INSTITUTO TECNOLÓGICO DE COSTA RICA.

ESCUELA DE SEGURIDAD LABORAL E HIGIENE AMBIENTAL.

Proyecto de Graduación para optar por el grado de Bachillerato.

Safety Program for the assembly and disassembly processes of Trópika, habitation module, in the Solar Decathlon 2014 competition.

Academic advisor professor: Andrés Robles Ramírez.

Industrial advisor professor: Juan Carlos Martí Revelo.

Adelina Ortega Rojas

André Blanco Moraga

May, 2014

RECORD OF PUBLIC ADVOCACY OF GRADUATION PROJECT.

Graduation project publicly defended before the examining board composed of teachers Tannia Araya Solano and Ara Villalobos Rodríguez, as a requirement to qualify for the bachelor's degree in Labor Safety and Environmental Hygiene Engineering of the Instituto Tecnológico de Costa Rica.

The guidance and supervision of the work of students was led by faculty advisor Andrés Robles Ramírez.

Ara Villalobos Rodríguez

Jury Professor

Tannia Araya Solano

Jury Professor

Andrés Robles Ramírez

Faculty advisor

Adelina Ortega Rojas

Student

André Blanco Moraga

Student

Cartago, May 21, 2014.

DEDICATORY

I dedicate this project to my friends, those people that were there to make this path the best, to Jessica Alfaro Ruiz, the love of my live, to Adelina Ortega Rojas, my sister from another mother, for all your efford and support and my family, that always is there for support me and make this possible. Also, to the new integrant of my family, we are waiting you…

…las joyas no tienen alma, sólo son espejos colores brillantes…"

—Silvio Rodríguez.

André Blanco Moraga.

I dedicate this project to God who has been my guide in all this process, to my family for always believing in me and for their unconditional support at all times but especially for the greater inheritance they have given me, education; to Andre Blanco Moraga, that since the beginning of this project became another member of my family, for his commitment, effort and dedication until the end.

"Hay hombres que luchan un día y son buenos. Hay otros que luchan un año y son mejores. Hay quienes luchan muchos años, y son muy buenos. Pero los hay que luchan toda la vida: esos son los imprescindibles."

—Bertolt Brecht

Adelina Ortega Rojas

Special thanks to the faculty advisors during this long year: Andrés Robles Ramírez, Alfonso Navarro Garro, Esteban Arias Monge and Miriam Brenes Cerdas, for all your support and advice; to Juan Carlos Martí Revelo for let us live this adventure, for you all, thanks.

SUMMARY

This project was made for the participation of Team Tec (Tech Team Costa Rica) in intercollegiate competition, Solar Decathlon Europe (SDE), France 2014. In this competition 20 universities from around the world must design, build and test a housing module that works with solar energy and must be sustainable. The organization of the SDE requires compliance with European safety standards, which have a higher level than the ones in Costa Rica.

To meet the level of security that should be, was defined as a general objective to propose a Safety Program for the assembly and disassembly process of the Trópika, habitation module proposed by Tec Team for the competition. In order not only to meet the requirements of the organization, but also to strengthen the safety of team members.

Among the main results are the following:

- During assembly the members of the team will be exposed to activities that involve risks with extreme level.
- Any team member has experience about construction works, which increase the risk of accident or incident.
- The knowledge of the team members in construction safety matters is deficient.
- SDE organization requires higher level of safety during all the stages of the project but especially during the assembly and disassembly process.

In response to the above a Safety Program for the assembly and disassembly of Trópika was developed, incorporating safety aspects that should be followed during these processes, safe work procedures in order to guide the team members in the work was prepared to be conducted. It also contains a training plan and an emergency plan. With this tool Tec Team is benefited mainly to have a guide document to perform the work of more securely way which helps to protect and care for the integrity of the team members.

Key words: Safety Program, assembly, disassembly, Trópika and Solar Decathlon Europe.

INDEX

Charts index

Figures index

I. INTRODUCTION.

A. Company identification.

1. Vision / mission of the company.

Created in 2002 by United States of America (U.S.A) Energy Department, the Solar Decathlon had such a success that inspired the European Union (U.E.) to create their own version: Solar Decathlon Europe (SDE); but the concept is the same: an international competition among which promotes universities to develop efficient houses. The objective of the participating teams is to design and build houses that naturally consume as few resources as possible and produce minimum waste products during their life cycle. Particular emphasis is put on reducing energy consumption and on all the necessary energy obtaining from the sun.

The event has a twofold purpose: educative and scientific. The Decathletes learn how to work in multidisciplinary teams and how to face the challenges of the future of building by developing innovative solutions. On the one hand, the public can see and becomes aware of the real possibilities of reducing the environmental impact and at the same time keeping the comfort and quality of the design in their homes. Also the professionals have access to techniques and processes that they can study and use. In addition, volunteers, who are essential for the development of the SDE, have the opportunity to share experiences with the teams and move ahead in their careers thanks to their work during the competition.

Moreover, universities, companies and public institutions have access to a new way of collaborating, for example, by trying out scientific projects in real conditions to launch them later onto the market or by improving and using existing products in a creative way.

2. Historical background.

The Solar Decathlon Europe has its origin in the American competition US Solar Decathlon. The SDE was born out of a bilateral agreement between the American and the Spanish governments, after the participation of the Polytechnic University of Madrid in previous editions in Washington DC. The first competition outside the United States, the Solar Decathlon Europe 2010, took place in Madrid in June 2010.

A similar agreement has recently resulted in the Solar Decathlon China. The European Edition is done in even years and the American competition in odd years; from its first edition in 2013, SD China will take place with some months of difference from the US Solar Decathlon. The three competitions have similar principles and objectives, but they are independently organized and have some differences regarding regulations and contests, adapting in this way to their own circumstances and contexts.

3. Geographic location.

The habitation module Trópika, will be made design and tested at the Tecnológico de Costa Rica, located in Cartago, Costa Rica. Then the house will be sent to the Cite Du Soleil®, Versailles, France; where it will be assembled in a Solar Village, place where the Solar Decathlon Europe 2014 competition will be held.

4. Organization.

The team that will represent Costa Rica during the competition is formed by engineering, Information Technologies and administration students, all from the Tecnológico de Costa Rica. The project's director is Juan Carlos Martí Revelo a graduated engineer in Industrial Design. Behind the Tec Team (name of the group) are a lot of people helping to make this project a reality: sponsors, faculty advisors and suppliers, nevertheless, the organizational breakdown structure (OBS) of the Tec Team is described on the next figure:

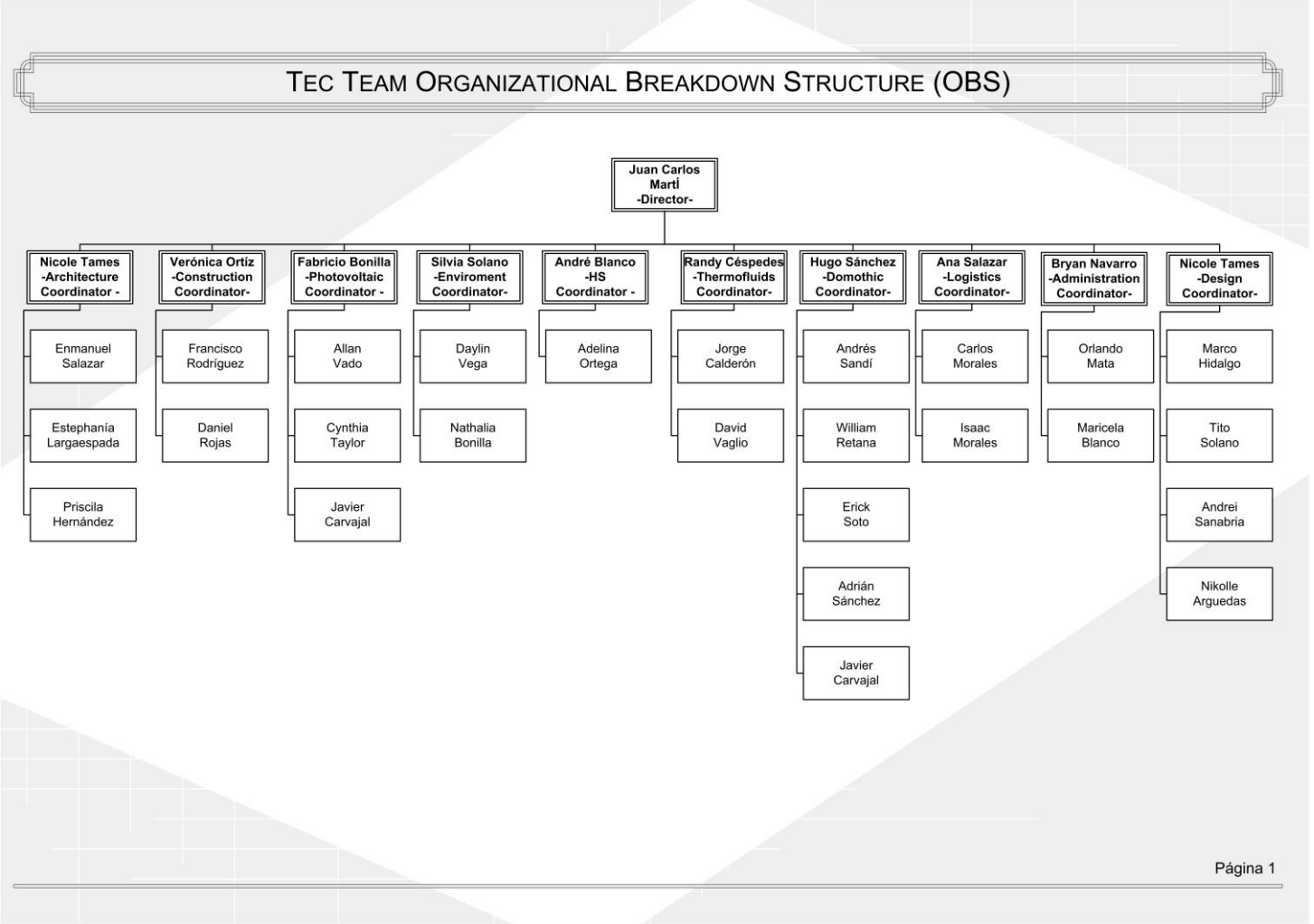


Figure 1. Tec Team OBS

5. Number of participants.

The Tec Team is integrated by 35 students from 12 fields, all of them from the Tecnológico de Costa Rica. Additionally it has internal consultants as teachers, researchers and external advisors and private sector professionals. The group covers different areas such as administration, construction, architecture and engineering. However, just 30 students are going to be able to work in the construction in France.

