ACREDITA CI
AGENCIA ACREDITADORA COLEGIO DE INGENIEROS DE CHILE S.A.

MASTER MANUAL FOR THE ACCREDITATION

OF SCIENCE-BASED ENGINEERING PROGRAMS

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This Master Manual for the Accreditation of science-based engineering programs is complementary to the following documents:

- Manual of Rules and Procedures for the accreditation of science-based engineering programs.
- Self-Evaluation Guide for the accreditation of science-based engineering programs.
- External Evaluation Guide for the accreditation of science-based engineering programs.

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INDEX

1. INTRODUCTION

As a provisional member of the Washington Accord, Acredita CI makes this Manual available to higher education institutions, which establishes the evaluation criteria for the development of the accreditation processes for science-based engineering programs under international quality criteria, in Chile.

2. ACCREDITATION

Accreditation is a process of review and evaluation of the quality of engineering education. For a program to obtain accreditation, it must demonstrate that it meets the evaluation criteria (quality criteria) of Acredita CI. Accreditation ensures that the graduate is prepared to enter the professional engineering practice.

The accreditation of a program ensures that the graduates of the program are people capable of designing and/or developing solutions to complex engineering problems[1]. In these processes of design and/or development, graduates demonstrate that they possess the Graduate Attributes[2] established by the Agency and that are based on the attributes defined by the Washington Accord.

The design and/or development of solutions to complex engineering problems refers to the design of systems, components, or processes that meet specific needs, duly considering public, cultural, social, and environmental health and safety issues, when appropriate[3].

3. REQUIREMENTS TO ACCESS ACCREDITATION

A program may be submitted to the accreditation process when:

a. Has two cohorts of graduates practicing the profession, and
b. It is taught at daytime schedule, with regular admission in person mode, and if the program is taught in more than one location, in afternoon schedule, it must present all these simultaneously to the process: locations, schedules and modalities.
c. The program must be taught by an autonomous Higher Education Institution as established by Chilean law.

[1] See definition in the annex 12.1 of this Manual
[2] Chapter 4 in this Manual
[3] See examples in Annex 12.3 in this Manual

4. GRADUATE ATTRIBUTES

The Graduate Attributes are indicators of the potential of the graduate to acquire the necessary skills for engineering practice. An accredited program ensures that the graduate includes these attributes in their educational process because they demonstrate the achievement of the graduation profile[4].

Notwithstanding the foregoing, Accreditation respects the characteristics and purposes of the institution that offers the program and its graduate profile, which normally considers the country's culture, the region in which the institution is inserted and its contribution to the development of the country.

In this way, the quality of a program depends on the graduation profile, and also on its design, the committed resources, the teaching and learning process and the evaluation of the students, including confirmation that the graduate attributes are satisfied.

Attributes are chosen to be universally applicable, to reflect minimum acceptable standards and to be objectively measured, and while all attributes are important, individual attributes do not necessarily carry the same weight. These are established generically, being applicable to all engineering disciplines. The program applies them within a disciplinary context, giving them a particular emphasis, but the individual elements applicable to each discipline should not be altered in substance or ignored.

The achievement of the graduate attributes is demonstrated through the achievement of the graduation profile of the program, therefore through the student's learning and the curricular activities of the design of the curriculum[5].

[4]Criterion 11: EFFECTIVENESS AND RESULTS OF THE EDUCATIONAL PROCESS
[5]Criterion 3: CURRICULUM

4.1. Graduate Attributes Definition

Washington Accord (WA)

Graduate Attributes	Definition For Washington Accord Graduate
Engineering Knowledge:	**WA1:** Apply knowledge of mathematics, natural science, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to the solution of complex engineering problems[6].
Problem Analysis	**WA2:** Identify, formulate, research literature and analyze *complex* engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences. (WK1 to WK4)
Design/ development of solutions:	**WA3:** Design solutions for *complex* engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations. (WK5)
Investigation:	**WA4:** Conduct investigations of *complex* problems using research-based knowledge (WK8) and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
Modern Tool Usage:	**WA5:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to *complex* engineering problems, with an understanding of the limitations. (WK6)
The Engineer and Society:	**WA6:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems. (WK7)
Environment and Sustainability:	**WA7:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. (WK7)
Ethics:	**WA8:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice. (WK7)
Individual and Team work:	**WA9:** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
Communication:	**WA10:** Communicate effectively on complex engineering activities[7] with the engineering community and with society at large, such as being able to comprehend and write

[6]Page 8: Definition of complex engineering problems.
[7] See definition of complex engineering activities in annex of this document.

	effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project Management and Finance:	**WA11:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
Lifelong learning:	**WA12:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The definition of graduate attributes is based on the Knowledge Profile detailed below, such as WK1 to WK8. An engineering program must ensure that these definitions are present in its design:

4.2. Knowledge profile of an engineering program

Washington Knowledge (WK)

WK1: A systematic, theory-based understanding of the **natural sciences** applicable to the discipline.
WK1: Conceptually-based **mathematics**, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modeling applicable to the discipline.
WK3: A systematic, theory-based formulation of **engineering fundamentals** required in the engineering discipline.
WK4: Engineering **specialist knowledge** that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is as the forefront of the discipline.
WK5: Knowledge that supports **engineering design** in a practice area.
WK6: Knowledge of **engineering practice** (technology) in the practice areas in the engineering discipline.
WK7: Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability.
WK8: Engagement with selected knowledge in the **research literature** of the discipline.
A program that builds this type of knowledge and develops the attributes listed below is typically achieved 4 to 5 years of study, depending on the level of students at entry.

5. EVALUATION CRITERIA

As we said, for a program to obtain accreditation, it must demonstrate that it meets the Acredita CI evaluation criteria. The evaluation criteria are defined so that, through their application, it is possible to get to know in the most reliable way possible to what extent the program ensures the quality of its educational process. Specifically, Acredita CI has defined the following 9 criteria:

1. Educational Objectives.
2. Graduate Profile.
3. Curriculum.
4. Faculty.
5. Infrastructure and Resources for Learning.
6. Effectiveness and Result of the Educational Process.
7. Connection with the Environment.
8. Organization and Administration.
9. Self-regulation and Continuous Improvement.

Criteria 1 to 6 are applied mainly at the level of the program; criteria 7 to 8 are applied mainly at the Unit level; and criterion 9 is both at the unit and program level. In order to facilitate and clarify the application of these criteria, a set of “aspects to consider” has been defined for each of them.

CRITERION 1: EDUCATIONAL OBJETCTIVES

The program has a clear definition of its objectives and has mechanisms that allow it to evaluate the achievement of them.

1.a. The Unit has a clear definition of its objectives and goals.
1.b. The program declares its reason for being and makes explicit the student population to which it is oriented, the occupational field for which the students are prepared and the educational project that guides the respective educational process.
1.c. The educational objectives of the program are coherent with the institutional mission and have formal academic management mechanisms to verify that they are achieved.

Definition

Educational Objectives: they are medium term; they refer to the expected professional performance of the engineers some years after they have graduated from the Institution. This performance reflects the dream of the institution expressed through its Mission. Therefore, it is relevant that the objectives always take into account the opinion of the internal community and the external community relevant to the program (stakeholders). (Concept of external consistency).

