American Council for Accredited Certification

Council-certified Indoor Environmental Consultant (CIEC) and
Council-certified Microbial Consultant (CMC)

Summary of
Job/Task Analyses
Exam Blueprint Reports

Prepared by
Adam B. Andrews, CIEC
Assistant Director
ACAC

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Introduction

The American Council for Accredited Certification (ACAC)

ACAC was founded in 1992 as the Arizona Indoor Air Quality Council to promote awareness and education in Indoor Air Quality through workshops and newsletters. By late 1995, the Council had more than 150 charter members. In 1998, the Council changed its name to the American Indoor Air Quality Council (or "the IAQ Council") and began to grow nationally. By 2002, membership had reached approximately 3000 members, 200 corporate sponsors and had 46 local chapters in 26 states and several international locations.

In 2005, the board of directors decided to narrow the organization's focus and concentrate exclusively on professional certification programs. On January 1, 2006, the Council terminated its membership functions and ceased all membership-related operations. From that date, the Council's activities have been confined exclusively to the development and administration of professional certifications.

In 2008, the Council transferred its assets to a new corporation, the Certification Council, Inc. d/b/a The American Council for Accredited Certification (ACAC). Incorporated in Arizona in June 2008 and granted not-for-profit 501(c)(6) status by the IRS, ACAC now functions as independent certifying body with no allied membership association. ACAC offers no newsletters, conferences, lobbying efforts or any other membership benefits. ACAC does not contract with training course providers, product manufacturers or advertisers. In short, ACAC's staff and volunteers are free to devote their full energies to certification-related activities. These include examination development, item writing, test administration, psychometric analysis and record keeping.

With the exception of a computer-based testing (CBT) provider, ACAC uses no vendors or service providers in its certification work. It relies instead on the administrative talents of its full time staff and the field experience of more than 100 volunteer certification board members who make all certification-related decisions for the organization.

Development of the CIEC and CMC programs

The CIEC and CMC certification programs were created in 2001 according to ACAC's "steering commmittee" procedure. According to this procedure, the Board of Directors voted to expand the scope of ACAC operations to include new certification programs and then appointed a core group of industry peers (the steering committee) with three responsibilities:

1. Decide upon a definitive list of industry stakeholders or interests that the certification boards must reflect.
2. Suggest other certification board members who are independent industry experts and who represent each of the industry stakeholders.
3. Suggest industry texts/resources to serve as the knowledge base for the certification exams.

The board of directors then appointed a certification board for each certification program from among steering committee members and their suggested experts so that a) all stakeholders were represented, but b) no single interest predominated. The CIEC and CMC certification boards was tasked with several responsibilities:

1. Develop eligibility requirements for their certification program.
2. Produce a formal list of reference texts to be used in the examination.
3. Authorize the drafting and validation of Exam Topics documents.
4. Authorize and approve the development of examination items keyed to these exam topics
5. Authorize the assembly of an examination drawn from the reference texts and reflecting the exam topics.
6. Validate examination items for inclusion in the item banks.

By 2011, both the CIEC and CMC certification programs included a list of exam topics and exam references, a large item bank arranged according to these exam topics and references, a certification exam tied to these topics, and a formal list of eligibility requirements validated by the certification board.

Since 2006, the CIEC and CMC certification boards have employed certain psychometric practices in the construction, administration and review of their examinations. As a result, the certification boards had the advantage of existing historical data to aid in their review of existing item banks and test forms. These data included item-level statistics such as difficulty and reliability indices as well as test form-level statistics on internal consistency and content validity.

In an effort to enhance their integrity and credibility, the ACAC board of directors recently authorized the CIEC and CMC certification boards to update and improve their certification programs according to accreditation standards published by the National Comission for Certifying Agencies (NCCA).