6. Product.

Trópika is a tropicalized construction which uses techniques that seek maximize the benefit of our tropical conditions and local materials. This model is proposed in a way that can be replicated in any country in the world that has similar climatic characteristics of Costa Rica, being affordable and with the possibility of being built and vertical residential complex.

Trópika goes far beyond a housing module that works through solar energy, since it is involved in the commitment to produce the least possible environmental impact, not only in performance, but from the design and construction stages, while achieving a high level of comfort without neglecting the needs of the elderly.

7. Market.

People over 65 were elected as target market module to Trópika, who may or may not have special needs. All the module design is thought-out in the accessibility so it comply with the national law 7600 in all it aspects.

8. General production process.

The design of the habitation module is one of the early stages, and then make the assembly in Costa Rica, followed this, housing is sent to the city of Versailles in France, home of the competition for 2014, which will be made the housing assembly, but this time in the Solar Village where housing is open to the public, demonstrating their functionality for ten days and then be disassembled and shipped back to Costa Rica. During the design and planning of the proposal, the team must send reports to an interdisciplinary jury, which will assess the progress made, these assessments contemplate deliverables stipulated in the competition regulations.

B. Graduation Project Justification

Every year large number of deaths and injuries to workers in the construction sector occur as a result of the inherent dangers that have this type of work. In the U.S. 67% of workers in the construction sector believed to be at risk (Suraji, 2006), however only stick to this figure would limit the situation; this belief is shared by workers in the same field worldwide. In Europe each year there are more than 50,000 fatal accidents in the construction industry; for every ten minutes one accident of the same category would be happening (Rubio, 2005).

Although, the above data is not a secret to those in charge of construction processes, the factors that trigger these accidents are not properly controlled. Is noteworthy that not only the direct construction workers are affected, also outsiders to reach work areas suffer due to lack of control of risks in this sector of the industry (Williams, 2006).

As development proceeds on the topic of safety, construction companies have been forced to implement safety standards for the performance of their works, however does not take into account that this issue should be promoted as an organizational culture.

Taking into account the issues raised by previous authors for the competition Solar Decathlon Europe 2014, intercollegiate competition of international prestige, where is designed and built an eco-sustainable solar house, strict rules are set to follow regarding technical safety criteria for the different stages of the project. During the assembly and disassembly of Trópika, the students and all the involved personnel will be protected from an emergency. It is important to mention that none of the team members is a worker of the construction industry and have never worked in this area, many of the team members do not have knowledge on safety for the work to be performed, and so, it is mandatory to provide safety training for jobs in the construction industry. According to Rule 52 of the competition Solar Decathlon Europe 2014 regulation, safety is an area of great importance to the organizers, in which the planning and execution safely is emphasized in the production process, especially in the assembly and disassembly of the module.

This represents great responsibility for the health and safety department which should ensure the welfare of the work team conformed by approximately 30 students and

employees hired because as indicated in the SDE rules Version 2.1, of the competition Solar Decathlon Europe, Rule 3.3: each team is responsible for safety in operations and each team member must work safely throughout the project.

Planning and control in the early stages of the construction process are key to the management and prevention of hazards that may arise during the construction work, in this particular case, this planning must be done in terms of assembly processes and disassembly of the housing. Planning early allows control of hazards related to the type of tasks performed, however also allow better manage any unexpected event that may occur, for which competition is paramount.

Once in France, Trópika assembly, should be done under very strict standards and complying with the time set by the organizers, so it can be exposed and compete in the Solar Village without penalties. Being the assembly and disassembly tasks performed mostly by student members of the team, the procedures must be fully planned because any accident indirectly affects the initial manner stipulated time for these workings, which is a risk that the team cannot afford.

A good risks prevention and the personnel training during the constructive process decrease our risk to have an incident or an accident and that way our risk to be penalized or even disqualified from the competition.

Many studies of accidents in the construction sector indicate that 80% of accidents have causes related to organization errors, planning and control and the remaining 20% is due to runtime errors. Hence, the importance of integrated the prevention from the design, and the need of have everyone involved in the production process inform of the risks that they are exposed (Banchs, González, llacuna& Pujol, 2004).

The Safety Plan for the assembly and disassembly processes of the habitation module Trópika, is part of the deliverables the de competition organizers request; this requirement is important because the report is evaluated by experts and they decide if the team is approved to continue with the competition. It is important to mention that even if the Safety Plan is approved by the organization but the Team is not informed about the safety procedures, the Tec Team can be eliminated from the competition.

The participation in this event is a unique opportunity to show the potential of our country to the world and also make known the Tecnológico de Costa Rica as a great source of knowledge and science of Latin America. This project also promotes the interdisciplinary with the participation of at least 12 carriers of the university in a unique way due to the fact that the Tecnológico de Costa Rica has never been involved in a competition as big as this one (Chinchilla, 2013). This show the importance to ensure high quality standards in safety and our Safety Plan try to ensure this aspect.

C. Statement of the problem.

The proposal of the Tecnológico de Costa Rica for the Solar Decathlon Europe 2014 competition requires a Safety Program that promotes safe conditions necessary during assembly, disassembly housing module.

D. Graduation project objectives.

General Objective:

Propose the Safety Program for the processes of assembly and disassembly of the habitation module Trópika in the Solar Decathlon Europe- France, 2014 competition.

Specific Objectives:

• Assess the associated hazards with the various stages of assembly and disassembly of the habitation module Trópika.

• Propose the safe work procedures for assembly and disassembly of Trópika.

• Propose the safety training plan in the assembly and disassembly process for the members of Team Tec.

• Establish the safety program components for assembly and disassembly of Trópika.

E. Reaches and Limitations of the Work.

Reaches

Beyond being a requirement to comply with the Solar Decathlon Europe 2014 regulations, the project offers a proposal for a Safety Program for the stages of assembly and disassembly of the housing module Trópika, to reduce the risks that the team members and workers hired during assembly and disassembly are exposed.

Being a prefabricated home, the Safety Program acts as a guide to perform safely the process of assembly and disassembly of companies of prefabricated construction in different latitudes.

Limitations

Within the program the hazards associated with environmental hygiene and health to which are exposed the people involved in the process of assembly and disassembly are not covered.

This proposal is made in order to prevent hazards during assembly and disassembly processes, because while creating this Safety Program, the housing module continues at the design stage. This is why the identification of hazards in the initial stage of this project is done by collecting information of companies involved in the construction of prefabricated housing, expert input and literature review.

Also are taken into account the endogenous and exogenous factors in Versailles, France. In case Safety Program originally designed for Trópika to be used for other projects should be taken into account the specific characteristics of the projects to perform the necessary technical adjustments.

II. THEORICAL FRAMEWORK.

The construction works have always been regarded as dangerous activities because of the increased incidence of accidents in this sector, with a greater rise in fatal consequences (Lopez, 2000). Due to the activities that are performed, it is necessary to take into account the nature of the assembly and disassembly processes to have a more accurate view of the dangers that may be occurring in the workplace. In the specific case

of Trópika, the assembly process for Solar Decathlon Europe 2014 competition include the following conditions:

-The construction works will be in a temporary work center where site characteristics are not known with certainty and the necessary conditions to safeguard the integrity of those who work in it conditions do not exist.

-It is a unique product because it does not correspond to mass production, and therefore it is not possible to test up to improve procedures.

-Safety knowledge of the workers in the construction sector is very low because the total work personnel are students from different careers that are part of the team that will built the house and never has been involved in this activity. (Solar Decathlon Europe, 2013).

-Work will be on public roads, representing interference to others, creating risks that normally would not exist.

-Outdoor work will be undertaken so that people who are working will be subjected to inclement weather. This factor also affects the activities and can paralyze work for unknown periods (Rubio, 2005).

These aspects are considered an influential factor in the concretization of accidents in the field of construction. The accidents in the construction sector are conceptualized as situations where the integrity of a worker is compromised due to an undesirable event that occurs as a direct result of unsafe conditions and activities that were not controlled by the project managers. The project managers are responsible for creating and maintaining a working environment in which workers can perform their tasks safely (Holt, 2008).

This growing employment sector attracts the attention of specialists in the area of security, this led to many studies and after many years and philosophy the community defined important terms with respect to the possibilities and probabilities that an accident or incident occur; such terms must be analyzed to better understand the issue. The concepts in this paper have focused on the construction industry. The most important are:

-Hazard: A condition with the potential to cause injury to staff, damage to equipment

and/or the structure, material loss, or loss of ability to perform a function described. The possibility that a hazard is realized depends on the conditions of the working environment, preparing workers for the task and preventive measures taken. (Vaidogas, 2010).

