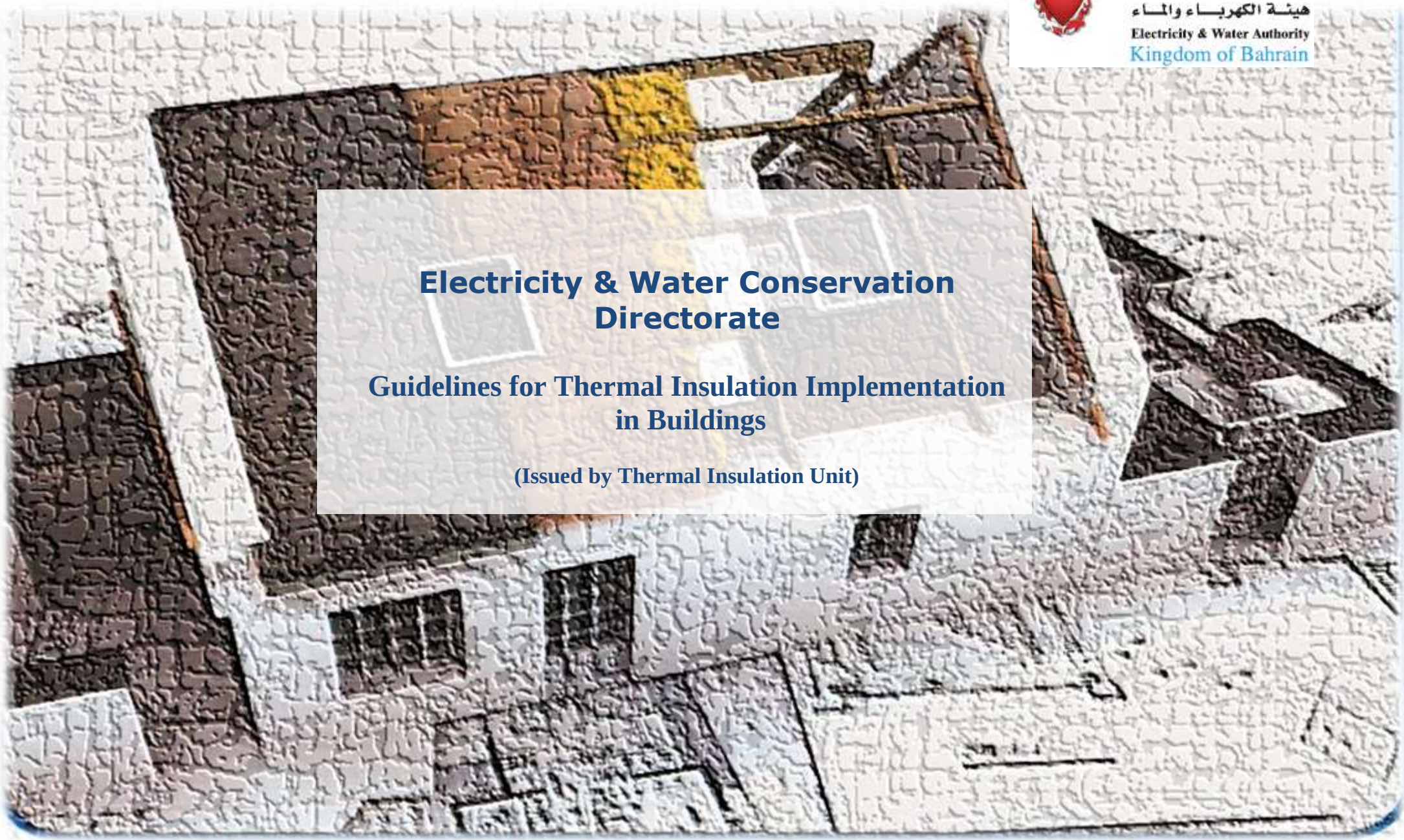


EWA
هيئة الكهرباء والماء
Electricity & Water Authority
Kingdom of Bahrain

Electricity & Water Conservation Directorate

Guidelines for Thermal Insulation Implementation in Buildings

(Issued by Thermal Insulation Unit)

INDEX

1. INTRODUCTION

Why Thermal Insulation is required for Buildings in Bahrain?

Energy is consumed in buildings for air-conditioning, lighting, cooking, cleaning, recreation … etc. Reports and studies, which were conducted in Bahrain, revealed that more than 65% of energy is consumed by air conditioning. The rate of energy consumption by air-conditioning is influenced by three main factors:-

1. Thermal performance of the building, which is affected by a number of factors, such as building form, building orientation, glazed surface areas, and thermophysical properties of building materials of the envelope of the building.
2. User's behavior in terms of controlling air-conditioning, lighting and other equipment.
3. General policy of the nation with respect to energy cost, building rules and regulations.

No doubt that the building form, building layout, building design and thermophysical properties of used building materials have considerable influence on the amount of energy needed for the provision of indoor thermal comfort requirements. Therefore it is the duty of architects and designers to conduct the required analytical studies, which lead to benefit from the climatic factors with the objective of reducing the need for air-conditioning and maximum utilization of natural lighting.

