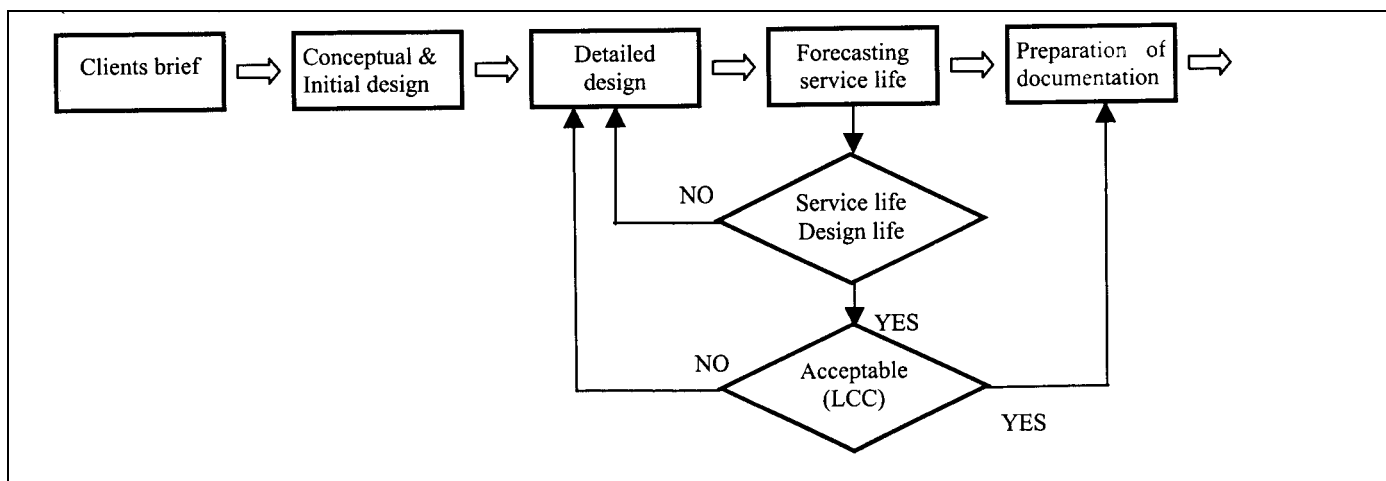
Both British standard, BS 7543:1992 “Guide to Durability of building and elements, products and components” (BS 7543:1992) and Canadian standard, S478-95 “Guideline on Durability in Building” (S478-95: 1995) are very useful technical documents for design for durability and/or service life planning.

Main notable difference among the Ministr R & D, AIJ Guide in Japan and these standard could be said that the first one is result of authorized research result and the second one is a proposal from the professional body (AIJ), therefore, the both do not still have any regulatory or compulsive character for building design in Japan expect some part of them had or would be specified in the building code or regulation.

### 3.1.4 Service life planning in ISO 15686

Standardizing works for service life planning in the ISO TC59/SC13/WG9 (TC59/SC14 at present) started in 1993 in Japan at just before the opening of 6th DBMC held in Japan. Since the, Part 1: “general principle” (ISO 15686-1) was issued in 2000 and Part 2 (ISO 15686-2): “Service life prediction procedures” was successively issued in 2001, and reminder parts as audit, LCA etc. are under preparation.

The target and the role of Part 1 can be found in the scope of it; this part of ISO 15686 describes the principles and procedures that apply to design when planning the service life of buildings and constructed assets. The systematic process of service life planning is shown in Figure 3 in the standard (ISO 15686-1) and this could be summarized as in Figure 2.



**Figure 2. Stepwise service life planning process in ISO 15686-1**

### 3.1.5 Service life planning in the new code in Japan

At present rather complex work is forced to designer, their burden and risk could be reduced if a certain design life would be selectively provided and that the corresponding components, materials and some details of the service life would be prepared. Above way of service planning has become to be possible for designer including supplier of dwelling system in Japan in accordance with the newly enforced “Housing Performance Indication System” HQAL (2000) in the “Housing Quality Assurance Law” enforced in 2000. HQAL (2000) This performance indication system is intended to provide customers with reliable information on nine types of performance items and their levels.