CRITERION 2: GRADUATION PROFILE

The program has a relevant graduation profile, updated, validated, disseminated and known by the community. The program shows that the graduation profile includes the graduate attributes of the Washington Accord.

2.a. The institution has quality assurance policies and mechanisms that reaffirm the consistency among the graduation profile, mission, vision and institutional purposes.
2.b. The graduation profile is consistent with the offered degree. The graduation profile is related to the educational level of the program.
2.c. The academic unit has policies and mechanisms designed to capture the requirements of the environment in the disciplinary and professional field that are its own, providing feedback of its action in the area of graduation profile.
2.d. The academic unit demonstrates to have policies and mechanisms that allow knowing the state of art of the scientific, disciplinary or technological bases that underlie the academic education intended to be provided, considering them in the definition of the declared graduation profiles. These mechanisms include a periodic review of the graduation profile, with a frequency that is at least equivalent to the duration of the curriculum.
2.e. The graduation profile is expressed in an accurate and explicit way and considers the distinctive characteristics of each mention, when they exist.
2.f. The graduation profile is consistent with the graduate attributes.
2.g. The graduation profile is adequately disseminated, both internally and externally, being known by the academic community and the relevant external community.

CRITERIO 3: CURRICULUM

The program has systematic and documented processes for the design and implementation of its teaching-learning process oriented towards the achievement of the graduation profile and the graduate attributes. There are periodic evaluation policies and mechanisms for the subjects offered, depending on the declared learning objectives.

3.a. The program structures its curriculum, subject programs and curricular activities in function of the graduation profile.

3.b. The curriculum identifies the different areas of education that lead to satisfying the graduation profile, making explicit the curricular and personal development activities tending to provide an integral education in the students.

3.c. The program establishes learning objectives or results and assessment instruments that can be verified and relevant to the graduation profile and, therefore, to the graduate attributes. These learning objectives or outcomes and assessments can be set at the level of each subject, cycles or educational levels, remain essential to verify learning as the student progresses in the curriculum.

3.d. Curriculum considers theoretical and practical exercises in a consistent and integrated manner. To do this, the program has, when necessary for the achievement of the graduation profile, effective associations with employers for quality internships during its development, so that students achieve the knowledge, skills and the necessary readiness to effectively exercise their future occupational activity.

3.e. The curriculum and the corresponding curricular activities are formally and systematically made known to students.

3.f. The institution, the unit and the program have a system that allows to quantify the real academic work of the students in comparable units (credits or chronological hours), according to a reasoned and proportional standard defined in the academic regulations of the institution in question. It is suggested to adhere, preferably, to the System of Transferable Credits (SCT-Chile).

3.g. For the graduation process, students develop one or more activities in which they demonstrate their ability to integrate the disciplinary and professional education received according to the defined graduation profile. These activities are part of the curriculum and are considered within the declared duration of the program.

3.h. The academic unit has policies and mechanisms to periodically evaluate the curriculum and subjects offered, propose modifications and keep it updated in all its locations, schedules and modalities, when they exist.

3.i. The academic unit collects information in the community relevant to the graduates' occupation and performance situation and uses the obtained background information to update and refine its curriculum.

3.j. In the event that the graduation profile of a program requires proficiency in a second language, such knowledge will be required in the admission processes or learning, exercise and evaluation opportunities will be provided via curriculum.

CRITERIO 4: FACULTY

The program has a sufficient and suitable teaching staff to fully comply with all the activities and learning committed in the curriculum, which allows its students to progress systematically towards the achievement of the graduation profile.

4.a. The number, stay and dedication of time by the faculty ensure the application of the curriculum for the compliance with the direct teaching and activities inherent to the teaching-learning process (evaluations, practical works, preparation of assignments and exercises, the use of information and communication technologies), as well as the supervision of the teaching-learning process and the assistance and guidance for students out of the class time.

4.b. The program proves to be provided, as a whole, with a qualified and competent faculty in order to develop the curriculum in accordance with its purposes and the graduation profile. The qualification and competence of the faculty will consider the disciplinary needs regarding the academic education received and pedagogical education, as well as the program path in the scientific, professional, technical or artistic field, as appropriate.

4.c. The program has a highly dedicated and long standing academic core, leading and giving sustainability to the educational project along the time and allowing covering the needs within the curriculum in all the locations, sessions and modalities.

4.d. There are known standards and instruments for the selection, recruitment, evaluation, promotion and dismissal of the academics, applied systematically and being able to be provided with special regulations for the unit.

4.e.Policies and improvement mechanisms are applied that allow updating and training of faculty in disciplinary and professional aspects.

4.f. Policies and improvement mechanisms are applied that allow updating and training of faculty in pedagogical aspects.

4.g. Mechanisms are applied that allow to evaluate the activities of the faculty of the program -particularly the report on the learning results- which are applied effectively and systematically in the administration of the faculty. These instruments consider the opinion of the students, superiors and peers for the qualification of academics.

4.h. The program has instances of communication and participation of faculty, clearly established and known, that facilitate the coordination with the program authorities regarding the matters that are specific to their teaching functions.

CRITERIO 5: INFRASTRUCTURE AND LEARNING RESOURCES

The program is provided with the infrastructure, learning resources and equipment required for the achievement of the expected results in the students. Likewise, the institution applies policies and mechanisms for the development, replacement, maintenance and safety of the said infrastructure and resources.

5.a. The program has the infrastructure according to its nature (such as classrooms, laboratories, workshop stations, libraries, equipment, experimental areas, and computing resources, among others) which is sufficient and functional to the needs of the curriculum and the number of students. The ownership of the facilities and infrastructure –or the rights of the institution thereon- ensures the current and potential development of the program, as well as the quality of the education given to the students.

i. Faculty and students have access to a library provided with the facilities, equipment, expert staff and technical processes allowing giving an appropriate attention. The library is also provided with an information system with network access.
ii. The library has physical and virtual information resources (texts, books, scientific magazines and other necessary materials for the development of the program activities) duly updated, complying with the rights of intellectual property and in alignment with the needs of the graduation profile, the curriculum, as well as the institutional guidelines and principles. Likewise, there are physical spaces available to study, both in individual or group manner.
iii. The program has access to the technological, computing and support resources for the teaching-learning process that are enough in number, quality and updating. Such resources help to develop the pedagogical, disciplinary and professional program activities.
iv. There are the necessary facilities to carry out professional practices, field trips, degree and thesis work or any other activity included in the curriculum.

5.b. There are the necessary financial resources for the systematic fulfillment of supply, replacement, maintenance and updating needs of the teaching infrastructure, equipment and resources.

5.c. There is a concern with the presence of an adequate balance between the number of students admitted to each class and the total amount of the resources available, considering its teachers, its infrastructure, equipment and budget.

5.d. There are protocols for universal accessibility and safety that are strictly applied in the learning venues, facilities and resources.

CRITERION 6: EFFECTIVENESS AND RESULTS OF THE EDUCATIONAL PROCESS

The program has quality assurance policies and instruments with respect to:
- Admission.
- Teaching-learning processes and evaluation.
- Academic progress towards the graduation.