-Damage: The result produced by a hazard on the quality of individual or collective lives (NIOSH, 2007).

-Risks: Although the dictionary of the Royal Spanish Academy of Language defines it as the proximity of the damage, in the context of prevention of risk must be understood that the probability of damage occurs in the presence of a hazard and that can therefore, be quantified. The risks may not only affect the health of the people involved in the construction work, also have a direct impact on the quality of construction, direct and indirect costs, delivery times and even damage to third parties. In this particular case any risks that cannot be controlled will affect the rating obtained for the Solar Decathlon competition (Cortés, 2007).

When the concept is understood and the whole people realized that there is always the possibility of harm, the vision of the different workspaces expands and everyone start taking into account that all workspaces are different.

As regards the assembly and disassembly processes work is done at different levels, use of heavy machinery, material handling, handling of hazardous substances, use of dangerous tools, electrical installations, etc., which make these processes in a activity with high levels of risk. According to the Regulations of the 2014 Solar Decathlon competition, assembly is defined as the time between the arrival of the trucks with the materials for the construction of housing and the start of competition in the Solar Village where Trópika will be installed, moreover, the same rules defined disassemble the period of time between the completion of the public tour and the completion of the cleaning of the Village Solar.

The risks that the Tec Team members will be exposed, have a major impact, both for them and for the entire project itself. Those responsible for carrying out the works are students with no experience in construction, which greatly increases the possibility that the dangers are realized, and accordingly: possible delays in the schedule, increased

project costs, penalties, discredit Tec Team and damage to the integrity of students.

The best way to manage risks proactively is through a safety program for assembly and disassembly processes that drives safety performance in the workplace, this is achieved by implementing preventive measures that take care of lower impacts of hazards that may occur in the works, establishing a culture focused on safety, preventing delays in the project and maintaining a good image of the team (Jin & Chen, 2013).

In order to establish a solid program should be considered that the pillars of this must be dynamic and comprehensive. One element that should be taken into account in the construction process, are working procedures. These are formed by a table containing the information to perform a task so that worker´s health is not compromised. A safe work procedure is routine, repetitive and integral to the process, which ensures both a good production and the protection of the person performing the work (Kama, 2009). It should also take into account that emergencies are always present and ignore those can have serious effects.

To anticipate these events is necessary to implement emergency plans. These documents provide and organize the actions of those affected during unexpected events that occur in the workplace (U.S. Department of Labor, sf). By clear and correct definition of the actions to be taken when an adverse event occurs, it creates the possibility to minimize the potential injury and damage to equipment and materials. When an emergency occurs, people have to deal with an exceptional situation in which the actions taken and the time it takes will be crucial for efficient response. Keep in mind that the preparation stage is crucial in the process of emergency management. During this stage the plans are developed based on the analysis of vulnerability and responsiveness with which the team has (Aedo, Yu & Diaz, 2012).

To ensure that workers perform their work safely, trainings should be implemented, which are systematic, that are planned and ongoing activities whose general purpose is to prepare, develop and integrate members of a working group to that in the field of safety, so they can gain optimal performance, providing results in the reduction of the possibility of an accident or incident (Brow & Costa, 2009).

The personal protective equipment (PPE) is another preventive tool that is designed to

protect employees in the workplace from injuries or serious illness that can result from contact with chemical, electrical, mechanical hazards (OSHA, 2010). The industrial safety community prefers to use the PPE as a last resource to which one must resort to cover potential hazards (McDonald, 2004), but it is always important to know that the danger is present and that in spite of preventive controls, the possibility to occur also exist.

The above elements are integrated to create the safety program for habitation module. The union of these concepts, tools of information gathering, consultation with experts and bibliographic revision result in a systematic tool to implement hazard prevention. In the case of housing Trópika must create the program from scratch, because it will be adjusted to the specific needs of the project. Any safety measure should be taken with maturity and seriousness, since the purpose is to protect the integrity of all project workers (Crutchfield, 2007).

The Safety Program for the assembly and disassembly of the housing Trópika is a document that explains in detail the preventive measures to be taken during the process to overcome the hazards associated with each phase. All equipment and reviewers involved must know this Safety Program and therefore all activities under the provisions of it, to reduce the potential occurrence of accidents.

III. METHODOLOGY.

A. Kind of study.

For this project, an exploratory study was made, in this type of study the researcher examines an issue or problem unexplored, which have many doubts. Exploratory studies are used to identify promising concepts (Hernández, Fernández & Baptista, 2010).

It is also an applied research because the researcher proposes himself to apply certain knowledge to solve problems whose solution depends on the benefit of individuals or communities. This research also serves to take action and establish policies and strategies (Naghi, 2005).

This project qualifies as a case study type research. This because it is single case study which aims to understand the dynamics present in this context in order to describe and generate theory using different methods for collecting qualitative evidence (Martinez, 2006).

B. Kind of information

1. Primary sources

Books

- Practical Industrial Safety, Risk Assessment and Shutdown.
- Seguridad e higiene del trabajo: Técnicas de prevención de riesgos laborales.

Others

- Solar Decathlon Rules V. 2.1.
- Occupational Health and Safety Program Manual, City Elevator Ltd.
- Seguridad e higiene del trabajo: Técnicas de prevención de riesgos laborales.

2. Secundary sources

INTECO

- INTE 31-09-09-00 Guía para la elaboración del programa de salud y seguridad en el trabajo.

INSHT

- NTP 560: Sistema de gestión preventiva: Procedimiento de elaboración de las instrucciones de trabajo.

NIOSH

- Reviews of Research Programs of the National Institute for Occupational Safety and Health.

OSHA

- Training and Reference Materials Library - Elements of an Effective Safety and Health Program.
- Hoja de datos: Equipo de Protección Personal.

Others

- Manual para la formación de nivel superior en prevención de riesgos laborales.

C. Population and sample

The population of this project are students of the Tecnológico de Costa Rica belonging to the Tec Team, prefab building companies and state entities as EICPSA (first aid training) and the National Emergency Commission. The selection of the sample made with respect to the disposal of companies to work with structured interviews. The chosen construction companies are those who construction process had similarities with the one proposed of Trópika. Therefore, because the selection of the sample is performed at the convenience of the group is classified as unrepresentative type. Companies are informed that the data obtained from the interviews are confidential, and no names will be published.

D. Operationalization of variables

At next we show the operationalization of the variables, where each chart each one of the Project objectives. Each chart contains the variable of the objective, conceptualization, the indicator and its respective measures tools. Each tools will be described on the next section.

Objective 1. Assess the associated hazards with the various stages of assembly and disassembly of the habitation module, Trópika.

Chart 1. First objective variable operationalization.

Variable	Conceptualization	Indicators	Tools
Evaluation of possible risks during the stages of assembly and disassembly.	Identification and evaluation of the possible risks that are going to be present during the assembly and disassembly which can create negative consequences for the work process and the health of the people involved in the project construction.	Risks levels present during the assembly and disassembly of the habitation module.	-Expert's structured interview that work on homologous companies. -Brainstorming to the Tec Team. Possible hazards per work phase evaluation matrix. -Risks Administration Australian Standard AS/NZS 4360: 1999.

Source: Blanco y Ortega, 2013.

Objective 2. Propose the safe work procedures for assembly and disassembly of Trópika.

Chart 2. Second objective variable operationalization.

Variable	Conceptualization	Indicator	Tools
Safe Work procedures for the assembly and disassembly of Trópika.	Detailed descriptions of the tasks that will be develop in a safe way during the assembly and disassembly.	Responsibility level of the construction process leaders. Amount of safe and unsafe acts. Frequency of accidents and incidents because of a safety procedure breach. Safe and unsafe acts percentage. Fulfillment level of the safety requirements.	Organization Break down Structure (OBS). Responsible assignation matrix (RAM) Safe and unsafe acts check list Accidents and incidents records. Safety procedures elaboration guide. Check list for the safety procedures evaluation.
		Impact level of the environment risks.	Expert's structured interview that study natural events. Risks Administration Australian Standard AS/NZS 4360:1999.

		Efficiency of the adopted arrangement Fulfillment level of the emergency procedures.	Emergency response elaboration guide. Emergency plan fulfillment check list.

Source: Blanco & Ortega, 2013

Objective 3. Propose the safety training plan in the assembly and disassembly process for the members of Team Tec.

Chart 3. Third objective variable operationalization.

Variable	Conceptualization	Indicator	Tools
Safety training plan about the assembly and disassembly of Trópika for the Tec Team members.	The training plan seeks to cover the planned processes, systematic and organized tasks to modify, improve and increase the safety knowledge, skills and attitudes of the team members.	Team member's knowledge level of safety during the assembly and disassembly processes. Training needs priorities	Construction processes safety knowledge inquiry to the Tec Team members. Training subjects priorization matrix. Multi-vote technique.

Source: Blanco y Ortega, 2013.

Objective 4. Establish the safety program components for assembly and disassembly of Trópika.

Chart 4. Fourth objective variable operationalization.

Variable	Conceptualization	Indicator	Tool
Safety Program components	Components needed for a safety program to be effective and has the ability to improve the health of the workers involved.	Percentage of fulfillment. Level of fulfillment of the SDE organization evaluations. Responsibility level of the construction processes leaders.	Safety Program Elaboration Guide provided by the Solar Decathlon 2014 V. 2.1 Rules. Check list according to the fulfillment of the elaboration of a safety program based on the Solar Decathlon Europe 2014 V. 2.1 rules. Responsibilities assignation matrix

Source: Blanco y Ortega, 2013.