At present the system is not yet the compulsive measure, therefore, whether to use it or not is left to the designer’s, supplier’s and customer’s choice, however, rather higher ratio of newly built dwelling systems would be expected to apply the system. The nine types of performance selected in the Performance indication system are:

- Structural safety

- Easiness of maintenance
- Lighting & visual environment
- Fire safety
- Thermal environment
- Acoustic environment
- Preventive measures for degradation
- Indoor air quality
- Care for aged occupant

Preventive measures for degradation <direct translation into English> is almost equivalent to durability in English but a slight different meaning due to historical background.

For enforcement of the indication system, “Housing Performance Evaluation Standard” (HQAL 2000) has also been provided for the evaluation and ranking of each performance item and sub-items. In the evaluation standard, preventive measures for degradation, objective is limited to structural part or member of dwelling system, is divided into following three ranks based on the service life of dwelling in question.

Rank 3 : Necessary preventive measures for degradation are provided for some three generations\*

Rank 2 : Necessary preventive measures for degradation are provided for some two generations\*

Rank 1 : Necessary preventive measures for degradation are provided to conform to the Building Standard Law.

\*One generation term is supposed to be 25 to 30 years. This term corresponds to average duration which one generation would occupy a dwelling in Japan. Therefore, the Rank 3 means the service life of some 75 to 90 years.

The “preventive measures for degradation” is evaluated on the basis of the following conditions. Rank of the “preventive measures for degradation” express the level of preventive measures to sustain the service life of dwelling by the limit state. The limit state is described as the degraded state when the dwellings would reach to any one of the states as in below.

- The state when the performance or function degrades beyond the allowable threshold, and when it is impossible to recover this degraded state to the allowable limit by means of ordinary repair or partial replacement or renewal.
- For the case when the performance or function could be recovered back to the allowable limit by repair, however, the economical disadvantage caused by the successive use of the building in question is expected.

In practice, designers or suppliers can select any one of rank out of three ranks depending on their design policy and tactics, according to the evaluation system based on the factor method Motohashi & Nireki (2002), especially for steel and timber dwelling and this selection of a rank would be very similar process to set “design life” in the service life planning of building as already introduced in the Ministerial R & D, AIJ Guide even in ISO 15686-1.

## 4 ESTIMATION OF SERVICE LIFE

The following key terms in this paragraph are presented from ISO (ISO 15686-1:2000).

Design life	: (referred to Introduction in this paper)
Estimated service life	: Service life that a building or parts of a building would be expected to have a set of specific in-use conditions, calculated by adjusting the reference in-use conditions in terms of materials, design, environment, use and maintenance
Predicted service life	: Service life predicted from recorded performance over time
Forecast service life	: Service life based on either predicted service life or estimated service life
Factor method	: Modification of reference service life by factors to take account of the specific in use condition

### 4.1 Role of service life estimation

Mutual relation among design life, service life estimation and service life prediction in view of forecasting the service life of whole building, a part of building etc. in the service life planning can be illustrated as Figure 3.

Among with increase of social interests and need, various prediction system or sub-systems have been investigated, developed, and also usable durability data have been collected, however rather limited ones have been applied to the service life planning

for the limited building projects. It would be clear that one of the effective way to cope with the recent social requirement for service life issues of building should be improving the service life planning as to the design method even in the design for ordinary project. It would be also clear that further time would be needed to accomplish the service life planning system which depends fully upon the “prediction system,” here, the role of estimation system could be stressed.