These policies and instruments are objective, effective and consistently applied with regard to the graduation profile. In addition, the program shows substantive evidence of the compliance of the graduation profile and the graduate attributes.

6.a. The program has regulations and admission mechanisms explicit and of public knowledge. These norms are applied systematically in admission and are consistent with the requirements of the curriculum. The program explains its special admission system when appropriate.

6.b. The program takes the student's conditions for admission into account with respect to the curriculum requirements and provides leveling resources and activities, when required.

6.c. The program has articulated polices and instruments to:

i. Strength the study habits and techniques of its students.

ii. Identify any problem of retention and progression in an early stage, applying corrective measures.

iii. Intervene with assistance strategies, in order to enhance the student results, when appropriate.

iv. Set program students apart, as the case may be and according to the current regulations.

6.d. The program has evaluation instruments applied to the students, allowing to check the achievement of learning objectives defined in the curriculum and in the subject programs. Specially, when the curriculum considers professional internships, the program has designed evaluations in order to measure the depth and extension of the experiences linked therewith which were gained by the students.

6.e. The program shows that the learning outcomes achieved by the students satisfy those established in the declared graduation profile, and therefore, the graduate attributes. In particular, the evidence shows that students have the ability to solve complex engineering problems, in their field of expertise.

6.f. The program has systematic records of the academic performance of its students, who can access to the information on their progress. The program evaluates the progression of all its students in a disaggregated level by location, session and modality, when appropriate.

6.g. The program systematically analyzes the reasons for dropout, retention, progression, critical subjects and periods for the student’s degree according to cohorts and, if necessary, defines and applies actions tending to improve, regarding the compliance with the graduation profile and the decision-making capacity with respect to the obtained results.

6.h. The program students can access to orientation or mentoring mechanisms, when necessary.

6.i. The program applies the mechanisms allowing to have information and data analysis on the opinion and track of graduates and employers. Such information is applied to feedback the manner in which the quality assurance policies and instruments are formulated, as well as the graduation profile and the curriculum.

6.j. The program is informed on the occupancy rates and the employability characteristics of its graduated students and applies this information in order to feedback the educational objectives, the graduation profile and the curriculum by doing the necessary adjustments between the imparted education and the requirements of the labor environment.

CRITERION 7: CONNECTION WITH THE ENVIRONMENT

The connection with the environment is a key criterion of the labor of the program, directing and strengthening the graduation profile and the curriculum. There is a systematic, meaningful and mutually beneficial interaction with the public, private and social relevant agents of horizontal and bi-directional nature. There are policies and mechanisms for periodic evaluation of the impact of activities related to the environment in all areas of its work: as Academic Unit, in support of student learning or supporting the achievement of institutional purposes

7.a. The unit develops concrete actions of connection with the environment, which allows knowing the requirements of this, in the disciplinary and professional field that are their own, providing feedback on the graduation profile, curriculum and selection of the teaching staff.

7.b. The program defines and prioritizes the activities related to the connection with the environment in the interaction fields demanded by the social groups regarding its competence, setting clear objectives of the activities.

7.c. The program facilitates the mutual knowledge among its students and the eventual occupational sources of the profession.

7.d. The unit promotes the linking and connection of the program.

7.e.The unit and the program monitors the activities related to the environment and evaluates its impact in terms of meeting objectives.

CRITERION 8: ORGANIZATION AND ADMINISTRATION

The unit has an adequate government system and an effective and efficient teaching and administrative management of the resources necessary to fulfill the declared commitments.

8.a. The Unit plans the academic and economic management and has mechanisms that allow to evaluate the achievement of the purposes defined for the program.

8.b. The Unit has a qualified directive body which is well-dedicated in the compliance with the established responsibilities, tasks and assignments.

8.c. The Unit has administrative, technical and support personnel, duly trained, sufficient in number and with time in relation with the day-time/modality, as to comply properly with the tasks and cover the development need of the curriculum.

8.d. The program has at least one manager who supervises the assignment of tasks, provision of resources, registration and processing of information for management control, and summons teachers, support staff and other instances that come to teach the program, according to what is established in the study plan, and to the existing regulations and obligations and the academic offer committed by the Institution in its dissemination activities.

8.e. The unit has information systems and academic and administrative management tools appropriate to the management and communication needs in the program.

8.f. The Institution has committed financial resources assuring the program sustainability, as well as the planned continuation of students thereof along the time.

8.g. The academic unit has an annual budget which is updated and backed up and which it keeping adequate conditions for its operation with efficient budget control instruments.

CRITERION 9: SELF-REGULATION AND CONTINUOUS IMPROVEMENT

The unit and the program has the self-regulation instruments. The program performs the self-evaluation processes in a systematic manner and applies the available information derived from effected diagnoses, with the purpose of designing and introducing continuous improvement actions. In addition, the program proves that applies the actions engaged in the improvement or development plans

9.a. The self-evaluation process considers the participation of key internal/external informants - teachers, students, graduates and employers– and the self-evaluation report is known and supported by the program community.

9.b. The program has the suitable systems allowing to be provided with the valid and reliable information about its different action fields.

9.c. The improvement plan for the program is supported by the institution and unit management body, which is stated in an investment plan with the necessary funding.

9.d. The program consistently meets its established goals, ensuring the quality of the education provided.

6. THE ACCREDITATION DECISION

The accreditation decision is made by the Acredita CI Technology Council and depends on the assessment that this council makes of each of the evaluation criteria.

A criterion **is met** when there is evidence that policies and mechanisms are known and applied systematically, showing results that are periodically reviewed.

Otherwise, we are in the presence of a weakness: the criterion **does not met** and will be valued either as **in development** or as **inexistent**. A criterion that is not met is in development when there is evidence that the policies and mechanisms are known and applied, with preliminary results, but there is no evidence yet that it is systematic. A criterion that is not met is inexistent when the program has defects in its design or does not have formal or systematic policies or mechanisms in its educational process, or there are only statements, but without evidence of its application.

To make this assessment and make the accreditation decision, the Council relies on:

a. The self-evaluation report,
b. The evaluator peers committee report,
c. The program observations to this report (if any),
d. The evaluator peers committee's response to those observations (if any), and
e. The observations of the program to the Preliminary Report of the Council (if there are observations).

When the program is taught in different locations, schedules, modalities and special degree programs, all of them will be evaluated as a whole.

The process leads to one of the following three results:

- **Accredited for 7 years**
- **Accredited for 3 years**
- **Not Accredited**

1. **Accredited for 7 years:**

The program demonstrates that it meets the Acredita CI evaluation criteria. The program includes in its design the 12 Graduate Attributes, which are incorporated through its own graduation profile. It has mechanisms for continuous improvement to achieve committed education, with evidence that the policies and mechanisms are known and applied systematically, showing results that are periodically reviewed

2. Accredited for 3 years:

The program mets the criteria of Acredita CI, and may present some criteria with weaknesses in the category "does not met-in development". The program includes in its design the 12 Graduate Attributes which are incorporated through its own graduation profile. There is evidence that learning outcomes are achieved. However, the evidence is recent, failing to verify its permanence over time.