The CIEC and CMC boards therefore undertook the following tasks, which are summarized in this report:

- Development and validation of formal Job/Task Analyses
- Development of examination blueprints and tables of specifications

Job/Task Analysis Methodology

The DACUM Method

DACUM is a committee-based approach to job/task analysis that utilizes a panel of 6 to 12 expert workers to develop content domains for the certification examination. The DACUM process is a structured brainstorming session led by an experienced facilitator. During a 1-2 day work session, the facilitator helps panelists co-operatively describe their occupation using industry terminology. Research supporting this approach is available, including a study by O'Brien (1989) that evaluates the reliability of the DACUM research chart, a study by Rayner and Herman (1988) that compares the DACUM technique to the critical incidents and task inventory approaches, and a handbook by the US Department of Energy (1994) that uses DACUM as the basis of its training development programs.[1]

The DACUM approach is based on three premises:

(1) Expert workers can describe their job more precisely and completely than anyone else
(2) Any job can be effectively described in terms of the competencies or tasks mastered by successful workers in that occupation
(3) The specific knowledge, skills and techniques required by workers in order to correctly perform their tasks can also be described

DACUM panelists must be articulate workers who are considered outstanding in their occupation, with highly-developed technical knowledge and skill. A facilitator specifically trained in the DACUM process is essential for valid and usable outcomes. The facilitator must be able to elicit specific task statements, as well as deal with conflicts and debates that inevitably arise as the panel moves toward consensus.

During the DACUM work session the facilitator systematically guides the panel members through brainstorming and consensus-reaching discussions to describe their job in terms of *domains* and *subdomains*. ***Domains*** are the 6 to 12 distinct components of the job, stated in general terms. Together they give a comprehensive picture of the knoweldge and expertise required of the successful practitioner. ***Subdomains*** are the specific activities or areas of knowledge that must be completed or applied in order to master each domain. There are at least 5-10 subdomains per domain in a typical DACUM analysis.

Since domains and subdomains describe the competencies necessary to do the job, it is critical that they be described accurately and precisely, both in themselves and in relation to one another. This is accomplished by "storyboarding." The recorder writes domains and subdomains on large index cards that are taped or pinned to a whiteboard facing the panel. The cards are then replaced, reworded, and rearranged until the panel members agree that the storyboard is an accurate profile of their job.

The result of the 1-2 day DACUM work session is a ***Research Chart*** that shows the domains of knowledge and exptertise involved in the job along with their related subdomains. Domains are arranged sequentially (that is, in the order in which they are performed on the job), in order of importance, or in another logical order as determined by the panel. Subdomains are arranged similarly within each domain.

[1] O'Brien, T.P. (1989). *Reliability and construct validity of a DACUM occupational profile*. Journal of Vocational Education Research, 14, 21-38; Rayner, P., & Hermann, G. (1988). *The relative effectiveness of three occupational analysis methods*. Vocational Aspect of Education, 40, 47-55; US Department of Energy, *DOE Handbook: Tabletop Job Analysis* (1994).

A brief glance at a completed DACUM research chart gives a comprehensive and detailed view of the competencies required by any job.

Validation of a DACUM Job Analysis

Once a DACUM profile is developed and reproduced on paper, it is formally validated by a separate committee formed for this purpose. The validation committee may contain members of the original DACUM committee, but should also include new members as well. All committee members must be high performing, experienced practicitioners in the field.

The function of the validation committee is to review the work of the original DACUM committee and confirm that it fairly represents the scope and content of the job being analyzed. The validation committee examines the DACUM research chart as well as any ranking or weighting data that resulted from the original committee meeting. It is responsible for confirming the following statements:

(1) The DACUM research chart contains a comprehensive and detailed description of the job
(2) The domains and subdomains represented on the chart stand in appropriate relation to one another (either sequentially, in terms of relative importance, or by another rule established by the DACUM committee)
(3) Any ranking or weighting data submitted for validation accurately reflects the relative importance of the domains and subdomains ranked.

If it cannot confirm these statements, the validation committee must make adjustments to the research chart and accompanying documents. These adjustments must be the product of unanimous consensus.

If the original DACUM committee does not provide ranking or weighting data, the validation committee performs a ranking exercise for each listed subdomain.

Using a DACUM Job Analysis in Exam Blueprint Development

DACUM is especially useful in the examination blueprint process because of the straightforward correlation between research chart *domains* and examination content *domains*. During the blueprint process, validated *domains* from the DACUM process become the content *domains* of the examination.