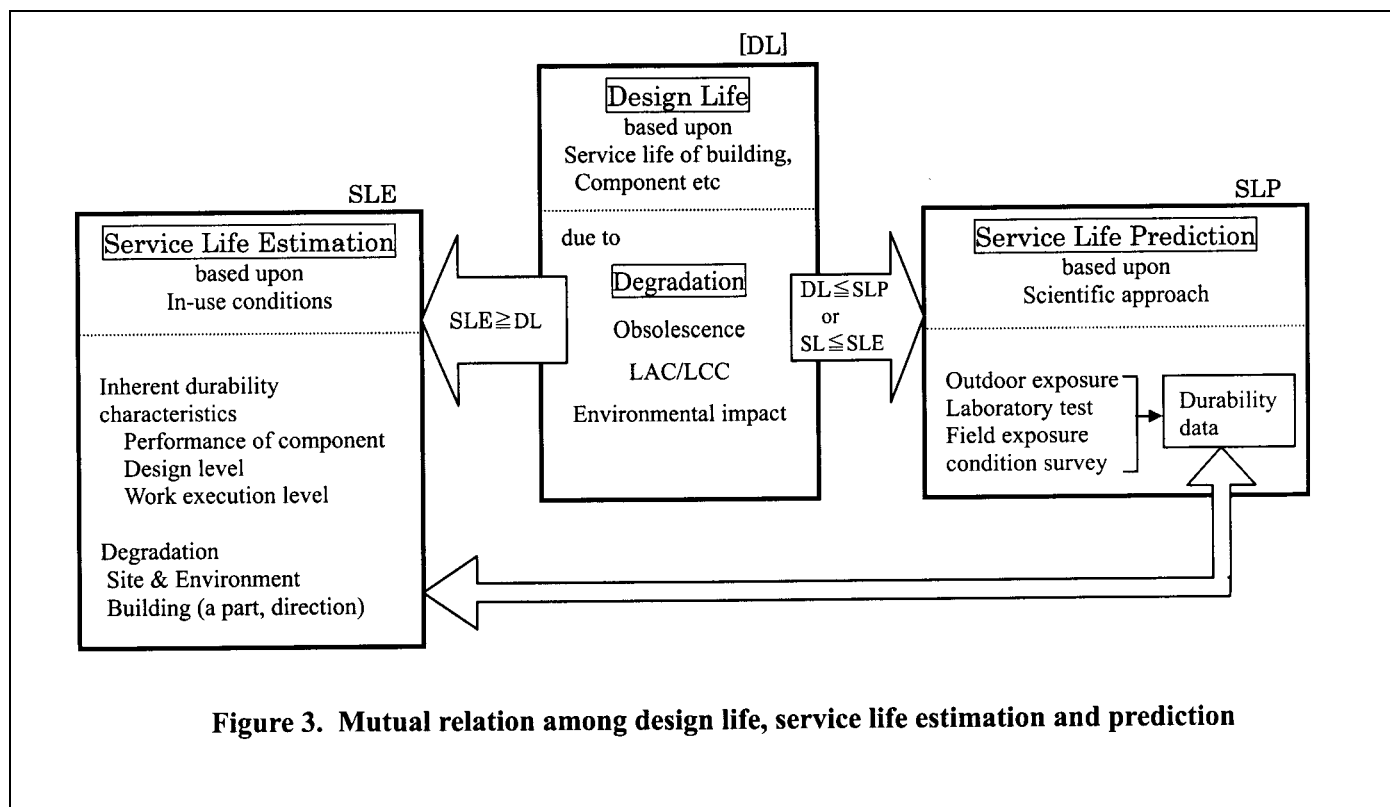


Figure 3. Mutual relation among design life, service life estimation and prediction

## 4.2 Factor method

The factor method specified in ISO (ISO 15686-1) was originally established in the Ministerial R & D in Japan, which intended to support the estimation of design life by designer as the system enable to be applied throughout all objective from a building to material on the basis of huge amount of research and technical documents, condition survey and expert knowledge (agreed among designer, scientist, university, engineer, constructor, manufacturer).

This factor method could be established in reliance on the elementary systems like durability evaluation, estimation/prediction as shown in Figure 4, and the actual process flow for external coating system of reinforced concrete building is shown in Figure 5 as an example. In practice, the service life of external coating system can be estimated according to the simple equation as in Figure 5.

### 4.2.1 Reference service life [Yo]

The reference service life for external coating systems (6 - 12 years for paint, masonry coating etc.) had been proposed in the Ministerial R & D at first, and the original set has been revised with adding for the new products, like high performance or hybrid coating (15 years) since then.

Generally the priority of decision making for setting a reference service life would be the existing research data, Nireki et al. (1987) (1990), including condition survey at first and then, technical information from manufacturers, previous experience, and the final design would be remained long discussion to have an agreement among the experts from wider fields.