Studies revealed that the thermal characteristics of the building envelope are one of the main criteria, which determine the overall thermal performance. For this reason, a code for thermal insulation is introduced. The code deals with the thermal characteristics of roofs, external walls, and glazed surfaces with the objective of reducing heat flow through the building envelope. This is done through limiting of the U-value for roofs and external walls together with defining the type of glass for windows and openings. The use of insulation materials is regarded as the most effective with respect to reducing the rate of heat transfer from outside to inside during the hot summer, and from inside to outside during the cold winter.

Heat transfer to and from the building takes place through the following: -

1. Walls and roofs.
2. Widows and glazed surfaces.
3. Openings.

During summer, the amount of heat transfer through roofs and walls ranges between 60-70%. This amount of heat should be removed by air-conditioning. Therefore the use of insulation materials for roofs and walls is very essential for energy conservation. Thermal insulation has many advantages, such as: -

1. Reducing the energy consumption required for cooling and heating.
2. Reducing the capacity of air-conditioning equipment and hence reducing capital cost.
3. Protecting the building components from thermal stress as a result of expansion and contraction.
4. Reducing the electricity bill for consumers.
5. The provision of comfortable indoor thermal environment.
6. Protecting the surrounding environment from harmful gases emitted by electric power plants.

Windows and glazed surfaces are considered as the weakest points with regard to heat transfer by conduction and radiation. Therefore, it is advisable to reduce the area of glazed surfaces, which are exposed to external climate and direct solar radiation and encourage the use of high performance glass and double-glazing.

2. THERMAL INSULATION REGULATIONS IN BAHRAIN

2.1 Thermal Insulation Order # 8/1999:

Was issued in 1999 by H.E. The Minister of Housing & Municipality making it compulsory to provide thermal insulation for all buildings in Kingdom of Bahrain from 5 floors and above, which require air-conditioning. The Order stipulates the following requirements:

A. Thermal insulation materials should be used for roofs and walls of all buildings which require air-conditioning according to the following:-

1. The overall thermal transmittance value (U-value) for the roof should not exceed 0.6 $W/m^2\text{-}^oC$
2. The overall thermal transmittance value (U-value) for external walls should not exceed 0.75 $W/m^2\text{-}^oC$.
3. High performance glass should be used for all buildings with more than three floors or if the area of the glazed surfaces ranges between 10-20% of the total external surface area of the building envelope. On the other hand, if the glazed area is more than 20%, double glazing should be used.

B. This regulation is applicable on all new buildings, which need air-conditioning, and for existing buildings that need to be reconstructed or refurbished. The order has been implemented for buildings above four floors.

2.2 Thermal Insulation Order # 63/2012:

Was issued in 2012 by H.E. The Minister of Housing & Municipality making it compulsory to provide thermal insulation for all residential buildings, facilities, warehouses and stores that need cooling/air-conditioning. Accordingly all buildings below 5 floors which were not covered in the previous thermal insulation order (8/1999) are now required to be provided with thermal insulation. This order has come effective on 1st September 2013, and the following are the requirements of thermal insulation:

a. Thermal insulation shall be provided for all external walls including exposed columns, beams, stair cases and light wells/shafts. External walls of the building abutting adjoining building(s) if any shall also be insulated.
b. Thermal insulation shall be provided for the roof including swimming pool decks and stair cases/lift machine rooms.
c. Floors and walls of air-conditioned spaces exposed to non-air-conditioned spaces like car park/service areas in the building should be insulated.
d. Spandrel areas of curtain walls should be insulated.

2.3 Thermal Insulation Order # 149/2018:

Was issued on 31st of October 2018 by H.E. Minister of Works, Municipalities Affairs and Urban Planning. It was published in the official Gazette on 1st of November 2018. The order is legally binding effective 1st March 2019. The main clauses of the technical regulation attached with the order are summarized in section 3 below.

3. THERMAL INSULATION REQUIREMENTS:

1. Maximum U-values for the roofs and walls shall be as follows:

Table (1)	
Thermal Insulation	**Maximum of Thermal Transmittance Value U Value (W/m2.C)**
Roofs	0.3
Walls	0.57

2. Glazed surfaces should comply with the following:

Table (2)			
Glass Area	**Max. U-Value (W/m2.C)**	**Max. Shading Coefficient**	**Min. Light Transmission**
Glass percentage less than or equal 40%	2.1	0.4	0.25
Glass percentage more than 40%	1.9	0.3	0.20
Skylights & Roof Openings	1.9	0.25	0.10
Shopfronts and Showrooms	1.9	0.76	-

3. In addition, all facades, surfaces and balconies that are exposed to external weather must also be insulated. All precautions should be taken to eliminate thermal bridges in walls, roofs, and windows/doors.