E. Tools description.

Diagnosis objective:

- Experts interview that work on homologous companies.

Specialized information collection method the use a professional dialogue between an interviewer and a interviewed with the purpose of learning through the experience of an expert on the subject, in this case, the construction engineer in a construction company manufactured housing form, the dangers present in the process of assembly and disassembly of prefabricated housing was the main topics of the interview. The frequency will be determinated by the amount of times the interviewee answer positively a question.

- Expert's structured interview that study natural events.

Specialized information collection method the use a professional dialogue between an interviewer and an interviewed with the purpose of learning through the experience of an expert on the subject, in this case, the National Emergency Commission of Costa Rica, the main topics of the interview is obtain information about natural events that could occur during the construction processes in France, based on the risks given by the SDE organization.

- Brainstorming of the Tec Team.

Tool that allows to generated new ideas in a non-structured way about a specific topic with two or more persons. With this brainstorming we obtain the possible risks presents during the construction process (Ricolfe, 2004). This tool will be used with the Tec Team.

- Possible hazards per work phase evaluation matrix.

This matrix allows to relate each task of the constructive processes to its risk level.

-Australian Risks Administration Standard AS/NZS 4360:1999.

Australian proposal methodology for risk administration that involved the context, identification, analysis, evaluation, treatment, communication and risks monitoring.

Design Objectives.

-Organization Breakdown Structure (OBS).

Organizational structure of the Tec Team.

-Responsibilities assignation matrix (RAM).

It is used to relate resources (persons) with activities, this way every one knows his/her role on an activity.

-Check lists.

The checklist is a questionnaire form used to verify the degree of compliance with certain rules set in advance for a particular purpose. For this project the following checklists were developed, which are based on their respective guides:

- Emergency plan fulfillment.
- Safe and unsafe acts evaluation.
- Safety procedures evaluation.
- Fulfillment of the elaboration of a safety program based on the Solar Decathlon Europe 2014 V. 2.1 rules.

-Accidents and incidents records.

Data control sheet that have the accidents and incidents that occur during the constructive processes.

- Safe procedures elaboration guide.

Tool that contains the minimal requirements that a safe work procedure should have. This will be applied for the risky tasks that will be developed during the assembly and disassembly of the habitation module. This instrument is based on the NTP 560: Preventive Management System: Safe work procedures elaboration.

- Emergency response elaboration guide.

Document containing the components and structure for the development of procedures to follow in case of emergency situations occurring during the process of assembly and disassembly. This is a tool that defines the process to be followed to develop a correct emergency response procedure.

-Construction processes safety knowledge inquiry to the Tec Team members.

Structured interview to obtain specific information from a specific population.

The inquiry consists in ten questions that pretends to know the knowing level of safe during a constructive process. The inquiry was applied to the Tec Team members.

- Multi-vote technique.

Allow to sort the issues of safety training for the assembly and disassembly procedures through voting, each person is assigned 9 points to vote for the various training topics, amount of votes allocated to each item per person is limited (1-9), so that the prioritization of topics will be established by the number of votes for each topic, more votes the higher the priority. This technique is developed to provide team members with their knowledge and greater interaction in the training process.

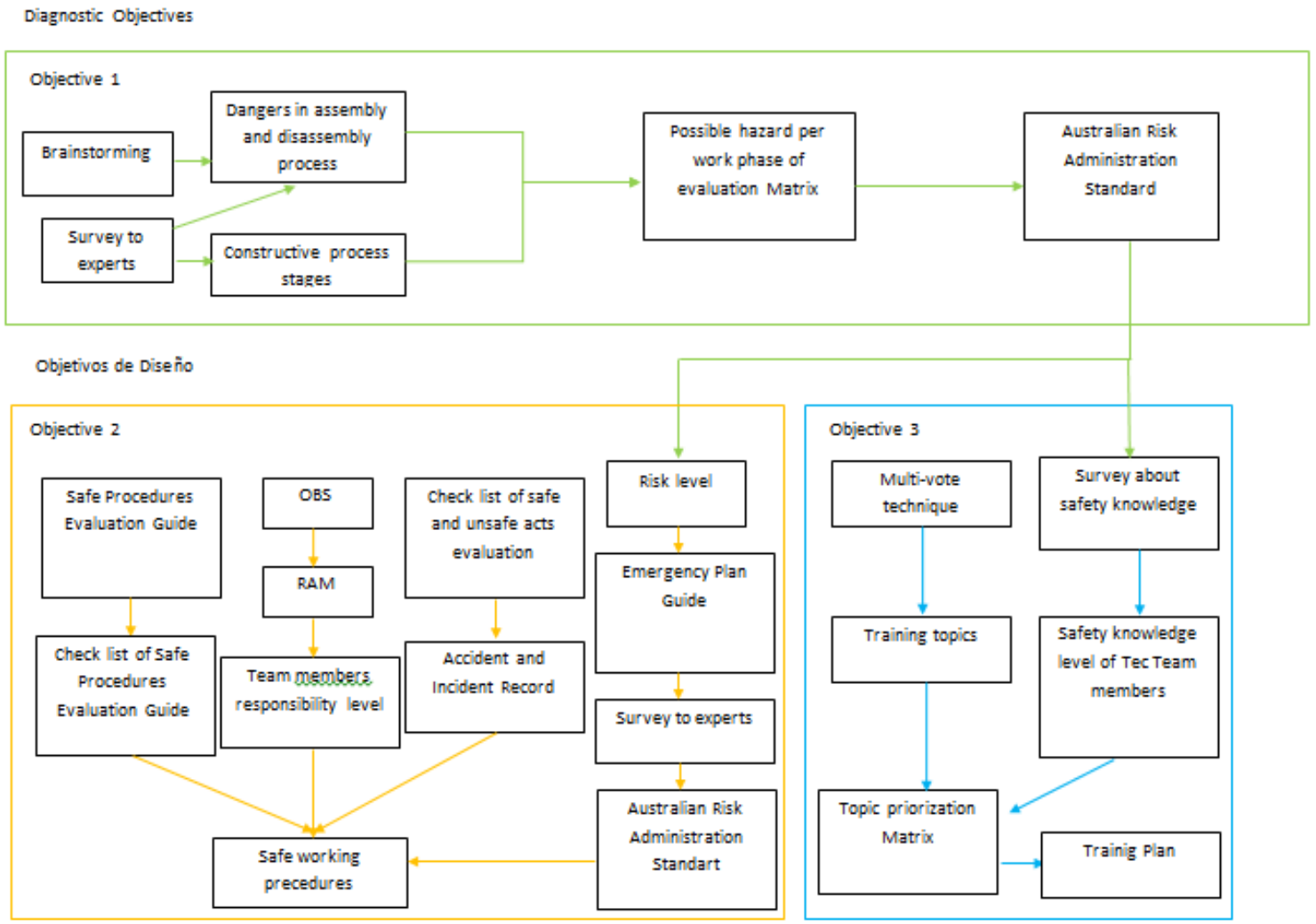
- Training subjects priorization matrix.

Relate the variables that were taking into account to determinate the training topics priority.

- Safety Program Elaboration Guide provided by the Solar Decathlon 2014 V. 2.1 Rules.

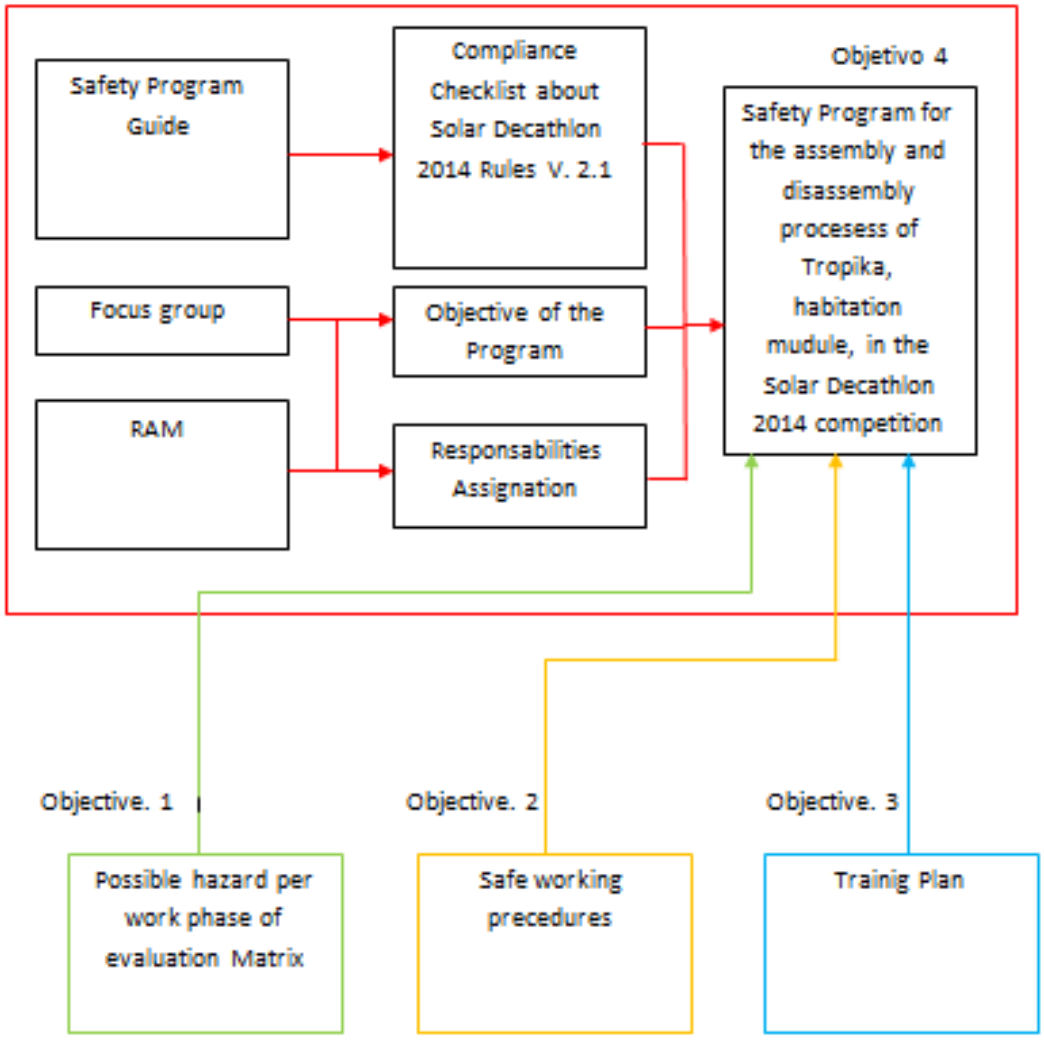
This guide is based in the SDE Rules. Its function is to establish the section that are essential for the French regulation.