Additionally, data from ranking exercises typically conducted by DACUM or validation committees are easily consolidated into a weighting rubric. First, the committee assigns each subdomain a rank score based on its relevance, criticality, frequency and difficulty. Subdomains are then grouped by domain and their scores are averaged, giving each content area a Domain Rank Score. Domains of the examintion are then weighted in direct proportion to these scores.

Rationale for Using DACUM with the CIEC and CMC Programs

A variety of methods exist for conducting Job/Task Analyses, including surveys of current practitioners, reports based on professional research, job observation by psychometricians and focus group studies. In the case of the CIEC and CMC programs, two characteristics were critical in the choice of a methodology:

(1) Both the CIEC and CMC certifications have narrowly defined, somewhat homogeneous target populations, which can be fairly represented by a small group of expert practitioners of the type normally used in a DACUM procedure.
(2) The purpose of the CIEC and CMC examinations is to test the conceptual knowledge of candidates whose practical field experience has been verified by other means. As a result, content domains on the examination should primarily emphasize bodies of knowledge rather than sets of physical skills or abilities.

In light of these facts, the respective boards determined that the CIEC and CMC programs would be best served by a focus group methodology that allows for the creation of domains based on conceptual knowledge. The DACUM method satisfied these criteria and was therefore chosen.

Job/Task Analysis Study

Composition of the CIEC DACUM committee

Composition of the DACUM committee must reflect the diversity of the population to be certified by the program – end users of the certification. The ACAC board of directors defined the certified population at the inception of the CIEC program in 2001. Their method for arriving at this definition was a discussion as industry and certification experts and the rule of unanimous consensus. The definition of the certified population is as follows:

- CIECs are both men and women
- All CIECs are involved in IAQ/IEQ consulting
- All CIECs are either principals or non-principal employees
- All CIECs have field experience of 8-15 years, 16-23 years or more than 23 years
- CIECs work in all four regions of the US: Northeast, South, Midwest and West

The board of directors reviewed this definition in preparation for the Job/Task Analysis and decided that it still adequately describes the CIEC target population. No modifications to the definition were suggested. The board then invited subject matter experts from each of these categories to join the DACUM committee.

Committee members submitted credentials, including field experience, to ACAC in writing. These credentials were formally verified by ACAC staff and are a matter of record in ACAC files.

Composition of the CMC DACUM committee

As with the CIEC, composition of the CMC DACUM committee must reflect the diversity of the population to be certified by the program – end users of the certification. The ACAC board of directors defined the certified population at the inception of the CMC program in 2001. Their method for arriving at this definition was a discussion as industry and certification experts and the rule of unanimous consensus. The definition of the certified population is as follows:

- CMCs are both men and women

- All CMCs are involved in consulting on microbial issues in the built environment
- All CMCs are either principals or non-principal employees
- All CMCs have field experience of 8-15 years, 16-23 years or more than 23 years
- CMCs work in all four regions of the US: Northeast, South, Midwest and West

The board of directors reviewed this definition in preparation for the Job/Task Analysis and decided that it still adequately describes the CMC target population. No modifications to the definition were suggested. The board then invited subject matter experts from each of these categories to join the CMC DACUM committee.

Committee members submitted credentials, including field experience, to ACAC in writing. These credentials were formally verified by ACAC staff and are a matter of record in ACAC files.

DACUM Process: Identifying Content Domains

The two DACUM committees met in separate rooms to begin their work. First they reviewed the examination content areas as documented for the existing CIEC and CMC programs. These were contained in Exam Topics documentation and Exam Reference Text documentation for each exam developed by the original CIEC and CMC steering committees (the steering committee process is briefly described on p. 4 above.)

Each committee then modified existing content areas in discussion with the guidance of a DACUM facilitator and placed them on a draft research chart as *Domains*. Additionally, the committee used DACUM's group brainstorming technique to suggest new domains as necessary. Next, the committees divided each domain into associated subdomains of knowledge– that is, specific activities or concepts necessary to the mastery of each domain.

Proposed domains and their associated subdomains were placed on cards and taped to a whiteboard. The cards were then rearranged, edited or replaced as necessary until the entire committee was satisfied that the domains and subdomains as arranged accurately represented the expertise of the successful indoor environmental consultant.

