



STUDY GUIDE

REGISTERED ROOF CONSULTANT EXAM

Prepared By

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RRC® STUDY GUIDE

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STUDY GUIDE
RRC[®] EXAMINATION
RCI, Inc.
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INTRODUCTION

One early goal of RCI was to develop a nationally recognized registration program. The Registered Roof Consultant (RRC) Program has been in existence since 1987, has gained recognition by many organizations, and has been established as a minimum standard of practice by some. RCI is working toward national recognition of its registration program and hopes to achieve this goal in the future. The primary beneficiaries of this program are the public, the roofing industry, and those individuals who become registered.

Registration is a two-part program based on verifiable minimum levels of education, ethics, experience, and satisfactory performance on a comprehensive written examination.

The application for registration allows RCI to verify certain aspects of education and roofing experience. The written examination confirms these qualifications by testing one's knowledge of roofing and the ability to use this knowledge in practical applications.

This study guide outlines subjects that are addressed in the written examination; however, it is not intended to be an inclusive listing of every topic addressed on the test. This document is strictly a guide. References used in the development of this exam are provided.

Please understand that the examination is not tailored to any one particular area of roof consulting or to the design and construction practices unique to any geographic area. It deals with roof consulting in general as indicated by the references listed on the next page. It may include all phases of roof consulting (evaluation, design, testing and construction), both steep- and low-slope roofing, and all systems (e.g., shingle, tile, slate, built-up, single-ply, metal and spray applied systems).

In order to receive a passing score on the examination, you must be thoroughly familiar with a broad spectrum of principles related to roof system design, testing and construction. This spectrum of knowledge includes roof system design parameters, specification development, project management, project administration, life cycle costing, roof assets management, conflict resolution, contracts and contract documents, construction materials, non-destructive testing, and report preparation. Education and experience in these areas are extremely important. However, practical application under the guidance of a qualified mentor may be even more important because it reinforces formal education and training and provides a sound foundation over a broad spectrum. It pulls everything together. The weakness most often identified with exam failure is a narrow focus in the industry.

The Registered Roof Consultant examination is offered several times each year. The dates and locations can be obtained from RCI or from the RCI website (rci-online.org).

The examination is 6 hours in length and will be delivered in two parts, each 3 hours long.

Each part of the examination carries equal weight and a passing score must be attained for the total exam. If a passing score is not achieved, the entire exam must be retaken.

Part 1 of the examination consists of one hundred and nine multiple choice questions and will involve questions on the following topics: ethics, roof condition surveys, audits or investigations, communication, testing, codes and standards, materials, construction documents, bid phase and construction phase. Part 2 includes fifty six design questions. Some problems may involve mathematical computations which require familiarity with basic algebra, geometry and trigonometry. Charts or tables needed for the solution of problems will be provided in the examination booklet.

Although not required, the following RCI education programs may be useful for anyone pursuing this designation: Roof Technology and Science I and II, Professional Roof Consulting, Advanced Thermal & Moisture, and Wind & Drainage.

Questions for the RRC Exam have been prepared based on the following documents:

	<u>Title</u>	<u>Author</u>	<u>Pub. Date</u>
1.	Annual Book of ASTM Standards, Vol. 04.04 Roofing & Waterproofing	ASTM	2009
2.	ASCE-7	ASCE-07	2006
3.	ASHRAE 90.1	ASHRAE	2007
4.	Canadian Roofing Contractors Assoc. Manual	CRCA	1997
5.	cedarbureau.org (Cedar Shake & Shingle Bureau)	CSSB	Nov 2004
6.	Concrete and Clay Roof Tile Design Criteria Installation Manual for Moderate Climate Regions	RTI/WSRCA	Jan 2002
7.	Construction Specification Canada (CSC)	CSC	accessed in 2008
8.	CSI Manual of Practice (Project Resource Manual)	CSI	2005
9.	Factory Mutual Research Corporation (FMRC), Approval Guide & Roof Coverings	FMRC	2005
10.	FM Global (FMLPD) Loss Prevention Data Sheets 1-28, 1-29, 1-52 (2007); 1-28R, 1-29R (1998); 1-49 (2000)	FMLPD	Various
11.	IECC		2006
12.	Industry Knowledge/Experience		
13.	International Building Code (IBC)	IBC	2003
14.	Manual of Low-slope Roof Systems, 4th Edition	Fricklas & Griffin	2006
15.	Math Calculations		
16.	Metal Roofing Design Guide	MBMA	2000