F. Analysis Plan



Source: Blanco & Ortega, 2013.

Figure 2. Analysis Plan.



Source: Blanco & Ortega, 2013.

Figure 3. Analysis Plan.

G. Schedule, economic cost and risks analysis of the project.

For an ordered confection of the project a schedule (appendix 1) was followed. Besides, the economic cost of the project is described on the appendix 2.

Adicional a lo anterior, se estableció un análisis de riesgos del proyecto (ver apéndice 3, con la finalidad de establecer medidas de mitigación o prevención de posibles riesgos que pudieran obstaculizar la realización del proyecto.

IV. CURRENT SITUATION ANALYSIS.

A. Activities Identification Process.

The SDE organization develops several leaders that have to be performing special tasks during the construction process. In this case, the Tec Team leaders are not the same of the assembly and disassembly. There are four important persons that are in charge of the logistic and safety of Trópika, those leaders are: Site Operation Coordinator, Site Operation Officer, Health and Safety Coordinator and the Health, Safety Officer and our department include another leader: Brigade Captain. The respective responsibilities are mention in the chart below:

Chart 5. Constructive process leaders RAM.

Leader	Responsibilities					
	Emergency Attention	Site Coordination	Risks Prevention Inspection	Site Logistic Coordination	First Aids Attendance	Emergency Communication
Site Operation Coordinator		X	X	X		X
Site Operation Officer		X	X	X		X
Health and Safety Coordinator	X		X			X
Health and Safety Officer	X		X			X
Brigade Captain	X		X		X	X

Source: Blanco & Ortega, 2013.

With the leaders tasks assigned the next step is to move forward to the constructive process activities and tasks:

The assembly and the disassembly of the habitation module is going to be divided into activities and tasks as described on the charts below.

Chart 6. Assembly process.

Activity	Task
Previous works	-Clean the construction site. -Arrival of the container to the site. -Install the working areas. -Place the metallic safety fences to delimit the construction site, crane area and other machinery area. -Place tends and safety ribbons to delimit the work areas. -Place the signposting. -Download tools. -Assemble basic equipment. -Installation of heavy equipment. -Installing the light equipment.
Site preparation	-Checking the ground levels. -Adjust footing level out. -Determinate the location of the footings. -Level out the footings.
Establishment of the foundation system	-Transport the footings with the forklift to the site. -Place the footings to its place. -Check alignment.
Establishment of primary structure	-Transport the columns from container to the site with the forklift. -Attach the column to the crane. -Hoist the column Set columns into the foundations. -Place column’s holders. -Transport the rafter to its site with the forklift. -Attach the rafter to the crane. -Hoist the rafter with the crane. -Placement of the rafters. -Attach rafters to columns.

	-Transport the floor's tie rafters with the forklift. -Attach the rafters with the floor tie rafters Attach the columns with the floor tie rafters. -Attach the footings with the floor tie rafter. -Transport the capping rafters with the forklift. -Install the scaffolding. -Hoist the capping rafter into position with the crane. -Attach the capping rafter to the columns.
Floor installation	-Transport the floor panel to the site with the forklift. -Classify the panels by its size. -Attach the floor panels to each other. -Place the floor panels with the crane. -Attach the floor panels to the rafter.
Enclosures	-Placement of the scaffoldings. -Transport the wall panels to the site with the forklift. -Attach the wall panels to the crane. -Wall hoisting. -Place the wall panels between columns. -Attach the wall panels to the columns. -Transport the inner wall to the site with the forklift. -Assemble the inner wall panels. -Inner walls hoisting with the crane. -Place the wall panels. -Attach the inner wall panels with the perimeter. -Transport the windows to the site with the forklift. -Assemble the windows items. -Place each element of the window -Transport the door to the site with the forklift. -Doors installations.
Roof installation	-Transport the roof rafter to the site with the crane. -Attach the roof rafters to the crane. -Hoist the roof rafter. -Attach the hoist rafter to the columns -Transport the roof battens from the container to the site with the

	forklift. -Attach the roof battens to the roof rafter. -Transport the roof deck to the site with the forklift. -Attach roof deck's pieces together. -Attach to the roof battens. -Install the support structure for the bathroom roof. -Install the water tanks. -Transport the bathroom ceiling panels to the site. -Attach the bathroom ceiling panels to the crane. -Hoist the bathroom ceiling panels. -Place the bathroom ceiling panels. -Attach the bathroom ceiling panels to the structure. -Transport the module ceiling panels to the site. -Attach the module's ceiling panels to the crane. -Hoist the module ceiling panels with the crane. -Place the module ceiling panels. -Attach the module ceilling panels to the structure.
Electrical installation	-Pipes installation under the floor, between the walls and above the ceiling. -Electrical equipment connection. -System verification. -System connection to energy.
Hall and ramp construction.	-Transport hall columns from container to the site with the forklift. -Attach the columns to the crane. -Hoist the hall columns -Place the hall columns -Attach hall columns to footing -Transport the rafter with the forklift. -Place the rafter with the crane. -Attach the rafter to columns -Transport floor enclosures with the forklift. -Attach floor enclosures to the rafter. -Transport the capping rafter -Hoist the capping rafter.

	-Attach the capping to the column -Transport the ramp to the site. -Assemble the ramp items -Place the ramp -Assemble the roof deck -Place the roof deck -Assemble the garden items -Place the garden items.
Final details	-Transport the marquee -Attach the marquee to the capping rafter -Transport the railings -Place the railings. -Place tensors -Transport the flowerpots -Place the flowerpots -Place the components -Transport the furniture -Place the furniture -Transport the grid -Place the grid -Place the components -Transport the metallic letters of the module -Place the metallic letters. -Transport the ramp accessories. -Place the ramp accessories. -Asssemble the ramp.

Source: Blanco & Ortega, 2013

Chart 7. Disassembly process

Activity	Task
Furniture and marquee removal	-Remove the marquee from the capping rafter -Remove the railings. -Transport the railings to the container. -Remove tensors. -Transport the flowerpots. -Remove the furniture. -Transport the furniture to the container. -Remove the grid. -Transport the grid -Remove the metallic letters of the module. -Remove the ramp accessories. -Disassembly the ramp.
Hall and ramp disassembly.	-Disassemble the garden items. -Remove the garden items. -Disassemble the roof deck. -Remove the roof deck. -Remove the ramp. -Disassemble the ramp items. -Transport the ramp to the container. -Remove the capping from the column. -Hoist the capping rafter. -Transport the capping rafter. -Remove floor enclosures from the rafter. -Transport floor enclosures with the forklift to the container. -Attach the rafter from the columns. -Remove the rafter with the crane. -Transport the rafter with the forklift to the container. -Remove hall columns from footing. -Remove the hall columns. -Hoist the hall columns. -Remove the columns with the crane.

	-Transport hall columns to the container.
Electrical des-installation	-Pipes uninstall. -Electrical equipment disconnection
Roof des-installation	-Remove the module ceiling panels from the structure. -Hoist the module ceiling panels with the crane. -Transport the module ceiling panels to the container. -Remove the bathroom ceiling panels from the structure. -Hoist the bathroom ceiling panels. -Transport the bathroom ceiling panels to the container. -Remove the water tanks. -Remove the support structure from the bathroom roof. -Remove the roof battens. -Remove the roof's deck. -Transport the roof deck to the container. -Remove the roof battens from the roof rafter. -Transport the roof battens to the container with the forklift. -Remove the roof rafters from the crane. -Transport the roof rafter to the container.
Enclosures	-Doors unistall. -Transport the door to container. -Remove each element of the window. -Disassembly the windows items. -Transport the windows to the container. -Remove the inner wall panels. -Remove the wall panels. - Disassembly the inner wall panels. -Transport the inner wall to the container. -Remove the wall panels from the columns. -Wall hoisting. -Transport the wall panels to the crane.
Floor des-installation	-Remove the floor panels from the rafter. -Remove the floor panels with the crane. -Transport the floor panel to the container.

Remove the primary structure and the foundation system	-Remove the capping rafter from the columns. -Hoist the capping rafter. -Remove the scaffolding. -Remove the columns from the floor tie rafters. -Transport the floor's tie rafters. -Remove rafters from the columns. -Remove the rafters. -Hoist the rafter. -Transport the rafter to the container. -Remove column's holders. -Remove columns from the foundations. -Transport the columns from container to the container. -Transport the footings to the container.
Final works	-Uninstall the light equipment. - Uninstall of heavy equipment. -Disassembly the basic equipment. -Remove the signposting. -Remove tends, safety ribbons and fences that delimit the work areas. -uninstall the working areas. -Departure of the container from the site. -Clean the construction site.