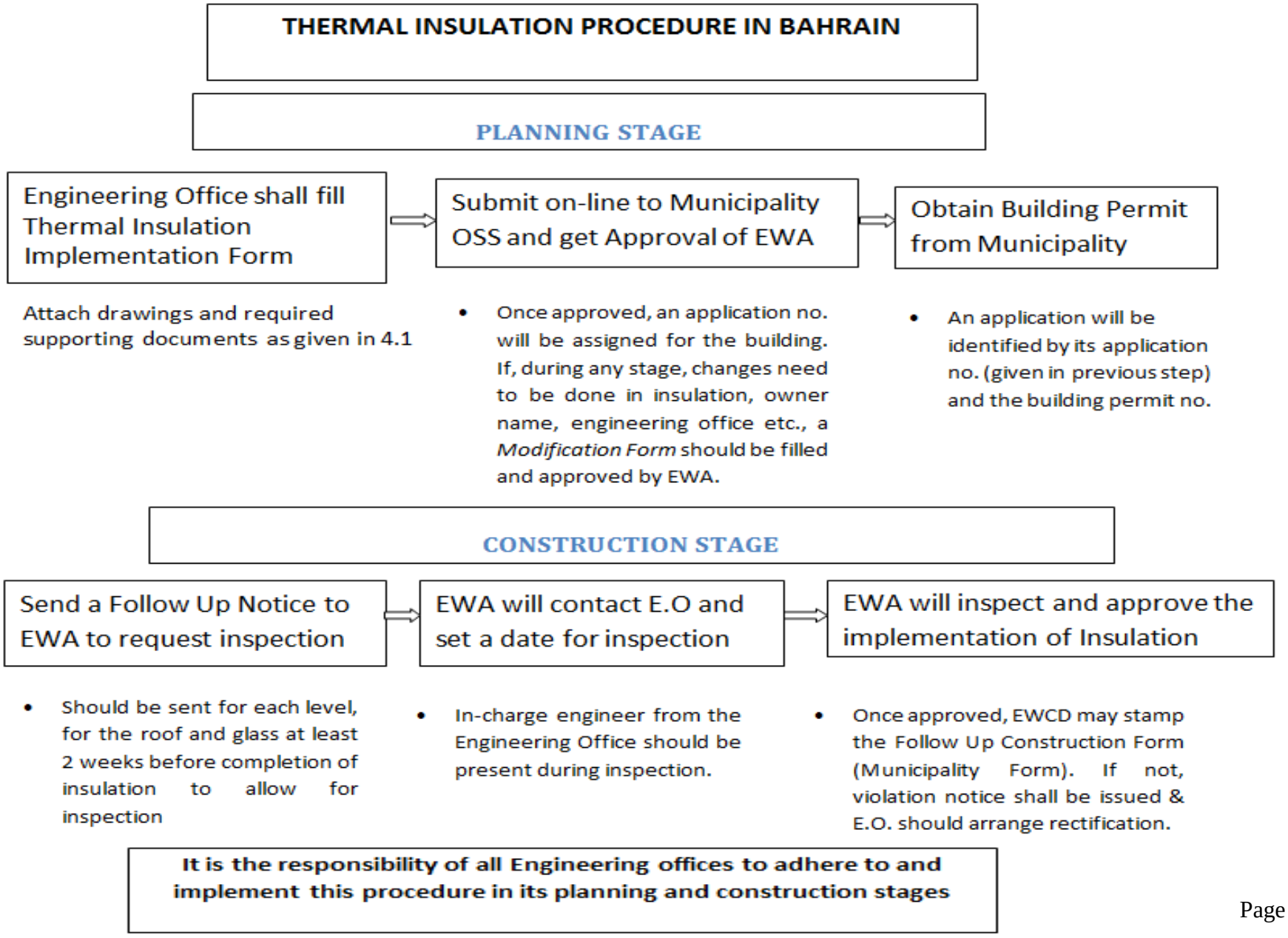
4. Roofs shall be prepared or coated to reflect sun rays and became of cool roof types. Solar reflectance should not be less than 0.65 and the thermal emittance should not be less than 0.75. Roofs containing photovoltaic panels may be exempted from this condition.

5. Specifications and properties of thermal insulation materials:
    - Must be approved by the Electricity and Water Authority of Kingdom of Bahrain and in accordance with EWA requirements and procedures.
    - Materials used in thermal insulation should be fire resistant and non-toxic when set on fire. Also, they should comply with the specifications and guidelines of the General Directorate of Civil Defense.
    - Data approved and issued by the Electricity and Water Authority should be used to calculate the U-Value for insulation materials used in external walls and roofs, according to the approved and accredited test reports. The Electricity and Water Authority is entitled to visit sites and take samples to verify data.

6. The following should be considered during the implementation of thermal insulation:
    - Storage of insulation materials in dry and non-exposed areas.
    - Prior to implementation, ensure that all surfaces are intact and free of any cracks, holes, or grease.
    - Covering insulation materials on both sides of the walls and roofs with layers in accordance with the appropriate installation method approved by the Electricity and Water Authority to protect against moisture.