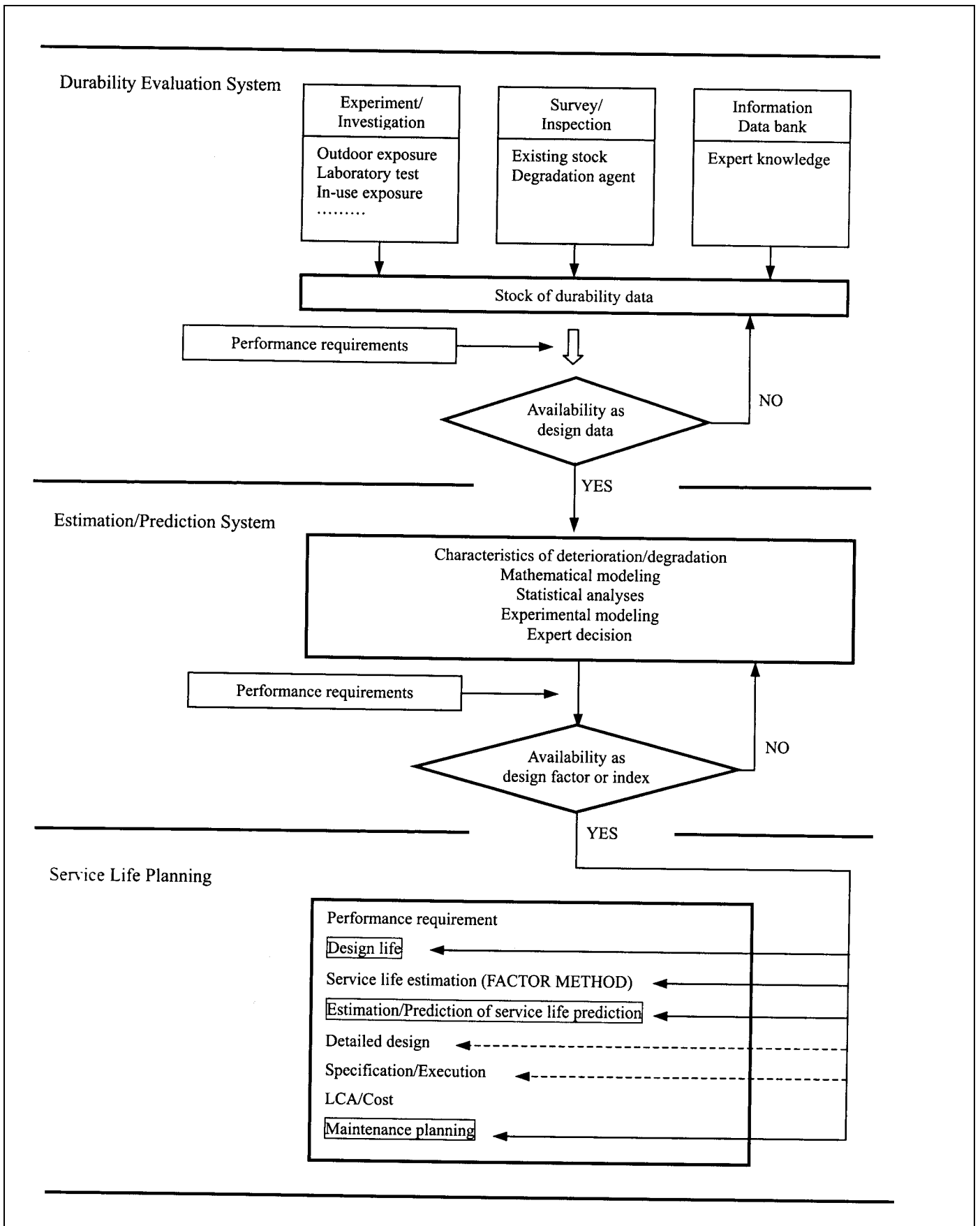