Conclusions reached by the DACUM committees were formalized on a DACUM research chart for each certification. Once the content of each research chart was formalized, the *domains* of the research chart became the *domains* used for ranking, weighting and exam blueprint development.

Ranking Subdomains

Using a modified nominal group ranking technique[2], the CIEC and CMC committees then decided on the relative importance of the identified subdomains to successful practice in their respective fields. Relevance, Criticality, Frequence and Difficulty scores for each subdomain were averaged across the each committee. These averages were then added together to form an aggregate rank score for each

[2] For an explanation of the nominal group technique, see Delbecq A. L. and VandeVen A. H, (1971). "A Group Process Model for Problem Identification and Program Planning," Journal Of Applied Behavioral Science VII (July/August, 1971), 466 -91; Vedros K. R., (1979). "The Nominal Group Technique is a Participatory, Planning Method In Adult Education", Ph.D. dissertation, Florida State University, Tallahassee.

subdomain. The aggregate rank scores of subdomains within each domain were then averaged to determine a Domain Rank Score for each domain on the CIEC and CMC research charts.

Weighting Content Domains

Content domains were weighted by the CIEC and CMC certification boards in direct proportion to their Domain Rank Scores – that is, Domain Rank Scores were converted to percentages according to the tables below, and these percentages were used as weights for the two 120-item examinations:

Table 1
Weighting of CIEC Content Domains

Domain	Domain Rank Score	% of sum	Domain Weight
1. IAQ Contaminants and Health Effects	9.40	17.41	20
2. Principles of the Built Environment	8.94	16.56	20
3. HVAC	9.12	16.89	20
4. Equipment	9.97	18.46	22
5. Guidelines, Regulations and Standards	8.08	14.97	18
5. Remediation	8.48	15.71	20
Sum	53.99	100.00	120

Table 2
Weighting of CMC Content Domains

Domain	Domain Rank Score	% of sum	Domain Weight
1. Biological Agents	10.16	21.67	26
2. Health Effects	7.14	15.23	18
3. Microbial Investigations	9.77	20.83	25
4. Microbial Sampling	9.62	20.51	25
5. Mitigation & Remediation	10.30	21.98	26
Sum	46.88	100.00	120

Cognitive Categories

DACUM facilitators next asked the CIEC and CMC committees to characterize the types of knowledge or experience required to participate successfully in their respective fields. The committees were presented with the following list of examination item types:

1. ***Knowledge*** – items that require the candidate to recall memorized facts such as standards, regulations, scientific data and mathematical formulae
2. ***Comprehension*** – items that require the candidate to understand processes, materials and equipment and their interactions in the built environment
3. ***Application*** – items that require the candidate to identify proper techniques, procedures and decision-making processes involved in IEQ consulting

Facilitators explained that the CIEC and CMC programs are constructed to verify field experience primarily through board review of project sheets, and that the main purpose of the written examinations is verification of industry knowledge. Committee members were then asked to state what percentage of their examination items should come from each cognitive category. Answers were averaged across each committee for each item type, with the following result:

Certification Exam	Knowledge	Comprehension	Application	Total

CIEC	45%	41%	14%	100%
CMC	46%	39%	15%	100%

This table, along with a DACUM research chart and a table of domain/task ranks and weights, was preserved for each certification program and forwarded to the appropriate validation committee.

Job/Task Analysis Validation

Results of the Job/Task Analysis were validated by a committee formed for that purpose.

Composition of the CIEC Validation Committee

As with the original DACUM committee, membership on the CIEC validation committee reflected the target CIEC population as defined by the board of directors. Several members of the original DACUM committee also participated on the validation committee, which is consistent with the DACUM process.

Composition of the CMC Validation Committee

As with the CIEC committee, membership on the CMC validation committee reflected the target CMC population as defined by the board of directors.

Validation Process

The validation study is essentially a repeat performance of the ranking/weighting exercise performed by the initial DACUM committee, with the additional option of suggesting new domains and/or subdomains and modifying existing ones.