17.	National Building Code of Canada	NBCC	2005
18.	NRCA Architectural Metal Roofing Manual	NRCA	2006
19.	NRCA Commercial Low Slope Materials Roofing Guide (2 Vols.)	NRCA	Feb 2001-2002
20.	NRCA Green Roofing Manual	NRCA	2007
21.	NRCA Metal Panel and SPF Roof Systems	NRCA	2008
22.	NRCA Perimeter Details (tested in accordance with ANSI/SPRI ES-1)	NRCA	accessed in 2008
23.	NRCA Roofing and Waterproofing Manual, Fifth Edition	NRCA	2001
24.	RCI Advanced Thermal and Moisture Manual	RCI	accessed in 2008
25.	RCI Code of Ethics	RCI	Mar 28, 2006
26.	RCI Manual of Practice	RCI	2010
27.	RCI Professional Roof Consulting Manual	RCI	2007
28.	RCI Roof Technology and Science I and II	RCI	2006
29.	RCI Rooftop Quality Assurance Manual	RCI	2006
30.	RCI Wind and Drainage Manual	RCI	accessed in 2008
31.	Residential Asphalt Roofing Manual	ARMA	1989
32.	Revere Copper and Common Sense	Revere Copper Products	
33.	Roof Drainage	RCIF	2005
34.	SMACNA Architectural Sheet Metal Manual, Sixth Edition	SMACNA	2003
35.	SPRI - Flexible Membrane Roofing: A Professional's Guide to Specifications, Seventh Edition	SPRI	2003
36.	SPRI.org	SPRI	accessed in 2008
37.	The Slate Book	Stearns/Stearns & Meyer	1998
38.	Underwriters Laboratory (UL), Roofing Materials and Systems Annual Directory	UL	2005
39.	Wind Pressures on Low Slope Roofs	RCIF	2005

As part of the exam revision process, the committee of subject matter experts systematically compiled a list of objectives that relate to the responsibilities, knowledge, and skills associated with acceptable performance within the roof consulting profession. This list provided the organizational framework for the exam and is attached below. The percentage of questions on the exam from each section is indicated.

Sections	Section/Objective Title	Percentage of questions from section on exam
Section 1	Ethics	1.8
Objective 1.1	Given a scenario, demonstrate knowledge of ethical conduct.	
Section 2	Roof Condition Surveys, Audits, or Investigations	14.5
Objective 2.1	Demonstrate knowledge of life cycle cost analysis	
Objective 2.2	Demonstrate ability to evaluate existing roof assemblies and related conditions	
Objective 2.3	Given a scenario, determine the potential risks related to existing design or construction	
Objective 2.4	Given a scenario, demonstrate knowledge of failure mechanisms of various roof systems and components	
Objective 2.5	Describe suitability of existing roof assembly	
Objective 2.6	Describe how environmental conditions deteriorate roofing materials	
Section 3	Communication	5.5
Objective 3.1	Given a scenario, demonstrate knowledge of roles and responsibilities	
Objective 3.2	Demonstrate the ability to prepare written communications	
Objective 3.3	Given a scenario, describe how to interact professionally with the client and other members of the project team	
Section 4	Testing	7.3
Objective 4.1	Describe proper sampling techniques	
Objective 4.2	Describe investigative procedures to analyze a roof assembly	
Objective 4.3	Demonstrate knowledge of industry standard test procedures	
Objective 4.4	Given a scenario, accurately interpret test data including anomalies	
Section 5	Design	34
Objective 5.1	Demonstrate knowledge of roofing systems and assemblies	
Objective 5.2	Given a scenario, demonstrate knowledge of thermal calculations	
Objective 5.3	Describe roof assembly design considerations	
Objective 5.4	Given a scenario, demonstrate knowledge of ventilation calculations	
Objective 5.5	Given a scenario, demonstrate the ability to perform wind uplift calculations	