Source: Blanco & Ortega, 2013

B. Process of analysis.

1. Risk identification and evaluation during the assembly and disassembly of the habitation module, Trópika**.**

The main objective of the Health and Safety department is to keep the integrity of all members of TEC Team, visitors and people of the surroundings in safe. That is why the department had made a compilation of all risk that can happen during the assembly and disassembly.
The TEC Team knows that the risk identification and evaluation is very important segment of the development of the project, which is why we collected information from several professional

segments that are related to this kind of activity, this way we decrease the uncertainty on the risk evaluation. The strategy we used allows to integrate the opinion from experts by interviews to the Health and Safety department from construction companies, also the opinions of the TEC Team by a brainstorming and the mentioned risks on the Solar Decathlon Europe V 2.1 rules. The results of the different information compilation are:

- Interviews to construction companies.

Structured interviews (appendix 4) were applied to 5 construction companies in Costa Rica. The companies were chosen by their disposal to help. The results are summarized on the next chart. The frequency is determinate by the times a company mention the existence of it during the construction process.

Chart 8. Risk groups and frequency obtained from the structured interviews.

Risks	**Frequency**				
	1	**2**	**3**	**4**	**5**
Electrical		X			
Different level falls				X	
Same level falls			X		
Falling objetcs			X		
Collision with vehicles		X			
Minor abrasions					X
Hits					X
Cutting injuries				X	

Overexertion				X	
Heatstroke		X			
Burns	X				
Fire	X				
Explosion	X				

Source: Blanco & Ortega, 2013

With this data we can see that the most frequent risks are the minor abrasions, hits, cutting injuries and overexertion, according to the experience of the Health and Safety department of the construction companies in Costa Rica.

- Brainstorming.

This data compilation technique was applied to the Team to know their perception of the risks that each department is exposed to. On the session we ask: Which risks do you consider that the Team is exposed during the assembly and disassembly of Trópika? The session was very productive and very important data was provided. The data is summarized on the next chart. Each category represents 20% of the frequency that a risk was mentioned.

Chart 9. Summarized data from the brainstorming session.

Risk	**Frequency**				
	1	**2**	**3**	**4**	**5**
Electrical			X		
Different level falls			X		
Same level falls		X			
Falling objetcs		X			
Collision with vehicles				X	

Minor abrasions					X
Hits					X
Cutting injuries				X	
Overexertion				X	
Heatstroke		X			
Burns			X		
Fire	X				
Explosion	X				

Source: Blanco & Ortega, 2013

- Solar Decathlon Europe 2014 V 2.1 Rules.

The SDE regulation suggests a list of risk that are mentioned in a law, nevertheless did not include the frequency of each risk. That why we integrated that list on the next chart. On that chart all de assembly and disassembly data are summarized. The frequency was weighted from the data of the brainstorming and the interviews, an impact was given to each risk and a level of risk was calculated. For that risk analysis we used the Australian's Risk Administration Standard AS/NZS 4360: 1999 because it can analyze with more precision all the risks. Besides, we included the mitigation for all the risk. The parameters of the frequency and impact level are described in the appendix 14.

Chart 10. Risk during the constructive process of the housing module.

Risk	Frequency	Impact Level	Risk Level	Individual Protection	Collective Protection	Risk level decrease
Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects.	-Training in electrical installations. -Earthing of the module. -Logout-Tagot preventive method.	H
Different level falls	B	4	E	-Protective equipment for working at heights.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use.	M
Falling objects	C	4	E	-Helmet use.	-Scaffold with skirting. -Crane's hook with safety lock.	M
Collision with vehicles	D	5	E	-Reflective vest.	-Delimited zone for trucks and forklift. -Preventive trucks checks.	L
Overexertion	B	4	E	-	-Manual handling training. -Work shifts.	H
Ergonomic	B	4	E	-Lumbar support belt.	-Training in material handling. -Ergomic tools. -Active breaks.	H
Fire	E	5	E	Emergency kit.	-Extinguishers. -Smoke detectors.	L
Explosion	E	5	E	-	-Training in hazardouzs substances handling. -Logout-Tagot preventive method.	L
Minor Abrasions	A	2	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	H
Hits	A	2	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Cuts	B	3	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Heatstroke	D	4	H	-Sunblock use. -Work clothes made of cotton.	-Hydration stations. -Rest shifts.	L
Burns	D	4	H	-Sunblock use. -Shirts with sleeves	-Sun shelter. -Rest shifts.	L
Same Level Falls	D	2	L	Safety shoes use.	-Tidiness program.	L

Source: Blanco & Ortega, 2013

The information that this chart give to the project is important because provides a better knowledge of the risk that are going to be present during the construction process. It is important to realize that the training of all the team members is very important and the consequences of ignore those can lead to fatal consequences.

Risk evaluation of project phases.

In this section we will define all the fundamentals phases, activities and task that will be part of the competition, including the risk analysis since the beginning of the project until the disassembly of Trópika in France. Each one of this tasks were analyzed to determinate the associated risk and the method to reduce the probability of happening.
This activities has been approved by the Construction Department and the constructive process advisors. Each one of these activities has their own task, resources and specific risks. All this information has been summarized in the next charts, which integrate the most important data of the constructive process. The charts were divided by activities for a better comprehension of the data.

- ✦ Project's development:
  - Team integration.
  - Design.
  - Sponsor's search.

On next chart we show the most important risk that were present in the project development's phase. The risk analysis was made with the administration department that also provides the frequency variable. The establishment of the parameters was made based on the Australian's Risk Administration Standard AS/NZS 4360: 1999, the parameters were defined according to specific requirements of this section (appendix 15).

Chart 11. Risk analysis and mitigation of the project's development phase.

Activities	Resources	Associated risk	Risk Analysis			Risk mitigation
			Frequency	Impact	Level	
Team integration.	TEC Team.	-Lack of communication between the group's members.	B	3	H	-Didactic sessions with the team. -Constant communication with the members.
Module design.	TEC Team and advisors.	-Delays on the design. -Flaws on the design. -Delays on the deliverables.	A	4	E	-Establishment of limit dates for deliverables. -Consultation with the advisors.
Sponsors search.	Administration department.	-Not get the required amount of money for the project.	C	5	E	-Establishment of a marketing program. -Entailment with the university's media and communications department.

Source: Blanco & Ortega, 2013

As we can see, the risk level in this section is severely high. As a solution we tried to involve every team member to the project to ensure the maximum dedication to it. Also we used a lot the advisor's time to make sure that our direction were right. In every phase of the project we saw everybody's dedication to the project, which told us that our mitigation method worked.

✦ Previous construction works at the university:

- Material's evaluation.
- Module's pre construction tasks.
- Assembly.
- Disassembly.

Chart 12. Risk analysis and mitigation of previous construction works on the university.

Activities	Resources	Associated risk	Risk Analysis			Risk mitigation
			Frequency	Impact	Level	
Material's evaluation	TEC Team, technical equipiment, materials to be tested.	-Lack of communication between the group's members.	B	3	H	-Didactic sessions with the team. -Constant communication with the members.
Module's pre construction tasks	TEC Team, advisors technical workshop.	-Delays on the design. -Flaws on the design. -Delays on the deliverables.	A	4	E	-Establishment of limit dates for deliverables. -Consultation with the advisors.
Assembly and disassembly	This section was described on the two next charts.					

Source: Blanco & Ortega, 2013

Chart 13. Risk analysis and mitigation of the assembly of the module.

Activities	Task	Associated risk	Risk Analysis			Individual Protection	Collective Protection
			Frequency	Impact	level		
Previous works	-Clean the construction site. -Arrival of the container to the site. -Install the working areas. -Place the metallic safety fences to delimit the construction site, crane area and other machinery area. -Place tends, and safety ribbons to delimit the work areas. -Place the signposting. Download tools. -Assemble basic equipment. -Installation of heavy equipment. -Installing the light equipment.	Ergonomic	B	4	E	-Lumbar support belt. -Reflective vest. -Sunblock use. -Work clothes made of cotton. -Shirts with sleeves. -Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -Ergonomic tools. -Active breaks. -Tidiness program. -Delimited zone for trucks and forklift. -Preventive trucks check. -Hydration stations. -Rest shifts. -Sun shelter. -Scaffold with skirting. -Crane's hook with safety lock. -Active breaks. -First aid kit
		Same Level Falls	D	2	L		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Heatstroke	D	4	H		
		Burns	D	4	H		
		Falling objects	C	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Falling objects	C	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		

		Cuts	B	3	H		
Site preparation	-Checking the ground levels. -Adjust footing level out. -Determinate the location of the footings. -Level out the footings.	Same Level Falls	D	2	L	-Safety shoes, safety helmet, safety glasses and gloves use.	-Tidiness program.
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Establishment of the foundation system	-Transport the footings with the forklift to the site. -Place the footings to its place. -Check alignment.	Collision with vehicles	D	5	E	-Reflective vest. -Sunblock use. -Work clothes made of cotton.	-Delimited zone for trucks and forklift. -Preventive trucks checks. -Hydration stations. -Rest shifts. -Tidiness program.
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
Establishment of primary structure	-Transport the columns from container to the site with the forklift. -Attach the column to the crane. -Hoist the column Set columns into the foundations. -Place column's holders. -Transport the rafter to its site with the forklift. -Attach the rafter to the crane. -Hoist the rafter with the crane. -Placement of the rafters. -Attach rafters to columns. -Transport the floor's tie rafters with the forklift. -Attach the rafters with the floor tie rafters Attach the columns with the floor tie rafters. -Attach the footings with the floor tie rafter. -Transport the capping rafters with the forklift. -Install the scaffolding. -Hoist the capping rafter into position with the crane. -Attach the capping rafter to the columns.	Falling objects	C	4	E	-Helmet use. -Reflective vest. -Safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit.
		Collision with vehicles	D	5	E		
		Hits	A	2	H		
		Minor Abrasions	A	2	H		