4. IMPLEMENTATION PROCDURE:

4.1Buildings of 2800sqm and above:



4.2 Buildings less than 2800sqm:

THERMAL INSULATION PROCEDURE IN BAHRAIN

PLANNING STAGE

Engineering Office shall fill Thermal Insulation Implementation Form ⇒ Submit on-line to Municipality OSS ⇒ Obtain Building Permit from Municipality

Attach drawings and required supporting documents as given in 4.1

CONSTRUCTION STAGE

E.O. should coordinate with owners & contractors ⇒ E.O will contact Contractor and set a date for inspection ⇒ E.O. will approve the implementation of Insulation

- Should coordinate for each level, for the roof and glass before completion of insulation to allow for inspection
- In-charge engineer from the Contractor should be present during inspection.
- If not approved, E.O. shall coordinate with contractor & owner to rectify the violation

Engineering offices shall be responsible for planning, building permit, construction stages and issue of completion certificate in accordance with the regulation of thermal insulation in the Kingdom of Bahrain and guide lines issued by Electricity & Water Authority.

4.2.1 The process for thermal insulation implementation is given below:

i. Planning & Building Permit Stages: Engineering Office shall submit the following with Building Permit application

a. Detailed drawings indicating materials and methods used for the thermal insulation of the roofs and walls and external glazing.
b. Thermal Insulation Implementation Form (Appendix 1)
c. Required supporting documents as stipulated in clause 4.1 & 4.2 below.
d. An undertaking by the Engineering Office as per form (Appendix-11)
e. A copy of valid certificate to practice thermal insulation in buildings, issued by Electricity & Water Authority to the Engineering Office**.**
f. Municipality shall issue the building permit based on the above submissions by the Engineering Office.

ii. Construction Stage:

a. The engineering office shall supervise the implementation of thermal insulation in the building at all stages of construction and ensure the use of thermal insulation materials for walls and roofs and the type of glass are as per the TII Form and the conduct of insulation is done properly.
b. The engineering office shall submit, on completion of the building, a certificate confirming that the thermal insulation for the building has been implemented and fully comply with the requirements of the Thermal Insulation Order Nos. 63/2012 & 8/19999 (as per form –Appendix 12)

4.3 Records to be maintained by the Engineering Office for supervision of TII for each building:

a. Copies of thermal insulation implementation forms and supporting documents submitted with BP application
b. Copies of thermal insulation implementation modifications approved
c. Copies of material approval forms for glass
d. Record of follow up notices & inspection reports as per format (Appendix-9)
e. Copies of violation notices issued to contractors
f. Record of violations & rectification of violations as per format (Appendix-10)
g. Copies of Final completion certificates issued.

4.4 Auditing of Engineering Offices by EWA

4.4.1 Electricity & Water Authority (EWA) shall carry out audit of Engineering Offices (E.O) registered with COEPP to qualify the E.O to implement Thermal Insulation Regulation as per ministerial order no: 63/2012.

4.4.2 The purpose of the auditing is to assess the following:

a. Qualified staff is available for implementation of thermal insulation in buildings.
b. Compliance to regulations of thermal insulation in building design and implementation.
c. Proper supervision of thermal insulation in buildings during construction is done and documented.
d. The buildings are free of any significant violations regarding the implementation of thermal insulation. Significant violations will include engineering office issuing a completion certificate for the building confirming that the completed building fulfill all the requirements of thermal insulation, although there is no insulation in roof or walls or non-insulating materials/un-approved glass are used.
e. Significant violations are not repeated especially after guidance notes and prior warnings by Electricity & Water Authority.

4.4.3 Procedure for Auditing of Engineering Office by EWA:

a. EWA to issue two weeks advance notice to Engineering Office with date/time/duration of proposed audit.
b. Random selection of projects that are in progress or completed.
c. Check the availability of qualified resources for proper conduct of thermal insulation in buildings as per regulations.
d. Examine the records being maintained and check their quality.
e. Examine at random thermal insulation forms & supporting documents submitted for the BP by Engineering Office to check whether the Engineering Office has covered all the requirements.
f. Site visits with the Engineer in charge to randomly selected projects and check the conduct of thermal insulation in selected buildings as per the approved TII Form.

On completion of periodic audit, Electricity & Water Authority will send the audit report to the engineering office. The audit report shall include audit findings and observations of EWA on the performance of the engineering office and the extent of its commitment in implementing the thermal insulation in buildings.

A certificate with limited validity shall be issued by Electricity & Water Authority to Engineering Office for practicing thermal insulation in buildings based on the results of the audit. Any major violation reported from the auditing process will disqualify the Engineering Office for practicing thermal insulation in buildings.

5. SUBMISSIONS BY ENGINEERING OFFICE

5.1 Planning Stage:

Required Submissions for Final Building Permit:

Required submissions	Remarks
1. Thermal Insulation Implementation Form (Appendix-A).	All the fields should be filled, signed by client & in-charge engineer, stamped and all pages should be numbered.
	If wall/roof insulation at other locations (such as shear walls, beams, columns, spandrel areas, swimming pool decks etc.) was different then separate U-Value calculation sheet with relevant data for each such locations should be included
2. Supporting documents for thermal resistivity/thermal resistance values of materials used in U-Value calculations	Documents from manufacturer & test certificate from accredited Testing Laboratories.
3. Calculation sheet for glass area as per prescribed format (Appendix-B).	
4. Calculation sheet for external surface area as per prescribed format.	
5. Performance data sheets from glass manufacturer for each type of glass	
6. Architectural plans for all floors	In the Architectural drawings dwf file, Types of doors, windows, curtain walls as per the schedule of doors/windows/curtain walls to be showed in all floor plans. The walls to be insulated should be highlighted.