Objective 5.6	Given a scenario, determine drainage requirements	
Objective 5.7	Describe how to prepare construction drawings	
Objective 5.8	Demonstrate knowledge of air barriers/vapor retarders	
Section 6	Codes and Standards	4.8
Objective 6.1	Identify building codes, industry standards and manufacturers' requirements	
Section 7	Materials	14.5
Objective 7.1	Identify fundamental properties of various material components	
Objective 7.2	Demonstrate knowledge of material interactions	
Section 8	Construction Documents	7.3
Objective 8.1	Demonstrate knowledge of contract documents	
Objective 8.2	Describe information to request from the client	
Section 9	Bid Phase	2.4
Objective 9.1	Demonstrate knowledge of bidding procedures	
Section 10	Construction Phase	7.9
Objective 10.1	Demonstrate knowledge of construction administration	
Objective 10.2	Demonstrate knowledge of roof top quality assurance procedures	
Objective 10.3	Demonstrate knowledge of post construction procedures	

SAMPLE QUESTIONS

Sample questions are provided from each section of the exam and are indicative of the types of questions you will encounter. Answers have been provided at the end of the study guide.

Ethics

1. You send a box of golf balls to the director of construction of an organization that outsources roof consulting services.

According to the RCI Code of Ethics, under which two of these circumstances would this be unethical? (Choose two.)

- A. if you paid for the outing with personal funds
- B. if your spouse worked for the same company as the director of construction
- C. if the recipient worked for a public entity and such gifts were prohibited by law
- D. if you were attempting to influence that person's judgment in connection with an existing or prospective project for which your firm was seeking an assignment

Roof Condition Surveys, Audits, or Investigations

2. The reflectivity of the roof surfacing is important to the life-cycle cost of the roof assembly.

Which surfacing has the highest initial reflectivity?

- A. white coatings
 - B. asphalt emulsion
 - C. aluminum coating
 - D. white mineral granules
3. Which two deficiencies should a consultant inspect for on a gravel built-up roof membrane system? (Choose two.)
- A. holes
 - B. pipes
 - C. wind scour
 - D. surface crazing

4. While investigating a roof, you observe large icicles forming at the eave of a sloped shingled roof system. The roof is covered with a large quantity of snow.

Which two should you do immediately? (Choose two.)

- A. Check the conditions in the attic space.
 - B. Check to determine adhesion between shingles.
 - C. Assess the surface condition of the shingles on all sides of the building.
 - D. Advise the owner to have traffic areas directly below the icicles barricaded and have the icicles removed.
5. According to the *Manual of Low-Slope Roof Systems, 4th Edition*, what is the most reliable method for judging roof component reliability?

- A. controlled laboratory tests
- B. roof consultant advisory panels
- C. long term field service performance
- D. interpolation of material performance in other applications

6. One of the challenges of completing a corporate roof review is describing the suitability of the existing roof assembly. The RRC is conducting a roof survey of a metal standing seam hydrokinetic roof system. It is a light gauge metal with a high gloss finish with no stiffening ribs in the pan.

Which statement should be included in the report?

- A. The contractor should have made certain that the rolling mill was well-tuned during installation.
 - B. Oil canning is a frequent phenomenon; there are inherent risks as the oil canning could result in a leak.
 - C. The metal pans should have been greater in width, heavier in gauge, finished with a flat texture with stiffening ribs.
 - D. Oil canning is likely due to the gauge, finish and profile of the panel's pan. The client should be aware of the visual effects which can be exacerbated by varying light conditions.
7. You are asked to investigate a situation where the roof membrane has pulled away from the parapet walls. The building is located in Boston, MA. The roof consists of a stone-ballasted EPDM membrane, foam plastic insulation, and a steel roof deck.

What is the likely cause?

- A. Shrinkage of the EPDM membrane has occurred due to loss of processing oils.
- B. The adhesive used to glue the EPDM base flashings to the parapet walls has failed.
- C. A hydrocarbon based solvent has attacked the exposed material, while the roofing under the stone ballast was protected.
- D. Contamination from a local airport has penetrated the exposed EPDM membrane flashings and caused swelling of the EPDM.