When accreditation is for 3 years:

a. Before the expiration of the accreditation, the process contemplates, by definition, that the program present a report to the Agency with substantive evidence that the detected weaknesses have been overcome. The report will be submitted within six months prior to the expiration date.
b. From the review of this report, the Technology Council will determine if it is necessary to visit the program in the field to verify the progress or the evidence presented in the report is sufficient to decide, based on the documentary review.
c. In any of these cases and verifying progress in overcoming weaknesses, the accreditation of the program will be extended in 4 years.
d. If the weaknesses are not overcome, the accreditation will not be extended to the program, losing its accredited status and it must be submitted to the process again in two years from that date.
e. If the program does not present the report or does not present it within the indicated period, it loses its accredited status[8].

3. Not Accredited

The program does not accredit when it has one or more evaluation criteria with weaknesses in the category “does not met-inexistent”, because it presents defects in its design, does not contemplate the 12 Graduate Attributes or does not have formal or systematic policies or mechanisms in its educational process, or there are only statements, but without evidence of their application.

6.1. Accreditation resolution

Prior to the accreditation decision process, Acredita CI will send a Preliminary Report issued by the Technology Council, so that the program can verify that the Council has considered all the evidence. If, in the judgment of the program, any element is missing, it may send the information deemed appropriate. This shall constitute substantive and documented evidence of compliance with the criteria. The program will have a period of 20 calendar days to send this information to the Agency.

[8] See Manual of Rules and Procedures for more detail about losing the accreditation.

With this information, the Council will decide on the accreditation of the program, in a session called for this purpose.

To inform the decision, the Agency issues an official document of a confidential nature for the program, called **Accreditation Resolution under international criteria** in which the decision is indicated, the weaknesses if they exist and the recommendations for improvement. Acredita CI will issue a **Certificate** that will specifically inform the decision of accreditation under international criteria of the program and the term in which it must be submitted to the process again.

The accredited program will be published on the Agency's website, informing the accreditation status and when it must re-submit to a new accreditation process.

The not accredited program may re-enter the process in two years from the date of notification of the decision.

6.2. Appeal process for a not accredited program

Only in the event that the program does not accredit, it may file an appeal of the decision with the Agency.

The appeal consists of a document in which the program presents additional information, such as substantive and documented evidence of compliance with the evaluation criteria, to support the request. This evidence, in any case, will be accepted as valid only if it existed before the process in which the program presented its observations to the Preliminary Report of the Technology Council.

The appeal will be analyzed by an Appeals Committee arranged for this purpose[9], which will make a final decision.

The result of this stage of the process is final and the program will receive an Accreditation Resolution under International Criteria informing the reasons for the decision and an accreditation certificate, if applicable.

6.3. Substantive changes after the accreditation decision

The program requires maintaining the conditions in which the accreditation was granted during the period in which it is accredited.

In any of the cases detailed below, in which Acredita CI decides to revoke the accreditation, the program could appeal to the Agency on the decision adopted, according to the appeal procedure

[9] See Manual of Norms and Procedures for Science-Based Engineering Programs

described in the Manual of Rules and Procedures for Accreditation of Science-Based Engineering Programs.

In the event that the Agency's administration has background information provided by a third party or by the Institution itself, which evidences changes or modifications to said conditions, it is established that:

Changes in the conditions under which accreditation was granted

If the case is that there is substantive evidence that the conditions under which the accreditation was granted changed or no longer exist and this affects compliance with the evaluation criteria, the Technology Council will analyze the case and from this analysis the need could arise of a verification visit. From the result of this action, the Technology Council will determine if the accreditation is maintained or revoked. In case the decision is to revoke the decision, the Institution will be informed by means of a new Accreditation Resolution under International Criteria[10].

Changes product of a new academic offer

In the event that the Academic Unit has accredited programs, the incorporation of a new degree will be considered a Substantive Change that can inform the Agency with the purpose of incorporating it into the existing accreditation. The new offer will be visited to evaluate its design and the resources to carry out the educational project. And if the criteria are met, its accreditation will be compared to that of the other programs of the Academic Unit, with the aim of presenting it together in the next cycle of renewal of accreditation.

Acredita CI CI will issue an Accreditation Resolution under International Criteria that replaces the previous one, to add the new offer.

Changes resulting from the closing of the offer with valid accreditation

In the case of closing of accredited offer, the Institution must inform the Agency in a timely manner.

[10]See detail of it in Manual of Norms and Procedures for Science-Based Engineering Programs.

7. SELF-EVALUATION PROCESS AND REPORT

For the accreditation process, the program must develop a self-evaluation process and report, taking into consideration the evaluation criteria. The **Self-evaluation Guide for the Accreditation of Science-Based Engineering Programs**[11]defines the format to do it.

The program prepares its **Self-Evaluation Report**, presenting an analysis and reflection at the academic unit level and at the program level, concluding about the degree of compliance with the evaluation criteria. It will refer to the background of the Annexes to support the results of its reflection. In addition, both the unit and the program must present substantive evidence of the work being declared. The **Self-Evaluation Guide** provides examples of what evidence the program might present to support its evaluative judgments.

Acredita CI requests the presentation of four mandatory annexes:
TABLE 1: correlation table between graduate profile competencies, curriculum and graduate attributes[12].
TABLE 2: folder of subjects that include the program of the subject and of the last two semesters of the evaluations developed by the students[13].
TABLE 3: tables of enrollment, retention, graduation and degree of the last 10 years.
TABLE 4: Table of graduate attributes and the learning results of the subjects.

In addition, the program can present a comparative analysis between the professional performance of its graduates according to their own statements and the professional competencies defined in this Manual.

During the self-evaluation process, the program could detect **weaknesses** in relation to the evaluation criteria; that is, evaluation criteria that are not met (in development or inexistent). In this case, the program must demonstrate that it has made significant efforts to overcome the weaknesses or will present actions in an Improvement Plan, in which it undertakes to resolve them.

All the efforts made by the program to overcome the weaknesses are understood as evidence of the commitment to improve the quality of its educational process. In general, Acredita CI understands that the actions, mechanisms or procedures that formally and systematically aim to fulfill the evaluation criteria and achieve the graduate attributes are part of a system of continuous improvement in the quality of the program[14].

[11] www.acreditaci.cl
[12] Format in the Self-evaluation Guide.
[13] Format in the Self-evaluation Guide.
[14] See Conceptual Model of Continuous Improvement of Acredita CI the Self-evaluation Guide.

8. EXTERNAL EVALUATION BY THE PEER EVALUATORS COMMITTEE

The accreditation process includes the visit of a committee of peer evaluators, because the process is not complete if it is not validated by peers of the discipline, who understand the field of action of the program. The committee is external to Acredita CI and is proposed to the program by the Agency. The peer evaluators committee is made up of teachers, academics or professionals.

The external evaluation process is enriched when the academic unit presents the accreditation process to all or several of its programs simultaneously. This implies a simultaneous analysis of Self-Evaluation Reports that allow a better diagnosis of the Unit and the compliance of its purposes and allows for a specific look at the program, thus achieving an efficient process in the use of resources and a better process to ensure quality by its own characteristics. The proposed analysis of the evaluation criteria in this Manual refers to a process, by definition, of this nature.

Each committee will be headed by one or two evaluators transversal to the Unit, whose function is to analyze and verify the role of the Unit in the program's performance and internal consistency in relation to institutional purposes. The transversal evaluators coordinate the entire process and actively participate in the preparation of the Final Visit Report.