7. Elevation drawings	In the Architectural drawings dwf file, horizontal & vertical dimensions, types of doors, windows, curtain walls to be showed in all elevations. Floor slabs & roofs to be insulated should be highlighted.
8. Schedule of doors/windows/curtain walls/sky lights.	Include the schedule in the Architectural drawings dwf file,
9. Cross section drawings for each type of roof & wall with thermal insulation details.	One cross section drawing corresponding to each U-value calculation sheet in the TII Form should be submitted. Include these cross section drawings in the Architectural drawings dwf file.
10. Layout of columns/beams & Schedule of columns/beams	To be Included in structural drawings dwf file

5.2 Construction Stage:

1. Follow Up Notice as prescribed format	Copies of Building Permit and address card for **the entrance** of the building should be sent with **the first follow up notice**.
	If any violations in the implementation of thermal insulation were notified by EWCD, follow up notice should be sent when the rectification of such violation is being carried out.

2. Material Approval Form for Glass	Approval of EWA should be obtained for the glazing by submitting material approval form for glass (Appendix-E) with performance data for the glass from the manufacturer, certificates from glass supplier & Aluminum fabricator (as per prescribed format-Appendix F) and one sample for each type of glass before execution.
	Glass selection should be in accordance with Table (5.2) in the Code of Practice for thermal insulation in buildings.
3. Thermal Insulation Implementation Modification Form:	If the Engineering Office wants to make any changes in the Approved TII Form such as change of insulation materials in walls/roof, glass type, glass area etc., TII Modification Form should be submitted and approval obtained before incorporating any such changes in the building.
	Modification form should also be submitted for change of owner(s) & or Engineering office.
	Supporting documents required to be submitted, for each type of change proposed, are listed in the check list for TII Modification Form (Appendix-H).
4. Copies of delivery Notes for glass	Copies of Delivery Notes for glass from Manufacturer to local supplier & from local supplier to Aluminum Fabricator should be submitted at the time of glass inspection.
5. Copy of approved electrical load	Copy of approved electrical load from Electricity Distribution Directorate at the time of final stamping of Municipality construction follow up forms.

6. Thermal Insulation Design:

6.1 Definitions

- **Overall Thermal Transmittance (U-value) or Overall coefficient of heat transfer (U-factor):** This is the overall rate of heat transfer through a section (wall or roof) per unit area and per unit temperature difference, expressed as $W/(m^2.°K)$

- U-value is the reciprocal of the overall thermal resistance ($1/R_T$)

- **Overall thermal resistance (R_T):** This is the sum of the thermal resistance of all material layers constituting the wall or roof section, and includes the thermal resistance of the outside and the inside air films in $(h.ft^2.{}^oF)/Btu$ or $(m^2.{}^oK)/W$. $R_T = (R_o+R_i+R_1+R_2+---------+R_n)$

- R_o is the thermal resistance of the outside air film & R_i is the thermal resistance of the inside air film. These values are given in the table below:

Table (2)		
Thermal resistance for adjacent air layer		
Section	**Interior thermal resistance (R_i)**	**Outside thermal resistance (R_o)**
Wall	**0.121**	**0.059**
Roof	**0.166**	**0.059**

- R_1, R_2, --------- R_n are thermal resistance of materials constituting the wall or roof section.

- **Thermal resistance (R) of a material** is the resistance to heat flow through a unit area of homogeneous material when there is a unit temperature difference between two surfaces and its unit of measurement is (m^2-°C/W).

- Thermal resistance R of a material is calculated by dividing the thickness of the material by the thermal conductivity of the material (t/k) or by multiplying the thickness of the material by the thermal resistivity of the material.

- **Thermal conductivity (k)** is the property of the material, which determines the heat flow by conduction through unit thickness of unit area of the material across a unit temperature gradient. Thermal conductivity is influenced by the density, the porosity, water contents, and specific heat of the material. The unit of measurement is (W/m-^{o}C).

- **Thermal Resistivity (r):** The reciprocal of the thermal conductivity (1/k) is the thermal resistivity of the material. It is the resistance to heat flow through unit thickness when there is a unit temperature difference between the two surfaces. The unit of measurement is m-^{o}C/W.

- **Cavity Thermal Resistance (R_c):** It is the resistance of air in the cavity space to heat flow. It depends on the thickness of the cavity & the characteristics of the two surfaces enclosing the cavity. Following values could be used for thermal resistance of cavity:
  - For a cavity which is more than 5 mm thick (up to 20 mm) (R_C) = 0.11 m^2-°C/W
  - For a cavity which is more than 20 mm thick (R_C) = 0.18 m^2-°C/W

6.2 Thermal Insulation Design for Walls & Roofs:

- The designs for walls and roofs should be in accordance with the requirements of the thermal insulation regulations shown in Table 1, U-values should be calculated using the thermal insulation forms shown in Annex A. The forms must be signed by the owner of the project and the incharge engineer with the stamp and signature of the engineering office.