Communication

8. A reroof project has been undertaken using the *RCI Manual of Practice* documents under which the owner has roles and responsibilities.

Which statement describes the owner?

- A. The owner is the prime consultant's design team lead.
 - B. The owner is the person(s) who has title of the building.
 - C. The owner is the person(s) who is responsible for certifying payment for the work.
 - D. The owner is the entity with whom the contractor has entered into a contractual agreement.
9. According to RCI's *Rooftop Quality Assurance Manual*, daily reports should address which two items? (Choose two.)
- A. visitors
 - B. weather conditions
 - C. equipment requirements
 - D. payment request reviews
10. The owner has requested the services of an RRO to observe and report on the progress of a new roof installation.

According to the *RCI Rooftop Quality Assurance Manual*, when should the reports be distributed to the general contractor, roof contractor, consultant, and owner?

- A. 3 days
- B. 7 days
- C. same day
- D. with close out documents

Testing

11. You are using the ASTM D 3617 – 07, "Standard Practice for Sampling and Analysis of Built-Up Roof System during Application" on a project.

Unless otherwise specified, how many samples should be taken?

- A. Take at least one specimen for each separate roof.
- B. Take at least one specimen for each separate roof, plus one for each 4,300 sq. ft. (400 sq. m).
- C. Take at least one specimen for each separate roof, plus one for each 10,000 sq. ft. (929 sq. m).
- D. Take at least one specimen for each separate roof, plus two for each 10,000 sq. ft. (929 sq. m).

12. You are asked to investigate roof leaks at the lower roof area of a large supermarket in Los Angeles covered by an exposed PVC membrane. A roofer has already been on site to perform repairs and reported that 115 individual patches were applied to the membrane all over the lower roof surface. However, the building staff had only reported leakage near the junction with the higher roof.

When investigating the leaks, which initial course of action is appropriate?

- A. Have the roofer cut open some patches to demonstrate the types of faults the roofer found. Then perform a flood test on the upper roof to confirm that the leaks are eliminated.
 - B. Perform a detailed visual review of the membrane and have the roofer patch any further defects found. Then wait for the next rain to determine the success of the repairs.
 - C. Conduct a roof moisture survey, core cuts, and a visual survey at the lower roof area, and compare the results with the patch locations. Inspect the details at the high/low roof junction.
 - D. Perform a flood test on the lower roof to a depth of 6 inches (150 mm) to confirm that the leaks are eliminated, and then use electronic field vector mapping to locate and repair any remaining faults.
13. The UL 1256 "Fire Test of Roof Deck Constructions" measures which fire performance characteristic of the roof assembly?
- A. fire penetration and structural integrity
 - B. flame spread below the roof deck within defined time limits
 - C. fire spread on the top surface of the roof assembly under high wind conditions
 - D. flame spread on the top surface of the roof assembly within defined time limits

14. You have taken a test cut of an existing BUR where a blister has formed. The asphalt in the blister is on the lower ply and has a cratered surface.

What could be the cause for this condition?

- A. Water was present during application.
- B. There is a depression in the substrate.
- C. The asphalt was cold during application.
- D. The insulation cover board was wood fiber.

Design

15. Specific to the application of sprayed in place polyurethane foam roofing, what is the minimum dry-film thickness (DFT) range for the entire coating system?
- A. 0.008" to 0.015" (0.20 mm to 0.38 mm)
 - B. 0.010" to 0.018" (0.25 mm to 0.46 mm)
 - C. 0.010" to 0.020" (0.25 mm to 0.51mm)
 - D. 0.020" to 0.040" (0.51 mm to 1.02 mm)

16. Refer to Exhibit #1.

A conventional roof assembly includes a vapor retarder/temporary roof installed over insulation and a steel deck. You are provided with:

The sum of the R values ($\sum R_{vr}$) below the underside of the vapor retarder

The Inside Design Temperature (T_i)

The Outside Design Temperature (T_o)

The Design Dew Point temperature (which you are to assume is the temperature at the underside of the vapor retarder/temporary roof)

Assume that the temperature at the underside of the vapor retarder is equal to the Design Dew Point temperature.