Each program will be in charge of an evaluator, who, accompanied by the visiting Secretary, will carry out the external evaluation process. The role of the peer evaluators committee is to verify on the ground the information provided by the programs in their self-evaluation reports based on the nine evaluation criteria. More information about the peer evaluators committee is found in the **Manual of Rules and Procedures for Accreditation of Science-Based Engineering Programs**.

Before the visit, the evaluator of each program, a technology area counselor and the Acredita CI process coordinator will thoroughly review the self-evaluation report, the background form and the annexes. The Agency will prepare a questionnaire on elements that require more information, if necessary, which will be sent to the program to present this information during the visit. The program or programs may present new evidence, and even make adjustments to their procedures, which will be assessed by the peer evaluation committee as a whole. The **Manual of Rules and Procedures for Accreditation of Science-Based Engineering Programs** describes how this procedure is carried out. The visit is carried out together and simultaneously.

In addition to the background information presented by the program in the self-evaluation report(s), the evaluator(s) will select subjects to be reviewed in depth, with the aim of verifying the achievement of the students learning, with special attention to those that have an integrating character, if any, and those that the program has reported to be the key activities for achieving the graduation profile; in particular, those related to the subjects in which students design or develop solutions for Complex Engineering Problems, which demonstrates satisfying the Graduate Attributes.

9. PARTICIPATION OF OBSERVERS

The visits of the peer evaluators may include the presence of observers, in accordance with the Agency's purposes. It is common for Washington Accord member agencies to share accreditation practices and send observers, ensuring that processes are substantially equivalent among members. Observers may also be evaluators of the Agency in training. Acredita CI will inform the institution in a timely manner of the presence of observers and will ensure that they abide by the conflict of interest policy. Observers do not have the role of evaluators, but they accompany the committee and they are not allowed to ask questions to people related to the program in evaluation.

10. THE VISIT SCHEDULE

The visiting schedule is defined by Acredita CI and is put into consideration for the program. It will be prepared by the coordinator of the process according to what the peer evaluators committee defines in relation to the characteristics of the program and having as orientation that the visit of the peer evaluators committee will focus on the following elements:

a) The institutional policies for teaching and the results of the educational process, the strategic management and institutional resources, the internal quality assurance, and the link with the environment, and how these policies have an impact at the level of the academic unit responsible for the program and in the program itself.
b) The purposes of the academic unit responsible for the program, how it defines them in relation to institutional purposes and how it adapts institutional policies for itself and for the program(s).
c) The design of the graduation profile and the curriculum and the mechanisms that ensure its permanent revision.
d) The mechanisms to support the learning of students.
e) The physical and educational resources available.
f) Learning activities and mechanisms to demonstrate student achievement.
g) The result of the achievement of the graduation profile that includes the result of the design or development of the solutions of complex engineering problems.
h) The analysis of the achievement of professional skills in graduates.

Type of visit schedule

The following visit program considers a visit to an academic unit with three programs in process with a common plan between them. The programs are taught in one location, in daytime schedule. In the case of a visit to more than one location, schedule or modality, the necessary adjustments will be made, which may include increasing the number of visiting days or evaluators.

Day 0	
20:00	Internal meeting of the Peer Committee in hotel, prior to the start of the visit.

Day 1	
08:30	Transfer of the Peer Committee from hotel to the Institution.
9:00 – 9:30 The entire committee participates	Meeting with institutional authorities. *(For the review of the institutional policies on teaching and results of the educational process, institutional resources, internal assurance of quality and connection with the environment).*
09:35 – 11:00 hrs. The entire committee participates	Meeting with authorities of the unit that dictates the programs and with those in charge of curriculum design. *(For: the review of the definition of the purposes of the unit and its impact on the management of the programs; the review of the design of the graduation profile and the curriculum based on the educational objectives; and to know the support services to the students)*
11:05 – 12:05 hrs. The entire committee participates	Meeting with teachers / academics of the Common Plan. Attendees must not have managerial positions.
12:10 – 13:10 The entire committee participates	Meeting with Common Plan students
13:15 – 15:00 The entire committee participates	Lunch and internal committee meeting.
15:15 – 16:30 The entire committee participates	Tour of the Common Plan subject facilities
16:35 – 18:45 The entire committee participates	Committee Review Meeting
19:00 – 20:00	Meeting with employers of graduates of the program, **without contractual ties with the Institution, if they are graduates of the program, they must have more than 10 years of graduation**. Minimum assistance of 5 employers who are direct managers of the graduates. *(For the review of the professional performance of the graduates).*
20:05	Transfer of the Committee to Hotel.

Day 2 - each committee separately meets with representatives from each program repeating this schedule by program	
08:30	Transfer of the Peer Committee from hotel to the Institution.
09:00 – 10:00	Meeting with program authorities. *(To know in detail the teaching-learning mechanisms).*
10:05 – 11:00	Meeting with teachers of specific subjects of the curriculum to verify mechanisms of achievement of learning results. *(Especially those related to the subjects in which results are committed for the design or development of solutions to complex engineering problems).*
11:05 – 11:45	Meeting with representative students from each cohort and including students in the process of graduation. *(For the revision of the activities of the subjects, as well as of the services of support to the students).*
11:50 – 12:50	Tour of specialty facilities *(To learn know specific laboratory activities that support student learning).*
13:00 – 14:45	Lunch and internal committee meeting.
15:00 – 16:00	Meeting with students of specific subjects of the study plan. *(To discuss the design or solutions of their complex problems, those that the evaluator asked to look at in detail).*
16:05 – 17:30	Other meetings to review the evidence of achievement of student learning.
18:00 – 19:00	Meeting with graduates of the program that represent different generations, **without contractual links with the Institution**. Minimum attendance of 10 graduates with 6 months of work experience. *(For the review of the professional performance of the graduates).*
20:05	End of activities on day 2.Transfer of the Committee to Hotel.

Day 3	
08:30	Transfer of the Peer Committee from hotel to the Institution.
09:00 – 13:00	Internal work meeting of the Peer Review Committee. Joint committee meeting to analyze results by unit and by program.
13:00 – 14:00	Lunch and internal committee meeting.
14:15 – 14:30	Socialization of findings between the Peer Evaluators Committee and the program authorities.
14:35	End of the visit.

- It is requested to consider a work office for the Peer Evaluators Committee with a computer and printer and that it be adequate for the work to be carried out during the first day with the information of the unit in charge of the activities transversal to the programs.
- It is requested to consider a work office for each committee, for the activities of day 2, which will have at the committee's disposal the information required in the mandatory annexes, for detailed analysis of each committee.
- The program will make available to the committee a person to support administrative management and rigorous compliance with the program of the visit in the timeliness of the meetings.
- Each committee will be accompanied by a visiting secretary.

11. ANNEXES

11.1. Definition of Complex Engineering Problems

They are those that cannot be solved without a deep engineering knowledge that considers one or several of the following characteristics, which provide a fundamental basis, an analytical approach based on fundamental principles for it.

a) Deep theory-based knowledge of the engineering fundamentals necessary in the discipline.
b) Specialized engineering knowledge that provides the theoretical and practical frameworks for the engineering discipline; many of which are at the forefront of the discipline.
c) Knowledge that supports engineering design in a specific area (practice).
d) Knowledge of engineering tools (technology) in the practice areas of the engineering discipline.
e) Selected knowledge of the research literature on the discipline.