Floor installation	-Transport the floor panel to the site with the forklift. -Classify the panels by its size. -Attach the floor panels to each other. -Place the floor panels with the crane. -Attach the floor panels to the rafter.	Falling objects	C	4	E	-Reflective vest. -Safety shoes, safety helmet, safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit
		Collision with vehicles	D	5	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
Enclousures	-Placement of the scaffoldings. -Transport the wall panels to the site with the forklift. -Attach the wall panels to the crane. -Wall hoisting. -Place the wall panels between columns. -Attach the wall panels to the columns. -Transport the inner wall to the site with the forklift. -Assemble the inner wall panels. -Inner walls hoisting with the crane. -Place the wall panels. -Attach the inner wall panels with the perimeter. -Transport the windows to the site with the forklift. -Assemble the windows items. -Place each element of the window -Transport the door to the site with the forklift. -Doors installations.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
Roof installation	-Transport the roof rafter to the site with the crane. -Attach the roof rafters to the crane. -Hoist the roof rafter. -Attach the hoist rafter to the columns -Transport the roof battens from the container to the site with the forklift.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold
		Falling objects	C	4	E		

	-Attach the roof battens to the roof rafter. -Transport the roof deck to the site with the forklift. -Attach roof deck's pieces together. -Attach to the roof battens. -Install the support structure for the bathroom roof. -Install the water tanks. -Transport the bathroom ceiling panels to the site. -Attach the bathroom ceiling panels to the crane. -Hoist the bathroom ceiling panels. -Place the bathroom ceiling panels. -Attach the bathroom ceiling panels to the structure. -Transport the module ceiling panels to the site. -Attach the module's ceiling panels to the crane. -Hoist the module ceiling panels with the crane. -Place the module ceiling panels. -Attach the module ceiling panels to the structure.	Collision with vehicles	D	5	E	shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit. -Hydration stations. -Rest shifts.
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
Electrical installation	-Pipes installation under the floor, between the walls and above the ceiling. -Electrical equipment connection. -System verification. -System connection to energy.	Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects. -Safety shoes, safety helmet, safety glasses and gloves use.	-Training in electrical installations. -Earthing of the electrical system. -Logout-Tagout preventive method. -Lifelines. -Ladders use. -Tool's belt. -Training in material handling. -First aid kit.
		Different level falls	B	4	E		
		Falling objects	C	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Hall and ramp construction.	-Transport hall columns from container to the site with the forklift. -Attach the columns	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective	-Training in working at heights. -Lifelines, anchorage

	to the crane. -Hoist the hall columns -Place the hall columns -Attach hall columns to footing -Transport the rafter with the forklift. -Place the rafter with the crane. -Attach the rafter to columns -Transport floor enclosures with the forklift. -Attach floor enclousures to the rafter. -Transport the capping rafter -Hoist the capping rafter. -Attach the capping to the column -Transport the ramp to the site. -Assemble the ramp items -Place the ramp -Assemble the roof deck -Place the roof deck -Assemble the garden items -Place the garden items.	Falling objects	C	4	E	vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Manual handling training. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
Final details	-Transport the marquee -Attach the marquee to the capping rafter -Transport the railings -Place the railings. -Place tensors -Transport the flowerpots -Place the flowerpots -Place the components -Transport the furniture -Place the furniture -Transport the grid -Place the grid -Place the components -Transport the metallic letters of the module -Place the metallic letters. -Transport the ramp accessories. -Place the ramp accessories. -Asssemble the ramp.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Delimited zone for trucks and forklift. -Manual handling training. -Work shifts. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		

Source: Blanco & Ortega, 2013

Chart 14. Disassembly process.

Activities	Task	Associated risk	Risk Analysis			Individual Protection	Collective Protection
			Frequency	Impact	level		
Furniture and marquee removal.	-Remove the marquee from the capping rafter -Remove the railings. -Transport the railings to the container. -Remove tensors. -Transport the flowerpots. -Remove the furniture. -Transport the furniture to the container. -Remove the grid. -Transport the grid -Remove the metallic letters of the module. -Remove the ramp accessories. -Disassembly the ramp.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Delimited zone for trucks and forklift. -Ergonomic tools. -Active breaks. -Training in material handling. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
Hall and ramp disassembly.	-Disassemble the garden items. -Remove the garden items. -Disassemble the roof deck. -Remove the roof deck. -Remove the ramp. -Disassemble the ramp items. -Transport the ramp to the container. -Remove the capping from the column. -Hoist the capping rafter. -Transport the capping rafter. -Remove floor enclosures from the rafter. -Transport floor enclosures with the forklift to the container.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Manual handling training. -Ergonomic tools. -Active breaks.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		

	-Attach the rafter from the columns. -Remove the rafter with the crane. -Transport the rafter with the forklift to the container. -Remove hall columns from footing. -Remove the hall columns. -Hoist the hall columns. -Remove the columns with the crane. -Transport hall columns to the container.	Cuts	B	3	H		-Training in material handling. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
Electrical des-installation	-Pipes uninstall. -Electrical equipment disconnection.	Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects. -Safety helmet, safety glasses and gloves use.	-Training in electrical installations. -Earthing of the electrical system. -Logout-Tag out preventive method. -Lifelines. -Ladders use. -Tool's belt. -Training in material handling. -First aid kit.
		Different level falls	B	4	E		
		Falling objects	C	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Roof des-installation	-Remove the module ceiling panels from the structure. -Hoist the module ceiling panels with the crane. -Transport the module ceiling panels to the container. -Remove the bathroom ceiling panels from the structure. -Hoist the bathroom ceiling panels. -Transport the bathroom ceiling panels to the container. -Remove the water tanks. -Remove the support structure from the bathroom roof. -Remove the roof battens. -Remove the roof's deck. -Transport the roof deck to the container. -Remove the roof battens from the roof rafter.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit. -Hydration stations. -Rest shifts.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		

	-Transport the roof battens to the container with the forklift. -Remove the roof rafters from the crane. -Transport the roof rafter to the container.	Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
Enclosures Remove	-Doors unistall. -Transport the door to container. -Remove each element of the window. -Disassembly the windows items. -Transport the windows to the container. -Remove the inner wall panels. -Remove the wall panels. - Disassembly the inner wall panels. -Transport the inner wall to the container. -Remove the wall panels from the columns. -Wall hoisting. -Transport the wall panels to the crane.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
Floor des-installation	-Remove the floor panels from the rafter. -Remove the floor panels with the crane. -Transport the floor panel to the container.	Falling objects	C	4	E	-Reflective vest. -Safety shoes, safety helmet, safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit
		Collision with vehicles	D	5	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		

Remove of the primary structure	-Remove the capping rafter from the columns. -Hoist the capping rafter. -Remove the scaffolding. -Remove the columns from the floor tie rafters. -Transport the floor's tie rafters. -Remove rafters from the columns. -Remove the rafters. -Hoist the rafter. -Transport the rafter to the container. -Remove column's holders. -Remove columns from the foundations. -Transport the columns from container to the container.	Falling objects	C	4	E	-Helmet use. -Reflective vest. -Safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit.
		Collision with vehicles	D	5	E		
		Hits	A	2	H		
		Minor Abrasions	A	2	H		
Remove of the foundation system	-Transport the footings to the container.	Collision with vehicles	D	5	E	-Reflective vest. -Sunblock use. -Work clothes made of cotton.	-Delimited zone for trucks and forklift. -Preventive trucks checks. -Hydration stations. -Rest shifts. -Tidiness program.
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Final works	-Uninstall the light equipment. - Uninstall of heavy equipment. -Disassembly the basic equipment. -Remove the signposting. -Remove tends, safety ribbons and fences that delimit the work areas. -uninstall the working areas. -Departure of the container from the site. -Clean the construction site.	Same Level Falls	D	2	L	-Lumbar support belt. -Safety shoes use. -Reflective vest. -Sunblock use. -Work clothes made of cotton. -Shirts with sleeves. -Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -Ergonomic tools. -Active breaks. -Tidiness program. -Delimited zone for trucks and forklift. -Preventive trucks check. -Manual handling training. -Hydration stations. -Rest shifts. -Sun shelter. -Scaffold with skirting. -Crane's hook with
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Heatstroke	D	4	H		
		Burns	D	4	H		
		Falling objects	C	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		

		Cuts	B	3	H		safety lock. -Training in load handling. -First aid kit.
		Ergonomic	B	4	E		

Source: Blanco & Ortega, 2013

As we can see there is a lot of risks with high level on the constructive process. This gives us an alert of the serious possible consequences that we have to prevent to occur during the whole project development. To ensure the safety of every team member is obligatory to use safety shoes, helmet and reflective vest at all the working process. The special personal protection equipment will be used only on tasks with a specific risk's presence.

- ✦ Training.
  - Hydraulic tools training.
  - First aids attention training.
  - Electric system installations training.
  - Working at heights training.

Chart 15. Risk analysis and mitigation of risk during training.