Irrespective of building code requirements and based on the formula provided in the exhibit, which formula will accurately determine the total needed for the entire assembly ($\sum R_m$) to prevent condensation underneath the vapor during the winter?

- A. $\sum R_m = - [(\sum R_{vr}) \times (T_i - T_o)] \div (T_{vr} - T_i)$
- B. $\sum R_m = - [(\sum R_{vr}) \div [(T_i - T_o) \div (T_{vr} - T_i)]]$
- C. $\sum R_m = [(\sum R_{vr}) \div [(T_{vr} - T_o) \times (T_i - T_o)]]$
- D. $\sum R_m = [(\sum R_{vr}) \div [(T_{vr} - T_o) \div (T_i - T_o)]]$

17. According to the NRCA/CRCA, a properly installed base flashing for a BUR should be installed to what minimum height above the finished roof surface?

- A. 6 inches (152 mm)
- B. 8 inches (200 mm)
- C. 10 inches (254 mm)
- D. 12 inches (610 mm)

18. Refer to Exhibit #2.

A roof replacement project is being designed for a rectangular agricultural building ($I = 0.87$) with numerous window and door openings (partially enclosed). The roof has an eave height of 70 feet (21 m) and the location is a relatively open terrain of a rural area with a basic wind speed of 90 mph (145 kph). Assume wind directionality factor of 1.0.

According to the RCIF *Wind Pressures on Low Slope Roofs*, and based on the velocity pressure equation, as shown in the exhibit, what is the design pressure in the field of the roof?

- A. -32.72
- B. -39.75
- C. -41.16
- D. -47.31

19. Refer to Exhibit #3.

You have been asked to size a gutter for a contractor who only has 24 gauge galvanized steel available.

Referring to the exhibit, what is the maximum width of unformed metal stock that can be used to form a rectangular gutter based on the table given?

- A. 15 inches (380 mm)
- B. 20 inches (510 mm)
- C. 25 inches (640 mm)
- D. 35 inches (890 mm)

20. Which type of drawing is used to convey the design intent for a vent stack in a built-up roof construction?

- A. detail
- B. section
- C. diagram
- D. perspective

21. Which statement is correct about vapor retarders?

- A. Vapor retarders are most effective when placed at the warm side of the assembly.
- B. Vapor retarders are primarily intended to reduce the rate of air flow through a roof assembly.
- C. A typical pattern of roof fasteners that puncture a vapor retarder can reduce its effectiveness by over 40%.
- D. Sealing of laps in a vapor retarder helps reduce vapor transmission only when there is a separate air barrier present.

Codes and Standards

22. You are designing a roof replacement on a Factory Mutual Global insured building.

Which FM Global Loss Prevention Data Sheet should you consult for perimeter metal flashing attachments?

- A. FM 1-18
- B. FM 1-49
- C. FM 1-54
- D. FM 1-52

Materials

23. Which two functions does bitumen (asphalt, coal tar, or cold adhesive) serve in built-up roof membrane systems? (Choose two.)
- A. adhesion
 - B. peel strength
 - C. UV protection
 - D. weatherproofing
24. Extruded polystyrene insulation may have chemical incompatibility with which types of roof covering?
- A. thermoset
 - B. thermoplastic
 - C. metal roof panels
 - D. modified bitumen

Construction Documents

25. During discussions between the consultant and the owner, the consultant is to prepare a complete set of construction documents on a reroof project using an architectural-type contract. The documentation is to be quite specific regarding materials, application procedures, and cost.

Which type of contract should be used?

- A. unit price contract
- B. cost-plus fee contract
- C. combined bid contract
- D. stipulated (fixed) sum contract

Construction Phase

26. During a roof replacement project, it is discovered that one layer of 2.5 inch (64 mm) insulation is required on 500 square feet (46.5 square meters) of roof to fill in where the roof decks are at different levels.

If the contractor indicates that there will be no impact on the contract sum and time, which form should be issued?