And they have one or more of the following characteristics:

1. Involves technical or engineering matters and others of great scope or in conflict.
2. They do not have an obvious solution and require abstract thinking, originality in the analysis to formulate adequate models.
3. They involve infrequent problems.
4. They are out of norms, standards and codes
5. They involve several interest groups with very different needs (and even in conflict).
6. They are high-level problems that include many components or sub-problems.
7. They have significant consequences in a wide range of contexts
8. Requires judgment in decision making

11.2. Definition of Engineering Activities

The educational process could consider this type of activities to strengthen the graduate's competencies.

EA: Enginering Activities

Attribute	Definition
Preamble	**Complex activities** means engineering activities or projects that have all or some of the following characteristics:
Range of resources	**EA1:** it implies the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).
Interactions level	**EA2:** it requires the resolution of important problems that arise from the interactions between technical, engineering or other, long-range or conflicting problems.
Innovation	**EA3:** involves the creative use of engineering principles and research-based knowledge to produce changes or new looks.
Consequences for society and the environment	**EA4:** have significant consequences in a variety of contexts, characterized by the difficulty of prediction and mitigation.
Familiarity	**EA5:** it can be extended beyond previous experiences by applying criteria based on principles.

11.3. Examples of Complex Engineering Problems

EXAMPLE 1:
Course exam: **Heat transfer**
Mechanical Civil Engineering Program.

The purpose of this exam is to operationalize the concepts or technological situations. The exam's theme is "Heat transfer in the Natural Gas industry".

1.-Sea transport in spherical containers (40%).

Natural gas (mostly methane) is a fuel produced mainly in Asian Pacific countries. For its use in Chile it must go through three processes: liquefaction at origin, maritime transport and regasification at destination. As liquefaction requires bringing the gas from ambient temperatures in the gaseous state to –160ºC in the liquid state, with considerable thermodynamic complexity, we leave this process aside, focusing on the other two.

It is carried out in boats of 5 to 6 ponds, of 20,000 m3 each. The tanks are made of aluminum (k = 177 W/mK), 4 cm thick, with an outer layer of insulation (perlite, k = 0.046 W/mK) and another outer layer of aluminum (5 mm) to protect the isolation. They have an equatorial flange that divides the two hemispheres and supports the tank in the cellar. During the trip the saturated

natural gas at atmospheric pressure is kept at –160ºC, thanks to i) good insulation of the pond and ii) self-cooling produced by the evaporation (boil-off) of a small part of the gas. This gas serves as fuel for the boat's propulsion. The average air temperature is 12ºC.

a) You are asked to find the thickness of the insulation to allow an evaporation of only 0.05% of the initial gas content (by volume) per day during the trip. As a first approximation consider as the only significant thermal resistance that of the insulator.

b) With the found thickness, evaluate the evaporation rate using the complete formulation of the problem: The air temperature is 12ºC but there is a convective coefficient of 20 W/m2K between the air and the pond. An average solar gain of 350 W/m2 is considered, which affects a flat projection of the sphere (circle). There is also radiation from the entire surface of the pond into space, the effective temperature of which is estimated at –10ºC. The emissivity of the external face of the pond is 0.95.

2.-Regasification in plants located in Chile (60%).

The regasification of natural gas has as its central part a storage tank and a vaporizer. In coastal plants, seawater is used as a hot fluid. The water enters the evaporator at 18ºC and must be returned to the sea at no less than 13ºC for environmental reasons.

The equipment is the "Open Rack Vaporizer" (ORV) shown schematically in the attached figure. It is composed of vertical aluminum tubes. Inside, liquid natural gas rises, which evaporates completely and then heats up. Seawater descends from the outside of the tubes, available at 18ºC. Natural gas enters –160ºC (state saturated at 1 atm) and exits at 10ºC, therefore sensitive heat is transferred in the upper section of the tubes.

The tubes are 1 inch outside diameter (0.0254m × 0.0221m) and are arranged in a square arrangement 0.03175m apart. Unlike a shell and tube exchanger, the flow is not crossed but parallel to the tubes whereby an equivalent diameter must be defined to apply turbulent flow correlations. The following is requested:

a) First, set the ratio between the mass flow rates of water and natural gas to meet the goal of leaving water temperature. If you want to meet the goal of 13ºC, the water flow would be excessively large. A water outlet temperature of 5ºC is taken, counting that the water before returning to the sea will be brought to 13ºC by means of the combustion of the boil-off of the storage tank on land, in a certain equipment that is not studied in this control.

Now analyze an ORV tube with a flow rate of 250 kg/hr of natural gas.

b) Plot the temperature curves of both fluids along the tube. Determine the logarithmic mean temperature differences for the evaporation and sensible heating sections, and the corresponding heats to be exchanged.

c) Estimate the length of the pipe section for sensible gas heating. You can use the Dittus-Boelter equation to estimate the convective coefficients on both sides.

d) Estimate the length of the evaporation section, considering a simplified form of the Gungor-Winterton equation, using only the term of convective evaporation. This is:

Biphasic convective coefficient:

The two-phase flow parameter, X (also in a simplified version):

Methane Properties	Liquid	Gas	Units
Density	422,119	1,865	kg/ m3
Saturation enthalpies	287	797,7	kJ/kg
Specific heat	3497	2235	J/kg K
Viscosity	4,46×10-6	5,0×10-6	kg/m s
Thermal conductivity	0,26	0,013	W/m K

Property	Liquid	Units
Density	1000	m3/kg
Specific heat	4194	J/kg K
Viscosity	1,3×10-3	kg/m s
Thermal conductivity	0,587	W/m K

EXAMPLE 2:
Project of the subject **Engineering in Thermofluids**
Mechanical Civil Engineering Program

The project will be executed during the semester.

The students form groups of a 3. They have continuous supervision, with weekly presentations.

Project: Conceptual approach to the introduction of nuclear power in Chile

The national energy field in the first half of the 21st century will be increasingly stressed by the growing demand for energy (considering that electromobility will make transport more and more dependent on fixed plants).

In recent years, a strong incorporation of non-conventional renewable energies (mainly solar, wind and geothermal) has been observed, the possible decrease in water resources for hydroelectric generation, the resistance of coal to disappear, with new projects that have compromised areas so far unexploited, the increasing importance of natural gas, for whose distribution and use the country has made huge investments, among other related factors.

Considering that coal-based generation should gradually disappear, nuclear energy can be viewed as one of the alternatives for a fully connected electrical system at the country level. (It should be considered, of course, that small-scale generation with NCRE and outside national networks will continue to be the best alternative for small and isolated populations).

Some academic studies (university theses) have been carried out in Chile on nuclear energy, but they are 10 years old, that is, before the massive emergence of NCRE in the country. This changes the situation in favor of more variable energies over time, which require the availability of some less intermittent power plants.

However, the low availability of flat and sloping land in the Copiapó and Coquimbo regions, together with the enormous surface area required by solar power plants and the low availability of water, also make nuclear energy an alternative.