- The thermal resistivity or thermal conductivity values listed in Table (4) below may be used for calculating the thermal resistance.

- For materials not included in the above table, use thermal resistivity or thermal conductivity values given by the manufacturers supported by test certificate from a testing laboratory and submit such supporting documents with the TII Form.

6.3 Thermal Insulation Design for Widows & Doors:

- The selection of glass shall be according to the requirements listed in Table(2). The heat gain resulting from solar radiation in glazed surfaces is considered very high compared to other surfaces. Therefore, it is always recommended to limit the use of glass and avoid large glass facades, especially those exposed to direct solar radiation such as the west and south-west.

7. Insulation Materials & Systems:

7.1 Wall Insulation:

Material/System	Merits	Demerits
a. **Thermal Insulation Blocks / Panels** Consist of: • Cement block/panel thermally insulated by pieces of polystyrene boards. • Lightweight block/panel (AAC)	• Light weight: saves costs in foundation, building structure, labour etc. • Easy to handle and time saving in construction. • Easy to inspect.	• Separate insulation required for exposed external columns & beams.
b. Cavity wall (double wall) filled with insulation: If the external wall is of double wall construction, thermal insulation can be provided in the cavity with insulating material such as rock wool, polystyrene etc. of appropriate thickness. The cavity should be water proof.	More protection/life time to the thermal insulation materials	• Expensive. • Separate insulation required for exposed external columns & beams.
c. External Thermal Insulation Composite System: This system consists of fixing light thermal insulation board, (usually expanded polystyrene board using a special mortar on the external surface of walls), covering it with a reinforced glass fiber mesh and then finishing it with a thin layer of weather resistant plaster.	Provides joint less thermal protection for the entire external wall including external columns/beams eliminating thermal-bridges.	• Expensive.
d. **Walls with internal insulation**: This system consists of fixing light thermal insulation board (usually expanded or extruded polystyrene board) on the internal surface of the wall and covering it with plaster or gypsum board.	Provides joint less thermal protection for the entire external wall including external columns/beams eliminating thermal-bridges.	Size of the rooms on the periphery of the building will be reduced to the extent of thickness of insulation board & plaster board.

7.2 Roof Insulation:

Material/System	Merits	Demerits
a. Polyurethane Foam	These applications also usually perform better since the liquid foam molds itself to all of the surfaces.	Potential health effects that may result from exposures to the chemicals if proper precautions are not taken during the application.
b. Extruded Polystyrene-	The Inverted Roof system protects the waterproofing membrane from extreme thermal stresses, high ultraviolet exposure & mechanical stresses	Inverted Roof System with concrete screed requires provision of vent pipes over the separation layer on insulation boards.

7.3 Floor Slabs over/below Non A/C areas:

Material/System	Merits	Demerits
a. Soffit insulation with Polystyrene (extruded or expanded) covered with gypsum board	Lower cost	combustible & smoke develops.
b. Soffit insulation with Rock wool covered with gypsum board	Non-combustible & excellent fire proofing material.	Expensive

Typical wall & roof construction details (cross sections) for the above insulation systems are given in the Appendix.

8. Common Violations/Omissions Noticed in Thermal Insulation Implementation:

8.1 Procedural violations

Type of violation	Action required from Engineering Office (E.O)
a. Non Submission of Follow up notices (FUN) for walls floor wise during progress of construction	Ensure that Follow up Notice is sent for each floor when intending to start thermal insulation and at least two week in advance before its completion.
b. Non submission of copies of Building Permit (BP) & Address Card with first Follow Up Notice	Submit copies of BP & address card for **entrance of the building once only with first FUN**. No need for address card of flats.
c. Non Submission of TII Modification Form for changes in approved TII Form	E.O. should send a copy of the approved TII form to the client & contractor and advise them not to change thermal insulation materials in walls, roof or glass without obtaining prior approval from EWA. E.O. should submit TII Modification Form & obtain approval before incorporating any changes. Keep a copy of the approved TII Form/TII Modification Form at the site.
d. Completing the building without submission of follow up notices & thermal insulation inspections.	This is a serious violation of the Code of Practice. E.O. should be vigilant and ensure the procedures for FUN are followed strictly.