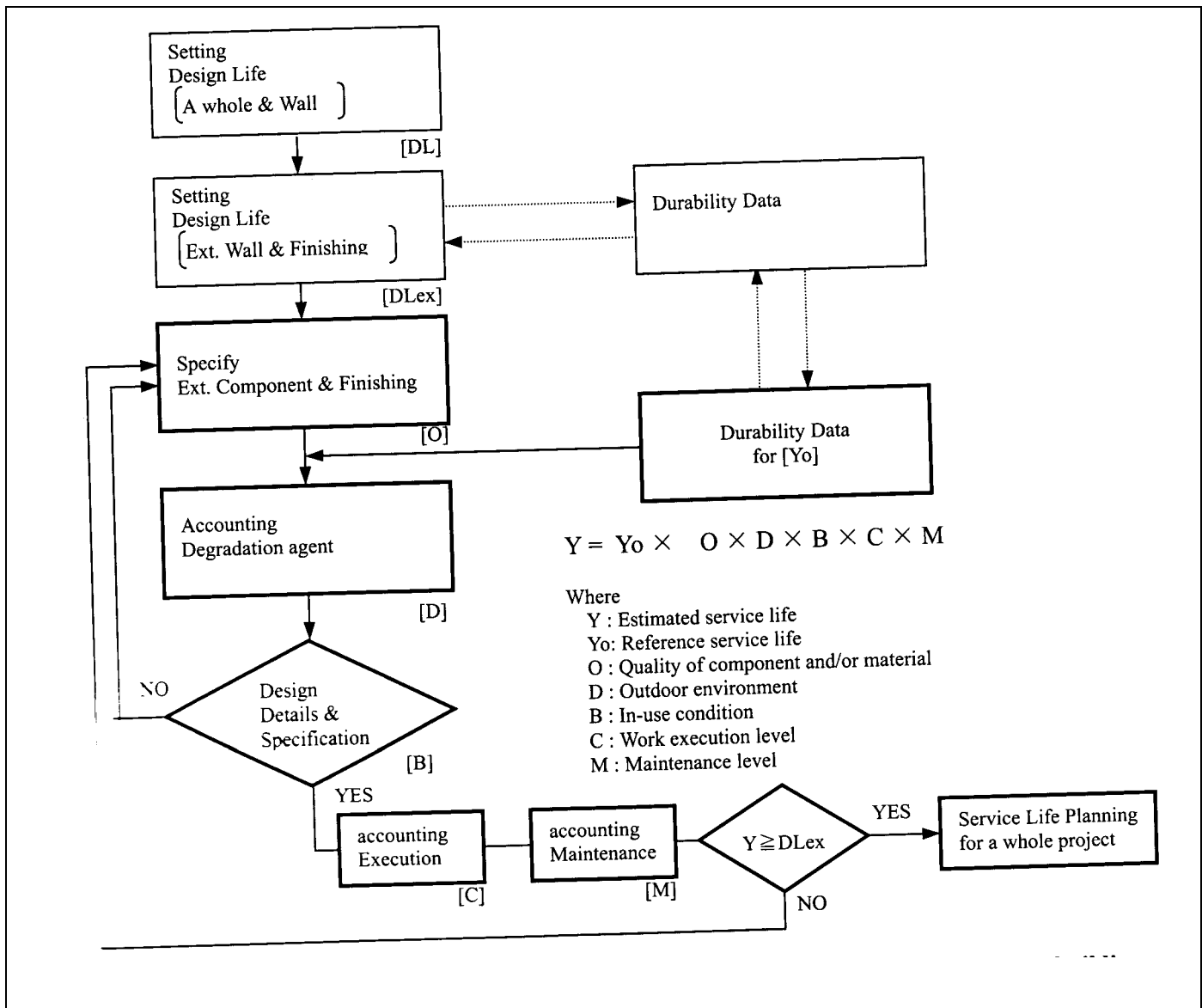