It is proposed to carry out the project of a nuclear power plant to be added to the interconnected system, with a capacity that is a significant addition to the national energy system. It is tried to know the advantages and disadvantages of this type of generation in a country like Chile based on a rigorous engineering study.

It is known that the project of a nuclear power plant has great importance in heat transfer phenomena, in an imposed flow system such as the nuclear fission reactor. The safety of the plant depends on the ability to extract the heat generated by the fission. This is the main reason why this problem is studied in this subject.

Of particular importance is addressing issues such as (non-exhaustive list):

a. Diplomatic, political, commitments, international treaties.
b. Scale of appropriate energy production in MW (e).
c. Choice of reactor and plant concept.
d. Waste flow and disposal.
e. Environmental impact.
f. Location of the plant (seismicity, population density, insertion of the plant in any region)-
g. Thermo-hydraulic design of the installation.
h. Specification of security systems.
i. Operation and qualification of personnel.
j. Useful life and dismantling.

<u>Some basic notions</u>

Nuclear reactor engineering is multidisciplinary. Nuclear physicists, structural engineers, environmentalists, etc., work on the subject in addition to thermofluidic engineers. We focus on light water reactors that use the water-steam system as a working fluid (others are: gases or liquid metals).

The energy source of a nuclear reactor is the fission process in fuel elements.

Power cycles

A primary coolant circulates in the reactor core to extract energy. Depending on the reactor design, the turbine will be powered by either the primary fluid or a secondary fluid that receives power from the primary.

Example of the first case is the boiling water reactor (BWR), which uses the Rankine power cycle.

In the pressurized water reactor (PWR) the primary coolant is kept in a subcooled liquid state. The turbine is powered by steam (secondary fluid) formed by heat exchange from the primary coolant.

Data of some plants that use the water / steam system:

(Take into account the critical data on water, p = 22.12 Mpa, T = 374.15ºC).

	BWR	PWR
Builder	General Electric	Westinghouse
No. of systems ref.	1	1
Total power, MWth	3759	3411
Net power, MWe	1178	1148
No. of primary circuits	2	4
No. steam generators	-	4 (tube type)
Primary Cooler (water)		
Pressure (Mpa)	7.17	15.5
Input T° (°C)	278	286
Output T° (°C)	288	324
Secondary Cooler (water)		
Pressure (Mpa)	-	5.7
Input T° (°C)	-	224
Output T° (°C)	-	273

EXAMPLE 3:
Subject:**Heat Transfer**
Chemical Civil Engineering Program

A heat exchanger is needed to cool 22,000 kg/h of a hydrocarbon mixture, from 80°C to 35°C. For this, water is available at 25°C, which can be heated to a maximum of 50°C. The hydrocarbon mixture is going to be circulated through the tubes. Cu ¾ ” BWG 16 tubes, 16 feet long, will be used in alternate (or triangular) arrangement with a "pitch" of 1”.

- It can be assumed that the heat transfer coefficients have values of 4,500 m^2 K/W for the hydrocarbon mixture side and 6,500 m^2 K/W for the water side. Consider scale resistors of $4x10^{-5} m^2$ K/W and $2x10^{-5}$ m^2 K/W for the tube side and the shell side, respectively.

a. For a tube bundle exchanger 1-2 (1 pass through the housing and 2 passes through the tubes) determine a water outlet temperature that ensures that the correction factor for the temperature difference is greater than or equal to 0,8.
b. For the temperature determined in part a., calculate the number of tubes per passage, in the exchanger, for a desirable velocity of the hydrocarbon mixture equal to 1.8 m/s.
c. Considering the results of parts a. and b., select an appropriate casing size and type of exchanger 1-2. Your choice should be such that the velocity in the tubes does not have a deviation greater than 20% from the desirable value.

NOTE: As is well known, the selection of casings sizes and configurations can lead to many, few, or no results that meet the required requirements. Therefore, the score will be rewarded if you try one or more conclusions and recommendations regarding the selection, either by suggesting modifications in the requirements or in different configurations of the casings considered in this problem. For this purpose, only comment or suggest, but do not make new calculations.

EXAMPLE 4:
Electrical Civil Engineering Program
Ballbot Project

Definition: A Ballbot is an autonomous robot designed to stabilize itself on a sphere having only one point of contact with the ground. Because of this, a Ballbot is extremely agile, being able to move in all directions of the plane. The Ballbot is a versatile design and is useful as a work or support surface, for carrying loads and even for transporting people.

The project consists of the construction of an autonomous Ballbot capable of remaining vertically stable on a fixed point. Performance will be evaluated against disturbances simulating a soft side impact and an increase in weight on the upper surface.

Specifications:

- The purchase of DIY kits is prohibited.
- The choice of structure is free and must be made by the students.
- The robot must be powered by batteries.
- The robot must have a smooth top surface of at least 20cm in diameter in which it must accept loads of at least 1kg.
- The purchase of motors and their control electronics is allowed.
- All processing must be done on board the robot.

11.4. Professional Competences Profile

The program has incorporated the Graduate Attributes in the educational process. An engineer who is educated based on the guidelines on the previous pages, will have a professional performance similar to that detailed below. The program may use these guidelines as support to verify its own results, incorporating systematic consultations with graduates[15] about the presence of these characteristics in their professional performance:

Characteristic	Professional Engineer
Comprehend and apply universal knowledge.	**EC1:** Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice.
Comprehend and apply local knowledge.	**EC2:** Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction in which he/she practices.
Problem analysis.	**EC3:** Define, investigate and analyse complex problems.
Design and development of solutions.	**EC4:** Design or develop solutions to complex problems.
Evaluation.	**EC5:** Evaluate the outcomes and impacts of complex activities.
Protection of society.	**EC6:** Recognise the reasonably foreseeable social, cultural and environmental effects of complex activities generally, and have regard to the need for sustainability; recognise that the protection of society is the highest priority.
Legal and regulatory.	**EC7:** Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities.
Ethics.	**EC8:** Conduct his or her activities ethically.
Manage engineering activities.	**EC9:** Manage part or all of one or more complex activities.
Communication.	**EC10:** Communicate clearly with others in the course of his or her activities.
Lifelong learning.	**EC11:** Undertake CPD activities Enough to maintain and extend his or her competence.
Judgement.	**EC12:** Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of his or her complex activities.
Responsibility for decisions.	**EC13:** Be responsible for making decisions on part or all of complex activities.

[15] Criterion No. 11: Effectiveness and Results of the Educational Process.

11.5. Minimum thematic content for engineering education

The minimum thematic contents do not intend to define a unique profile for each of the engineering, but to indicate what are the common knowledge of the Basic Sciences that must share all of them, as well as the indispensable that the professional field of each one of them requires respecting the different orientations that the institutions want to give to the engineering programs they teach. Below is a breakdown of these contents.

Engineering is an activity that is essential to meet the needs of people, economic development and the provision of services to society. Engineering involves the deliberate use of mathematics and the natural sciences, and of a body of knowledge of engineering, engineering technologies and techniques. Engineering seeks to produce solutions whose effects are anticipated in often uncertain contexts. Although it brings benefits, engineering activity has potential adverse effects. Consequently, engineering must be carried out responsibly and ethically, using available resources efficiently. Furthermore, it must be economical, safeguard health and safety, be ecological and sustainable, and it must generally manage risks throughout the life cycle of a system.