- A. addendum
- B. change order
- C. change directive
- D. supplemental instruction

27. Which two should be documented in the quality assurance observer's field reports? (Choose two.)
- A. safety
 - B. approval
 - C. deviations
 - D. deficiencies
28. A project is complete and the owner wants to make final acceptance (payment). A lien waiver is required by the contract documents.
- Which statement concerning lien waivers is correct?
- A. A lien waiver is a document from a subcontractor stating that the payment was received from the general contractor.
 - B. A lien waver is a security interest to protect the subcontractor from a general contractor by placing a lien on a property.
 - C. Since the subcontractor does not have a contract with the owner, the subcontractor has the right to lien the project with a lien waiver.
 - D. A lien waiver must be received by the owners project manager within in a statutory period (# of days) from the receipt of the contractor's final invoice.

Exhibit #1.

$$T_{vr} = T_i - [(\sum R_{vr} + \sum R_m) \times (T_i - T_o)]$$

$\sum R_m$ = Minimum sum of the total R of all roof assembly components

$\sum R_{vr}$ = Sum of R values between the warm side of the assembly and underside of the vapor retarder/temporary roof

T_i = Design Temperature inside the building

T_o = Design Temperature outside the building

T_{vr} = Temperature at the underside of the Vapor Retarder/Temporary Roof

Exhibit #2.

Velocity pressure equation

$$q_z = 0.00256(K_z)(K_{zt})(K_d)(V)(V)(I)$$

Wind Uplift pressure equation

$$p = q_h[(GC_p) - (GC_{pi})]$$

Velocity Pressure Coefficient Table

Mean Roof Height ft (m)	A	B	C	D
0-15 (0-4.6)	0.68	0.70	0.85	1.03
20 (6.1)	0.68	0.70	0.90	1.08
25 (7.6)	0.68	0.70	0.94	1.12
30 (9.1)	0.68	0.70	0.98	1.16
40 (12.2)	0.68	0.76	1.04	1.22
50 (15.2)	0.68	0.81	1.09	1.27
60 (18.0)	0.68	0.85	1.13	1.31
70 (21.3)	0.68	0.89	1.17	1.34
80 (24.4)	0.68	0.93	1.21	1.38
90 (27.4)	0.68	0.96	1.24	1.40
100 (30.5)	0.68	0.99	1.26	1.43

External Pressure Coefficient Table

Mean Roof Height \leq 60ft (18.3 m)

field	-1.0
perimeter	-1.8
corner	-2.8

Mean Roof Height $>$ 60ft (18.3 m)

field	-1.4
perimeter	-2.3
corner	-3.2

Internal Pressure Coefficients Table

open buildings	0.00
Partially enclosed buildings	0.55
enclosed buildings	0.18

Exhibit #3.

Girth		Galvanized Steel		Copper		Aluminum		Stainless Steel	
in.	mm	gauge	mm	oz.	mm	in.	mm	gauge	mm
up to 15	up to 380	26	0.5512	16	0.55	0.032	0.812	28	0.396
16-20	410-510	24	0.7010	16	0.55	0.040	1.016	26	0.477
21-25	530-640	22	0.8534	20	0.69	0.051	1.295	24	0.635
26-30	660-760	20	1.006	24	0.82	0.063	1.295	22	0.795
31-35	790-890	18	1.311	24	0.82			20	0.952
Over 35	Over 890	16	1.613					18	1.270

Table 1 -5 Recommended Minimum Gauges For Gutter

NOTE: Girth refers to the width of the unformed metal stock.

SAMPLE QUESTIONS ANSWERS

Note your answers. Review the appropriate document(s) in those areas to better understand the rationale behind the indicated correct answer.

Take advantage of the programs provided by RCI, including courses on the national and regional levels.

1. C and D
2. A
3. A and C
4. A and D
5. C
6. D
7. A
8. D
9. A and B
10. C
11. C
12. C
13. B
14. A
15. D
16. A
17. B
18. C
19. B
20. A
21. A
22. B
23. A and D
24. B
25. D
26. D
27. C and D
28. A