Figure 4. Factor method and relevant elementary systems, modified Nireki (2000)



**Figure 5. Service life estimation flow for external coatings of reinforced concrete building modified Nireki (2000)**

#### 4.2.2 Quality of component and/or material

For external coating, [B] can be obtained from the multiplied value of two sub-factors, the one; with or without top coating layer and the other; level of coating guide (for example the guides issued from the ministerial department, AIJ specification etc.: less than, according to, above the guide)

#### 4.2.3 Outdoor environment [D]

Fairly much amount of durability data based on performance evaluation concept are available for external coating system Nireki et al. (1987)(1990), then, this factor can be obtained from the multiplied value of two sub-factors as shown Table 1, the one: weight of degradation agents [W], the other: degree of each degradation agents [X], then the outdoor environment [D] is according to as in Table 2. Generally this factor [D] is naturally varied from the objective as such steel, concrete, timber, waterproofing, hence, sometime it has more complicated sub-factors has to be taken into account. Of course indoor environment should be taken into account as a factor if the environment affects the external wall from the inside.

It would be notable that the knowledge or experience based information from practitioners could be useful to adjust research based sources.

**Table 1. Sub-factor for [D]**

Items	Point W	Degree X			Reference
		3	2	1	
Temperature (? )	1.5	~ 7.5	7.5 ~12.5 22.5 ~	12.5 ~ 22.5	Yearly normal temperature
		W·X=4.5	3.0	1.5	
Humidity (%)	1.5	80 ~	70 ~ 80	~ 70	Yearly normal relative humidity
		W·X=4.5	3.0	1.5	
Rainfall (mm)	2.0	3,500 ~	1,500 ~ 3,500	~ 1,500	Yearly rainfall
		W·X=6.0	4.0	2.0	
Irradiation (kcal/m <sup>2</sup> ? day)	2.0	3,300 ~	2,900 ~ 3,300	~ 2,900	Total irradiation
		W·X=6.0	4.0	2.0	

**Table 2. Outdoor environment factor [D]**

Sub-factor (SW· X)	[D]
~ 10	1.1
10 ~ 19	1.0
19 ~ 21	0.9

4.2.4 In-use condition [B]

The direction of building and the part of it would be the dominant sub-factors for external coating system, then, [B] can be obtained the orientation and the part where the coating system is applied as in Table 3. Much more complicate sub-factors are taken into account for timber construction, and also this factor [B] is exclusive in another objectives.

**Table 3. In-use condition [B]**

Direction	Part of building		
	Horizontal salient Vertical salient	Around opening Non-flat surface	Ordinary external wall
West	0.7	0.7	0.8
North	0.8	0.8	0.9
South/East	0.9	0.9	1.0

4.2.5 Work execution factor [C]

The workmanship and on-site management would be the dominant factors affecting the site work, hence the planning for execution and management, and on-site inspection system are selected. In conclusion, the level of work execution could be shown in Table 4.

**Table 4. Work execution factor [C]**

		Execution plan factor				
		0.6	0.8	1.0	1.1	1.2
Inspection factor	0.6	0.4	0.5	0.6	0.7	0.8
	0.8	0.5	0.7	0.8	0.9	1.0
	1.0	0.6	0.8	1.0	1.1	1.2
	1.2	0.8	1.0	1.2	1.3	1.4
	1.4	1.0	1.3	1.4	1.5	1.6

The execution plan factor are in relevant to the following several sub-factors as in Table 5 to 8. On the bases of Table 5 to 8, execution plan factor can be set as in Table 9.

**Table 5. Constructor/Manager Sub-factor**

		Manager		
		Not qualified	2nd class architect* 2nd class manager*	1st class architect* 1st class manager*
Not qualified		0.7	0.9	0.9
2nd class painter*		0.8	1.0	1.1
1st class painter*		0.9	1.1	1.2

\*Qualified by national qualification system

**Table 6. Terms of execution**

Terms of execution	Point
Under inadequate ambient humidity	0.7
Under inadequate ambient temperature	0.8
Under appropriate condition	1.0

**Table 7. Work process**

Work process	Point
Inadequate	0.7
Slightly inadequate	0.8
Almost appropriate	1.0
Appropriate	1.2

**Table 8. Work environment**

Work environment	Point
Inadequate	0.7
Slightly inadequate	0.8
Almost appropriate	1.0
Appropriate	1.2

**Table 9. Execution plan factor**

Multiplied value in Table5.to8	Point
0.2 ~ 0.5	0.6
0.5 ~ 1.0	0.8
1.0 ~ 1.2	1.0
1.2 ~ 1.5	1.1
1.5 ~	1.2

On the other hand, inspection factor as in Table 4 related to the following several sub-factor as in Table 10. The inspection for external coating system would be quality of coating materials (conformity to specification, relevant quality standard, technical data from manufacture etc.) substrate (water content, alkaline, strength, cleanness etc.) and coating system (appearance, dryness, gloss, thickness etc).