8.2 Violations in the Conduct of Thermal Insulation

Type of Violations	Action required from Engineering Office (E.O)
Violations in Walls Insulation:	
Violations related to use of Light Weight Blocks	
a. Use of ordinary mortar instead of glue or thin bed mortar for joints.	Ensure that only glue or thin bed mortar supplied by the Manufacturer is used.
b. Use of ordinary (uninsulated) blocks adjacent to window/door openings & columns instead of light weight blocks.	Manufacturer's should be consulted on how to fix the window/door frames to the walls with light weight blocks and follow their instructions instead of using ordinary blocks.
c. Use of Ordinary (uninsulated) blocks for walls of light wells/shafts, external walls in G.F., balconies, walls behind louvers etc.	Walls of light wells/shafts open to sky and all external walls (even if they are in shaded areas like car parks, balconies, behind louvers) should be insulated. E.O. should instruct the contractor accordingly & use of ordinary blocks for the same should not be allowed.
Violations in Roof Insulation:	
Violations related to roof insulation with P.U. Foam	
a. Thickness of P.U. Foam less than the thickness given in the approved Thermal Insulation Implementation (TII) Form	Minimum thickness should not be less than what has been approved in the TII Form. E.O. should check the same before sending FUN for inspection.
b. Density of P.U. Foam is less than what was approved in the TII Form.	Specify the density of P.U. Foam to be the same as in the approved TII Form in the contract for water proofing and ensure its compliance.

c. Covering the P.U. Foam insulation with concrete screed before inspection.	E.O. should send FUN at least two weeks in advance before the completion of roof insulation & ensure that P.U. Foam insulation is not covered with concrete screed before inspection.
Violations related to roof insulation with extruded polystyrene:	
d. Separation layer not provided	Geo-fabric separation layer is required to be provided between extruded polystyrene and stone ballast or concrete screed. E. O. should ensure the same before sending FUN for inspection.
e. Vent pipes not provided over separation layer	If concrete screed is to be provided over the extruded polystyrene, vent pipes @ one per 50 m^2 of roof area should be provided over the Geo-fabric separation layer. E.O. should ensure that vent pipes are in place at the time of inspection. No need for vent pipes if stone ballast or loosely laid paving tiles are used over separation layer.
f. Using expanded polystyrene instead of extruded polystyrene approved for roof insulation.	Expanded polystyrene is not accepted for roof insulation as its water absorption is more compared to extruded polystyrene.
Violations related to glazing:	
a. Glass installed is different from the approved glass (different air space, different type etc.)	Submit Material Approval Form for glass & obtain approval of EWA before change to avoid rejection.
b. Clear glass is used in G.F. instead of insulated glass approved.	Only insulated glass is to be used. Obtain prior approval of EWA for any deviation from the earlier approval.