The graduate attributes are evaluable results, to attest that the educational objectives of the programs are being achieved.

The quality of a program depends not only on the stated objectives and the attributes evaluated, but also on the design, the committed resources, the teaching and learning processes of the program, and the evaluation of the students, including the confirmation that the Graduate Attributes are accomplished. Consequently, the Washington Accord bases the determination of the substantial equivalence of the programs accredited by the signatories, on the graduate attributes and on the best accreditation practices of which the signatory member accrediting agencies report.

Finally, an engineer who is trained based on the 12 WA[16] attributes listed, capable of designing solutions to complex problems based on the development of engineering activities that involve some or all of the aspects detailed here; and all this educational process is ensured with a solid knowledge base, as they are made explicit; will have a minimum professional performance similar to that detailed in this document as a Professional Competencies Profile. This profile can serve as a comparison parameter, to verify the minimum expected performance in graduates of Chilean engineering.

Engineering Education

The Colegio de Ingenieros de Chile A.G. has defined a base framework that includes the skills, knowledge and competencies that are specific to the professional engineer and, thinking of a professional profile that ensures the above, is that it proposes the following guide for higher education institutions that teach engineering programs.

[16] The acronyms refer to the Washington Accord, to differentiate the definitions of the Sydney Accord, SA; and the Dublin Accord, DA.

PROPOSAL OF THE COLEGIO DE INGENIEROS DE CHILE A.G.

STRUCTURE 5-YEAR UNDERGRADUATE CURRICULUM - ENABLER FOR PROFESSIONAL EXERCISE.
Consider the guidelines of the NATIONAL QUALIFICATION FRAMEWORK in the process of formalization.

<table>
<tr><td colspan="8">Scientific Education Area</td><td colspan="2">Professional Education Area</td></tr>
<tr><td colspan="8">Specialty Program for Bachelor's Degree</td><td colspan="2">Professional Engineering Program</td></tr>
<tr><td colspan="8">(240 SCT; chronological study hours = 5600 to 6400; minimum 40 subjects)</td><td colspan="2">(60 SCT; chronological hours = 1400 a 1600)</td></tr>
<tr><td>Semester 1</td><td>Semester 2</td><td>Semester 3</td><td>Semester 4</td><td>Semester 5</td><td>Semester 6</td><td>Semester 7</td><td>Semester 8</td><td>Semester 9</td><td>Semester 10</td><td>Semester 11</td></tr>
<tr><td colspan="5">Basic Sciences Subjects (12)</td><td></td><td></td><td></td><td colspan="2" rowspan="4"></td><td rowspan="4">Graduation Project</td></tr>
<tr><td colspan="6">Transversal Engineering Sciences (8)</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Fundamental Sciences of the Specialty (8)</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">Project Management (4)</td></tr>
<tr><td colspan="8">General Education Subjects (8)</td><td colspan="2">Specialty Applied Engineering (6)</td><td></td></tr>
</table>

60 SCT = Annual load of full-time studies that includes time in the classroom and personal study.
Academic semesters from 700 to 800 hours of study load.
High specialization in postgraduate.

Proposed subjects:

Scientific Education Area				Professional Education Area	
Basic Sciences	**Transversal Engineering Sciences**	**Project Management**	**General Education subjects**	**Fundamental Sciences of the Specialty**	**Specialty Applied Engineering**
1.- Introduction to Higher Mathematics.	1.- Materials Science	1.- Project Planning and Management	1.- English (4 levels)		1.- Specialty Elective
2.- Differential Calculus	2.- Computer Aided Design	2.- Project Evaluation	2.- Oral and Written Expression		2.- Specialty Elective
3.- Integral Calculus	3.- Economic and Financial Engineering	3.- Environmental Management	3.- Labor Law		3.- Formulation of the Graduation Project
4.- Multivariable Calculus	4.- Solid Mechanics	4.- Business Organization	4.-Ethics		4.- Graduation Project
5.- Differential Equations	5.- Computational tools workshop		5.- Innovation and Entrepreneurship		
7.- Probability and Statistics	6.- Modeling and Experimentation		Others		
8.- Introduction to Physics	7.- Computer programming				
9.- Mechanics I and II	8.- Thermodynamics				
10.- Electricity and Magnetism	9.- Operations Research with Linear and Dynamic Programming				
11.- Waves and Modern Physics					
12.- General Chemistry					

Basic Sciences

Engineering programs, whatever their specialty or mention, must develop in the graduate knowledge and understanding of the Basic Sciences, which correspond to the treatment of mathematics, physics, chemistry and other subjects that support a wide range of disciplines of engineering. The objectives of this area are:

- Contribute to the formation of logical-deductive thinking.
- Provide graduates with the foundations that allow them to successfully face problems that require analytical capacity and innovation.
- Provide sufficient preparation to update and deepen their knowledge.

Transversal Engineering Sciences

It corresponds to the scientific treatment of disciplines related to materials, energies, systems and processes, in order to provide the conceptual basis and analysis tools for the area of Applied Engineering.

Specifically, they must have a content that includes the general disciplines of engineering, such as Materials Science and Technology, Solid Mechanics and Materials Resistance (Theory and Experimentation), Fluid Mechanics and Hydraulic Machines (Theory and Experimentation), Thermodynamics and use of heat energy (Theory and Experimentation), Electrical Engineering, Electronics and Electrical Machines (Theory and Experimentation), Computing and Information Systems, Operations Research with Linear and Dynamic Programming, Environmental Engineering, Economic and Financial Engineering, Planning and Administration of Projects, mainly.

Specialty Applied Engineering

It includes the fundamental elements of engineering that allow the graduate to have a knowledge of the disciplines of each specialty, including the methodologies, standards and practices for analysis, studies and designs, in order to be qualified for the professional practice in the respective specialty .

The curriculum of the different specialties must have a sufficient breadth and level to participate competently in the planning, design and administration of infrastructure projects, productive processes, multidisciplinary projects or research.

It is a main requirement for the study programs to have design workshops in the respective specialties that allow knowing, understanding and applying the methods, calculation rules, legal regulations and in general the updated standards applicable to each specialty.

Project Management

A set of knowledge and skills of the economic and administrative disciplines to understand the impact of the economic environment on engineering projects and plan, manage, and control projects and processes, as well as evaluate and interpret the results. Applied to Engineering, is to be able to recognize objectives, coordinate the use and administration of resources in the most effective and efficient way possible, thus increasing productivity to be able to guarantee the compliance of this objective.

Social Sciences and Humanities

The Colegio de Ingenieros de Chile A.G. recommends that the programs contemplate the foundations and methodologies that allow to effectively develop the activity of engineering in a business context, facilitate the understanding of the globalized world, the restrictions imposed by finance, legislation, ethics and work with social responsibility.

General Education Subjects

The Colegio de Ingenieros de Chile A.G. recommends thatprograms include elective subjects that aim to complement professional education, with subjects not included in the other areas of education or to emphasize education in disciplines that are of interest to each student, within the scope of each specialty.