The level and method of inspection can be summarized as in Table 10. In practice, all the item, totaled 14 items, are ranked as 2 to 3 degrees in each level I toIII, and the inspection factor can be obtained as in Table 11.

**Table 10. Outlook of inspection level and method**

Item		Inspection level		
		?	?	?
Material [C]	Quality	Conformity	Test data	Authorized result
Substrate [S]	Water	Visual	Investigation	Measuring
	Roughness	Visual	Crack scale	Scaling
	Strength	Visual	Tape test	Tensile test
Coating [F]	Thickness	Use quantity	Thickness gauge	-

**Table 11. Inspection factor**

Item		Inspection level				
Material	Quality	-	I	I	II	III
Substrate	Water	I	II	III	III	III
	Alkali	I	II	III	III	III
	Absorption	-	I	I	II	II
Coating film	Roughness	I	I	II	II	II
	Soiling	I	I	I	I	I
	Strength	-	I	II	II	III
	Drying	-	-	I	I	I
	Appearance	I	I	II	II	II
	Gloss	-	I	II	II	III
	Thickness	I	I	I	I	II
	Hardness	-	I	I	I	I
	Adhesive	I	I	II	II	III
	Pin-hole	-	I	I	II	III
Inspection factor		0.6	0.8	1.0	1.2	1.4

4.2.6 Maintenance factor [M]

The dominant element for maintenance would be the inspection work and period (cycle) of inspection in the maintenance planning. In conclusion, the level of maintenance [M] could be shown in Table 12.

**Table 12. Maintenance factor [M]**

Value in Table 13.	Maintenance [M]
0.18	0.7
0.3 ~ 0.42	0.8
0.5 ~ 0.72	0.9
0.8 ~ 1.0	1.0
1.2 ~ 1.44	1.1

**Table 13. Inspection cycle and factor**

Inspection work factor	Inspection cycle factor				
	0.3	0.5	0.7	1.0	1.1
0.6	0.18	0.3	0.42	0.6	0.72
0.8	0.18	0.4	0.56	0.8	0.96
1.0	0.18	0.5	0.7	1.0	1.2
1.2	0.18	0.6	0.84	1.2	1.44

\*0.3 in inspection cycle factor means without any inspection

The inspection cycle factor as in Table 13 can be obtained in Table 14.

**Table 14. Inspection cycle factor**

Part of building		Inspection cycle				
Paint	Wall, Penthouse	-	4	3	2	1
	Others	-	3	2	1	0.5
Masonry coating	Wall, Penthouse	-	4	3	2	1
	Others	-	3	2	1	0.5
	Others	-	3	2	1	0.5
Inspection cycle factor		0.3	0.5	0.7	1.0	1.2

\*0.3 means without any inspection

As to the inspection work factor, objective of inspection can be classified into as A (ordinary wall), B (balcony, eaves) and C (pitched wall, around openings, exposed column and beam, parapet etc) in the order of deterioration of coating systems, and the level of inspection also can be divided into as ? (by visual or contact (touch)), ? (measuring by using simple devices, like scale, cross cut test etc.) and ? (measuring by using specific device, like colour and gross meter, adhesive tester etc.). In Table 15, the inspection method for each degradation and level of inspection are shown as an example.

**Table 15. Inspection level and inspection method**

Degradation	Inspection level		
	I	II	III
Discolouration	Visual	Visual, Colour chart	Colour meter
Blister	Visual	Visual, for top coating	Visual, for top coating
	-	Visual, for core layer	Visual, for core layer
	-	Adhesive, Cross cut	Adhesive, Cross cut

\*Totalled 16 items have been provided

Then, inspection work factor can be obtained as in Table 16.