Meeting separately as they had in the original DACUM sessions, CIEC and CMC committee members were first asked to review their DACUM research chart and confirm that it represented a comprehensive and detailed description of profession being certified. The committees discussed the following items:

- Suggestions for changes to the order or wording of existing domains and subdomains
- Suggestions for deletion of existing domains or subdomains from the research chart
- Suggestions for addition of new domains and subdomains to the research chart

No changes were made to the existing research chart except by unanimous consensus of the validation committee.

Committee members were then asked to review the aggeregate rank scores of the subdomains on the original DACUM research chart and confirm that they fairly represented the relative importance of the knowledge areas wtihin each domain. The committees then discussed proposed adjustments to the rank scores and made adjustments by unanimous consensus only.

Finally, committee members reviewed the proposed distribution of exam items among the cognitive categories of knowledge, comprehension and application. As in the previous exercises, the CIEC and CMC committees made adjustments by unanimous consensus only.

Outcome of Validation Study

Appendix A contains the validated DACUM research charts for the CIEC and CMC programs, listing the domains and subdomains involved in the practice of indoor environmental consulting and microbial consulting, respectively.

Examination Specification Development

Once the CIEC and CMC Job/Task Analyses were formally validated according to the DACUM method, the two certification boards developed specifications for the CIEC and CMC examinations.

Since both CIEC and CMC examinations already existed, this process involved reviewing and validating existing elements of the specification in addition to authorizing changes and creating new specifications.

CIEC Test Description:

The CIEC board determined that the following elements of the existing CIEC examination, which were established by the original CIEC certification board in 2001, still adequately serve the purposes of the certification program:

1. *Purpose of the exam*

   To identify persons with acceptable knowledge of indoor environmental investigation and consulting, and to qualify them for board certification as Council-certified Indoor Environmental Consultants.

2. *Intended candidate population*

   Individuals with at least eight (8) years verifiable experience in indoor environmental consulting whose experience comes from at least three of the following areas: Lead/Asbestos, Microbial, IH/Chemicals/Toxicology, Building Sciences, and General IEQ/HVAC.

3. *Test length, exam item type and administration time limit*

   120 dichotomous multiple choice questions in 180 minutes.

   Test length for the CIEC exam was set by the original CIEC board in 2001. The 2011 board examined KR-20 reliability indices collected for the exam since 2001 in order to validate this decision. The committee concluded that 120 items allotted to 6 content domains according to a weighted blueprint made for a test of sufficient length. Research supporting this approach which links optimum examination length with test form reliability includes Feldt & Brennan (1989), R.F.Burton (2004) and Burton (2006) .[3]

[3] Feldt, L. S. & Brennan, R. L. (1989). *Reliability*, in: R. L. Linn (Ed.) *Educational measurement*(3rd edn) (New York, Macmillan), 105–146; Burton, R. F. (2004a) *Multiple choice and true/false tests: reliability measures and some implicationsof negative marking, Assessment & Evaluation* in *Higher Education*, 29(5), 585–595; and Richard F. Burton (2006): Sampling knowledge and understanding: how long should a test be?, in *Assessment & Evaluation in Higher Education*, 31:5, 569-582.

Similarly, the original CIEC board had specified in 2001 that the exam contain only dichotomous multiple choice (type-A) items. This decision was reviewed in 2011 and unanimously confirmed. This item type demonstrates a high correlation with accurate measurement of special knowledge and allows a large content domain to be efficiently tested in a defined period of time. Though multiple choice testing has faced criticism, its chief disadvantages stem from its weakness in testing strategic thinking, judgment and experience. Since the CIEC exam is designed primarily to test the factual knowledge of professionals whose field experience will be verified by other means, these weaknesses were of little concern to the board. In fact, dichotomous multiple choice items were unanimously chosen as the most appropriate in this case.

The original CIEC board used research suggesting 90 seconds per multiple choice item as a benchmark for high-school level tests featuring complex multiple choice items.[4] A 180-minute examination was therefore specified.

4. *Exam administration mode*

   Computer-based testing through a secure third-party provider. This has the advantages of convenient year-round scheduling and increased number of testing sites, increased security, error-free scoring and randomization of the order of exam items and distracters to eliminate the need for multiple forms of the test.