9 SUMMARY OF THERMAL PROPERTIES OF BUILDING MATERIALS Table (4)

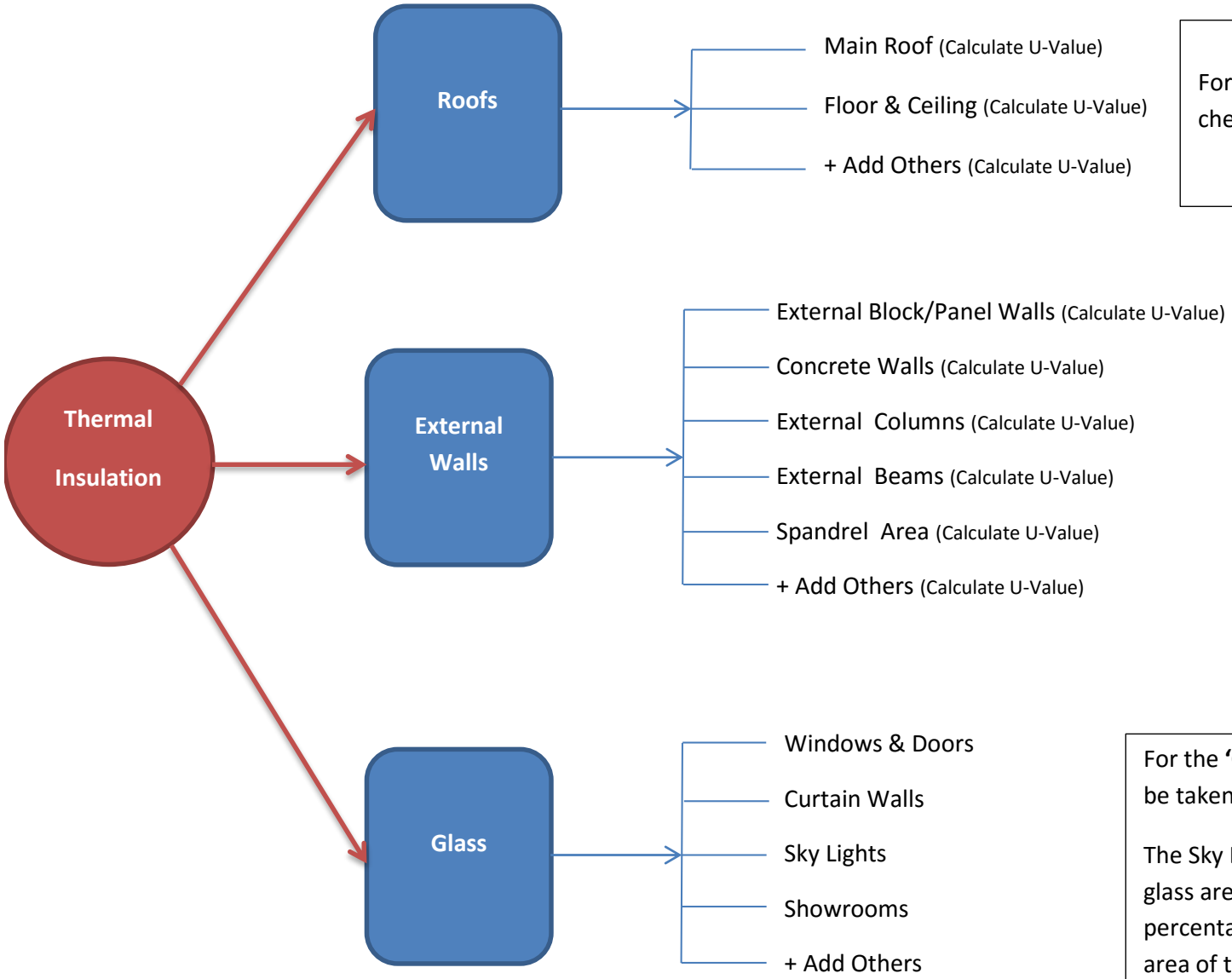
No.	Material	Density	Thermal Resistivity	Thermal Conductivity
		Kg/m^3	$1/k\ (m\text{-}^{O}C/\ W)$	$K\ (W/m\text{-}^{O}C)$
1	CONCRETE / FOAMED CONCRETE / DENSITY 400	400	6.67	0.15
2	CONCRETE / FOAMED CONCRETE / DENSITY 800	800	4.35	0.23
3	CONCRETE / FOAMED CONCRETE / DENSITY 1200	1200	2.63	0.38
4	CONCRETE / REINFORCED CONCRETE (1% STEEL)	2300	0.43	2.3
5	CONCRETE / REINFORCED CONCRETE (2% STEEL)	2500	0.40	2.5
6	CONCRETE SCREED	2200	0.69	1.45
7	BLOCK / SOLID CONCRETE BLOCK	2100	0.75	1.34
8	BLOCK / HOLLOW CORE CONCRETE BLOCK – 100MM	1500	1.66	0.602
9	BLOCK / HOLLOW CORE CONCRETE BLOCK – 150MM	1390	1.29	0.778
10	BLOCK / HOLLOW CORE CONCRETE BLOCK – 200MM	1350	1.13	0.885
11	SLAB / HOLLOWCORE SLAB (150mm)	1350	0.80	1.25
12	SLAB / HOLLOWCORE SLAB (200mm)	1350	0.75	1.33
13	SLAB / HOLLOWCORE SLAB (265mm)	1350	0.63	1.59
14	SLAB / HOLLOWCORE SLAB (320mm)	1350	0.58	1.72
15	SLAB / HOLLOWCORE SLAB (400mm)	1350	0.53	1.90
16	SLAB / HOLLOWCORE SLAB (500mm)	1350	0.45	2.22
17	MORTAR	1800	1.33	0.75
18	PLASTER / RENDERING	1300	1.75	0.57
19	PLASTER BOARD	900	4.00	0.25
20	GYPSUM BOARD	950	6.25	0.16
21	GRANITE	3650	0.38	2.65
22	TILES (CERAMIC)	2300	0.77	1.3
23	MARBLE	2720	0.40	2.5
24	SOFT WOOD	500	7.14	0.14
25	PLYWOOD	650	7.14	0.14
26	HARD WOOD	650	6.25	0.16

10 Automated BP Approval:

The Electricity & Water Authority has collaborated with the Information & eGovernment Authority of Kingdom of Bahrain to launch an electronic portal to automate the approval and granting of building permits through the internet.
The electronic service is designed to make the process of application and approval seamless and the building permit is granted immediately. All necessary databases of building materials are uploaded in the system and are kept up-to-date to streamline the process and replace the manual steps to process BP described earlier. The process may be summarized as follows:

1. Engineering office / user use the browser to log in the system using his / her assigned user id and password.
2. Navigate to the Thermal Insulation Section.
3. Commence the application process by selecting each part of the project individually: Roofs, Walls, and glazing.
4. Selects the materials to be used in each part selected in point 3 above.
5. The user specifies the necessary parameters of his design such as desired areas, orientations, etc.
6. U values, as well as other technical parameters, such as shading coefficients, etc. are calculated automatically. All other conditions relevant to thermal insulation are validated as well.

Once the process has been validated, BP is granted immediately without the need to upload or submit any T.I related attachment. The whole process is depicted briefly through the following layout.



For the **'Roofs'** category, the U-Value should be checked individually by the system for each item.

For the **'External Walls'** category, the Overall U-Value for all items should be checked by the system.

Overall U-Value =SUM(A_1*U_1+ A_2*U_2+ ……+ A_N*U_N)/SUM (A_1 + A_2 +…..+A_N)

Where A=Area in m^2

U=U-Value for each item

For the **'Glass'** category, the glass specifications should be taken from the attached list (Attachment G-1).

The Sky Light Area should not be added to the total glass area (m2), which will be used to calculate the percentage of the glass related to the total wall surface area of the building.