**Table 16. Inspection work factor**

Inspection item		Paint group				Masonry coating			
1	CD Discolouration	I	I	II	III	I	I	II	II
2	GD Decreasing gloss	I	I	II	II	I	I	II	II
3	CK Chalking	I	I	II	III	I	I	II	II
4	CT Soiling	I	I	II	II	I	I	II	II
5	BT Blister (Top coat)	-	I	II	II	-	-	-	-
7	CT Crack (Top coat)	-	I	II	II	-	-	-	-
9	ST Peel (Top coat)	-	I	II	III	-	-	-	-
6	BU Blister (Core layer)	-	-	-	-	-	I	II	III
8	CU Crack (Core layer)	-	-	-	-	-	I	II	III
10	SU Peel (Core layer)	-	-	-	-	-	I	II	III
11	M Mixture	-	-	-	-	-	I	II	III
12	W Decreasing thickness	-	I	II	III	-	I	II	III
13	CS Breaking (Core layer)	-	-	-	-	-	I	II	III
14	AS Breaking (Substrate)	-	I	II	II	-	I	II	II
15	CF Crack (Substrate)	-	I	II	II	-	I	II	II
16	FS Lifting (Mortar)	-	I	II	II	-	I	II	II
Inspection work factor		0.6	0.8	1.0	1.2	0.6	0.8	1.0	1.2

## 5 CONCLUSIONS

The factor method would remain its service life for a while, might be expected by the limit state when the service life prediction at present would be further improved and enable to cover the most objectives, and make the factor method as an obsolescent tool.

The factor method still has various aspects to be investigated toward farther practical application even though its parts have been adopted in the newly enforced Japanese code on housing systems, the concept of is in the main text and some details are in the evaluation standard in the enforcement document for the code, Motohashi & Nireki (2001)

*Limited or partial application* – A part or some parts of the factor method including the its concept can be of assistance in the various projects likely for setting a reference service life, ranking or rating of environment on site work, maintenance conditions, and such way of application could be expected to increase in different way of manners.

*Further investigation into the factor* – Periodical investigation into the already set and the new reference service life should be important to sustain the reliability of this method mainly based on the up to date durability data. Further examination of new factor or sub-factor like microclimate and GSI data into the environment factor, re-examination of work execution, much more consideration of the maintenance planning and sub-factors for maintenance level.

*New application to existing buildings* – At present, interest to the service life planning has been rather focused upon the new construction even ISO 15686-1 says that, it can be applicable both new and refurbishment of existing structures “with additional considerations may apply to existing building” in its scope. This additional considerations are not so simple as to just replacement of several terms and factors in the principles, in fact, there necessary to provide tactic measures and sequential technologies as such condition survey and diagnostics method to define the state of degradation, condition assessment to determine margine of service life, evaluation of repair material and/or replace component, service life estimation for refurbished parts and finally estimation or prediction of “residual service life”.

Above sequential technologies and techniques had already been investigated in the Ministerial R & D, especially in the target [I] and [IV] as in the Ministerial R & D, and various practical guides for existing stock had been established on the basis of the Ministerial R & D. These guides were originally for government-owned buildings and nowadays these are referred to the public and privately-owned buildings Guide(1993), Guide(1999), Guide Note(1998). AIJ had also issued the relevant guide “Principal Guide for Condition survey, Diagnosis and Repair of Buildings” (Sub-committee, Durability), and the new guide “Principal Guide for Refurbishment of Buildings” will be issued within 2001.

One of the prime policy targets of the MLIT in the fiscal year 2001 is activation of the used (second hand) housing market, this leads again to housing performance indication system for existing housing and also performance evaluation standard and criteria as almost similar track as of new housing, this relates to the crucial issue, residual service life of existing dwelling, often estimation would be required for the both before (at a certain time) and after the refurbishment (improved, upgraded) of the dwelling in question.

To apply the factor method for existing buildings have already been experienced usually in conjunction with improvement or refurbishment project (for a building or a part of building), like repair and improvement work project for the external insulation waterproofing of publicly-owned multifamily flats; taking some practice as examples – as to decision making for the selection of new waterproofing to be replaced at first, execution work level, maintenance planning during the next time of refurbishment, as the new way of application of the factor method.

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