5. *Scoring method*

   Criterion-referenced scoring based on a cut score developed by the modified Angoff method. As the CIEC examination is delivered via computer-based testing, raw scores are calculated automatically upon completion of each test and reported to ACAC in real time.

CMC Test Description:

The CMC board determined that the following elements of the existing CMC examination, which were established by the original CMC certification board in 2001, still adequately serve the purposes of the certification program:

1. *Purpose of the exam*

   To identify persons with acceptable knowledge of microbial investigation, sampling, monitoring and consulting, and to qualify them for board certification as Council-certified Microbial Consultants.

2. *Intended candidate population*

   Individuals with at least eight (8) years verifiable experience in designing and conducting microbial sampling regimens, whose experience comes from the building sciences, microbiology and microbial risk analysis.

[4] A. J. Nitko, Educational Assessment of Students. 2nd ed. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc.: 1996).

3. *Test length, exam item type and administration time limit*

120 dichotomous multiple choice questions in 180 minutes.

Test length for the CMC exam was set by the original CMC board in 2001. The 2011 board examined KR-20 reliability indices collected for the exam since 2001 in order to validate this decision. The committee concluded that 120 items allotted to 6 content domains according to a weighted blueprint made for a test of sufficient length. Research supporting this approach which links optimum examination length with test form reliability includes Feldt & Brennan (1989), R.F.Burton (2004) and Burton (2006) .[5]

Similarly, the original CMC board had specified in 2001 that the exam contain only dichotomous multiple choice (type-A) items. This decision was reviewed in 2011 and unanimously confirmed. This item type demonstrates a high correlation with accurate measurement of special knowledge and allows a large content domain to be efficiently tested in a defined period of time. Though multiple choice testing has faced criticism, its chief disadvantages stem from its weakness in testing strategic thinking, judgment and experience. Since the CMC exam is designed primarily to test the factual knowledge of professionals whose field experience will be verified by other means, these weaknesses were of little concern to the board. In fact, dichotomous multiple choice items were unanimously chosen as the most appropriate in this case.

The original CMC board used research suggesting 90 seconds per multiple choice item as a benchmark for high-school level tests featuring complex multiple choice items.[6] A 180-minute examination was therefore specified.

4. *Exam administration mode*

Computer-based testing through a secure third-party provider. This has the advantages of convenient year-round scheduling and increased number of testing sites, increased security, error-free scoring and randomization of the order of exam items and distracters to eliminate the need for multiple forms of the test.

5. *Scoring method*

Criterion-referenced scoring based on a cut score developed by the modified Angoff method. As the CIM examination is delivered via computer-based testing, raw scores are calculated automatically upon completion of each test and reported to ACAC in real time.

[5] Feldt, L. S. & Brennan, R. L. (1989). *Reliability*, in: R. L. Linn (Ed.) *Educational measurement*(3rd edn) (New York, Macmillan), 105–146; Burton, R. F. (2004a) *Multiple choice and true/false tests: reliability measures and some implicationsof negative marking, Assessment & Evaluation* in *Higher Education*, 29(5), 585–595; and Richard F. Burton (2006): Sampling knowledge and understanding: how long should a test be?, in *Assessment & Evaluation in Higher Education*, 31:5, 569-582.

[6] A. J. Nitko, Educational Assessment of Students. 2nd ed. (Englewood Cliffs, New Jersey: Prentice-Hall, Inc.: 1996).

Tables of Specifications

The CIEC and CMC certification boards used the Domain Rank Scores computed during the DACUM process to develop a Domain Weight for their respective examinations (see Tables 1 and 2 above). The boards then created exam blueprints to match these weighted content domains exactly. The number of items appearing on each exam from each content domain will be directly proportional to the percentage weight of that domain as reported in Tables 1 and 2.

Additionally, within each domain, the number of items appearing from each cognitive category will be directly proportional to the percentage weight of that category as determined during the DACUM process.

No deviation from the validated domains was authorized. See the Appendix B for the CIEC and CMC examination blueprints.

APPENDIX A – Validated DACUM Research Charts

DACUM Research Chart: CIEC Certification Program

		Subdomains					
	Domains	**A**	**B**	**C**	**D**	**E**	**F**
1	**IAQ Contaminants and Potential Health Effects**	Scientific data on full range of IAQ contaminants	Potential health effects associated with IAQ contaminants	Common sources of contaminants in the built environment	Methods for preventing and reducing exposure	Relationship between building occupants and IAQ issues	
2	**Principles of the Built Environment**	Pathways and driving forces for IAQ contaminants in the built environment	Relevant construction techniques: single family homes	Relevant construction techniques: multi-family residential buildings	Relevant construction techniques: commercial buildings	Relevant construction techniques: institutional facilities	Effect of common building materials and furnishings on indoor air quality
3	**HVAC**	HVAC design principles	HVAC system components	Role of HVAC system in controlling IAQ contaminants	Role of HVAC system in maintaining building pressurization	Role of HVAC system in building ventilation	Diagnostic procedures for evaluating HVAC systems
4	**Equipment Selection, Calibration and Operation**	Identification of key equipment used in IAQ investigations	Principles of sampling and monitoring	Techniques for calibrating sampling and monitoring equipment	Techniques for operating sampling and monitoring equipment	Procedures for handling sampling and monitoring data	Principles of data analysis and interpretation
5	**Guidelines, Regulations and Standards**	Federal guidelines, regulations and standards touching IAQ	State and local guidelines, regulations and standards touching IAQ	Industry guidelines, regulations and standards touching IAQ	ACAC Code of Conduct		
6	**Remediation**	Procedures for developing appropriate project documentation	Selection and use of personal protective equipment	Principles of containment engineering and construction	Common remediation techniques: microbial contamination	Common remediation techniques: non-microbial contamination	Techniques for post-remediation verification

DACUM Research Chart: CMC Certification Program

		Subdomains						
	Domains	**A**	**B**	**C**	**D**	**E**	**F**	**G**
1	**Scientific knowledge of biological agents**	Bacteria	Fungi	Amebae	Viruses	Dust Mites	Endotoxin	mVOCs
2	**Health effects and risks associated with exposure**	Bacteria	Fungi	Amebae	Viruses	Dust Mites	Endotoxin	mVOCs
3	**Principles of Microbial Investigation**	Guidelines, Regulations and Standards touching microbial investigations	Pathways and driving forces for microbial contaminants in the built environment	Principles for evaluating the role of HVAC systems in microbial issues	Construction techniques relevant to microbial investigation	Building materials and furnishings relevant to microbial investigation	Techniques for walk-through investigations in the indoor environment	Proper use and limitation of monitoring devices in microbial investigations
4	**Principles of Microbial Sampling**	Limitations and proper use of microbial sampling	Principles for designing a sampling regimen	Proper use of current sampling technologies	Calibration and limitations of sampling equipment	Protocols for executing an effective sampling regimen	Analysis of sampling data	Evaluation and interpretation of sampling data
5	**Principles of Microbial Remediation**	Procedures for developing appropriate project documentation	Selection and use of personal protective equipment	Principles of containment engineering and construction	Common remediation techniques: microbial contamination	Common remediation techniques: non-microbial contamination	Proper use and limitations of chemicals in microbial remediation	Techniques for post-remediation verification

APPENDIX B – CIEC and CMC Examination Blueprints

CIEC Examination Blueprint

Domain/Cognitive Category	Knowledge	Comprehension	Application	Total # Items	Percentage
1. IAQ Contaminants and Health Effects	9	8	3	20	17
2. Principles of the Built Environment	9	8	3	20	17
3. HVAC	9	8	3	20	17
4. Equipment Selection, Calibration and Operation	10	9	3	22	18
5. Guidelines, Regulations and Standards	8	8	3	18	15
6. Remediation	9	8	3	20	16
Total # Items	54	49	17	120	
Percentage	45	41	14		100

CMC Examination Blueprint

Domain/Cognitive Category	Knowledge	Comprehension	Application	Total # Items	Percentage
1. Biological Agents	12	10	4	26	22
2. Health Effects and Risks of Exposure	8	7	3	18	15
3. Microbial Investigations	11	10	4	25	21
4. Microbial Sampling	12	10	3	25	21
5. Mitigation and Remediation	12	10	4	26	22
Total # Items	55	47	18	120	
Percentage	46	39	15		100