Activities	Associated risk	Risk Analysis			Individual Protection	Collective Protection
		Frequency	**Impact**	**Level**		
Safety in electrical installation.	Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects.	-Training in electrical installations. -Earthing of the module. -Logout-Tagot preventive method.
Safety in constructions (prevention labor risk).	*Theory	-	-	-	-	-
Ergonomics.	*Theory	-	-	-	-	-
First aid training.	Controlled environment by an expert.	-	-	-	-	-
Extinguisher use.	*Theory	-	-	-	-	-
Emergency Response	*Theory	-	-	-	-	-

Source: Blanco & Ortega, 2013

Due to the controlled environment that the team members will be exposed, the risk will be relatively low level risk, nevertheless, all safety measures will be taken during the training phase.

✦ Construction works. This section were divided in 3 principal phases:
- Assembly.
- Maintenance.

2. Natural Events Risk Evaluation.

The natural events risks are usually height that is why we must be prepared to face it. Costa Rica have several events that occur constantly due to the fact that is located in the "Pacific's Fire Belt", this is the zone that have more tectonic activity in the whole world, also we are frequently affected by tropical depressions that lead to several events (floods, landslides, etc.).
In France with have to ensure everyone safety in case of a natural event so we decided to use our country natural events risk chart to France because that way the safety factor will be higher.
To identify and evaluate the risks from natural events we interviewed (appendix 7) several experts of the Emergency National Commission of Costa Rica with the condition that the risks have to be similar to Versailles. To evaluate those risks the HS Department used the Australian's Risk Administration Standard AS/NZS 4360: 1999, the parameters to apply the evaluation were established on the appendix 16.

The results are summarized on the next chart:

Chart 16. Natural events risk evaluation.

Risk	**Risk analysis**		
	Frequency	**Impact**	**Level**
Earthquake	D	5	E
Hurricane	E	4	H
Floods	C	3	H
Landslide	D	5	H
Tornado	E	5	H

Source: Blanco & Ortega, 2013

The main characteristic of these risks is that have a low frequency but very height impact. During the assembly of the module, the HS Department have to stay careful with the weather changes and prevent all the consequences of these risk. The mayor objective is to preserve the health and safety of the team and the way to do it is by an emergency plan that contemplates the best way to manage all the scenarios.

3. Training Needs Evaluation

The training for the team is a very important section that has to be apply in the better way to ensure a good developed of the project. Each time a person is about to do an activity, for which, it does not have a significant experience he/she has to be trained to do it in the correct way.

This project has the special characteristic of making students into constructors in less than a year, that is why it is important to ensure that every member really knows how to do his/her specific tasks.

The Health and Safety Department has been studying the knowledge in safety matters, development of work task and previous trainings on specific task to determinate the subjects for the training, this, to prepare them more on those areas that had more failures.

For the team evaluation a web page call surveymonkey.com was used to develop an electronic questionnaire for them to answer. The subjects that were evaluated on this questionnaire were: basic safety subjects, personal equipment protection, muti-vote technique, manual handling of loads, signaling and specific task security rules. At next we show the results of the questionnaire on next chart. For a better summarization of the data the answers were evaluated in a scale from 0 to 100%.

Chart 17. TEC Team training evaluation.

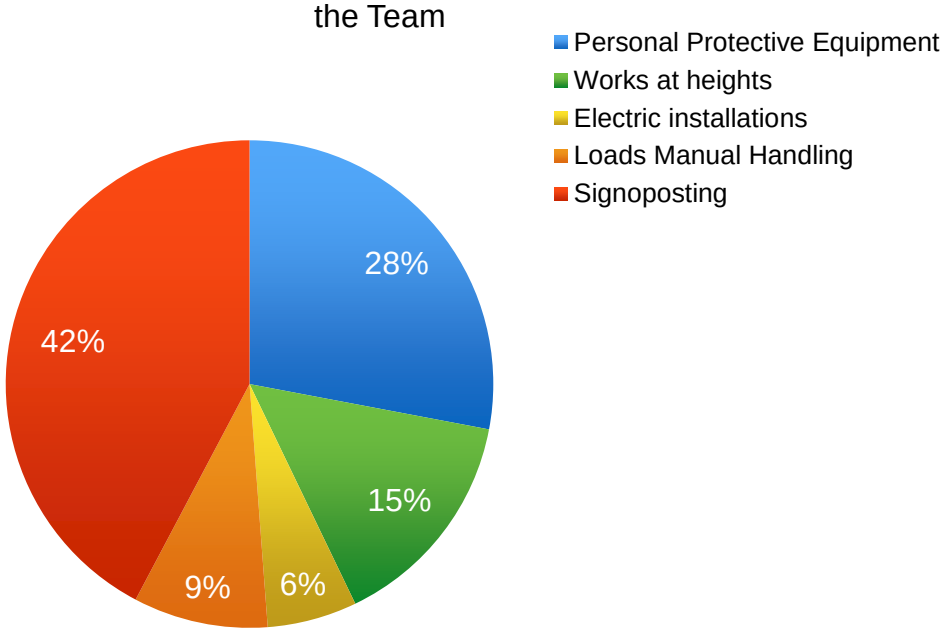
Question number	Question	Correct Answers
1	Which risks do you consider that are going to be present during the assembly and disassembly of the module?	Summarized data on chart 11.
2	Choose the correct personal equipment protection to use in work at heights tasks.	47%
3	Do you know the basic rules to develop a work a heights task?	25%
4	Do you know the hazardous energies control technique known as Log-out Tag-out?	9%
5	Mention the basic rules to develop an electric installation work.	10%
6	Mention the personal equipment protection to use in an electric installation.	30%

7	Loads manual handling security measures.	15%
8	Mention the general personal protection equipment to be use during the assembly and disassembly process.	75%
9	Mention the safety signposting that should be on the construction site.	71%
10	Multi-vote technique: Choose the training subjects that should be given to the team.	1-Risk during construction works. 2-Protection personal equipment. 3-Fire prevention system. 4- Others.

Source: Blanco & Ortega, 2013

On the next graphic we show the important data of each subject:

Graphic 1.Basic Knowledge on Safety evaluation of the Team



As we can see the technical knowledge in safety matters is very restricted, especially in the safety rules to follow during critical task like works at heights and electric installations. This shows us the reinforcement level that the department has to apply in the trainings.

As expected this results reflects the lack of experience in general construction matters of the Team, nevertheless, this is a good opportunity for the Health and Safety Department to inculcate safety work habits.

The subjects, according the results of the evaluation, of the trainings will be:

Chart 18. Trainings priority subjects.

Subject	Responsable
Safety in electrical installation.	TEC's Team advisor
Safety in constructions (prevention labor risk).	TEC's Team advisor
Ergonomics.	TEC's Team advisor
First aid training.	Costa Rica's Red Cross
Extinguisher use.	Costa Rica's Firefighters Institute
Hydraulic tools use.	TEC's Team advisor

Source: Blanco & Ortega, 2013

The specific topics of the trainings and the time of each one will be established by the responsible person.

With this training we expect a great safety preparation of the team. We also know that every member of the team is committed to care each other health, so everybody will be making their task in a safety way and also watching out for our teammates.

In conclusion, the constructive processes have a very height risks level and all the members of the team will be involved in it. With no experience, every one of us will assume the responsibility of develop our goal: Assembly the living module in just ten days but we have to be 100% sure of our main objective, to preserve our health and safety. An exhaustive study of all the possible risks during the whole competition was made and this will ensure that those risks will decrease their level by the creating a HS Program as a way to control them.

The process of analysis is the foundation of every program so we have to make it right.

V. CONCLUSIONS.

- During the assembly and disassembly of the construction processes the members of the Tec Team will be exposed to eight risks, which according to the risks analysis, are categorized as extremes and during each activity at least one of those risks will be present. This alerts us about the stringency that have to be applied during those processes in safety matters.

- The team members are not experts or have any experience on construction labors, this condition make them vulnerable to an accident or incident because of the lack of knowledge of safe working procedures during the construction process.
- The Tec Team have a deficient knowledge in construction safety; the analysis tell us that three of the dangerous activities that will be develop during the constructive process (electrical installation, works at heights and loads manual handling safety) are the subjects with the less expertise.
- There are high-level safety requirements established by Solar Decathlon Europe organization on work procedures, trainings, supervision and control of the activities that will be developed during the assembly and disassembly processes. Those requirements were not implemented in the initial phase of the project.

VI. RECOMMENDATIONS.

- Is imperative to establish safety engineering controls to all the construction process tasks. This way the probability of occurrence of any accident will have an important decrease, the construction process will be efficient and the project unforeseen economics impacts will be lower.
- Safe works procedures have to be implemented for the assembly and disassembly phases of the construction process in Versailles, France. This strategy will maintain everybody health and safety and the project's planned schedule on time.
- The implementation of a Safety Training Plan for the Tec Team is necessary to aware everybody of the high level risks that will be present during the construction process, and also, to have workers on the field with the capacity to identify a risk situations and avoid them.
- A safety program has to be implemented to the project to ensure the approval of begin the construction in France but, more important, to ensure that everybody will be on a risk-controlled environment during the whole construction process.

VII. SOLUTION ALTERNATIVES.

Given the conditions founded during the diagnostic phase, it was determined that the development of a program is necessary, that program is titled:

"Safety Program for the processes of assembly and disassembly of the housing Trópika for Solar Decathlon 2014 competition."

The program referred has improvement alternatives that make instruments for safely carrying the assembly and disassembly processes.

Below the proposal of Safety Program is developed:

Safety Program for the assembly and disassembly process of Trópika, habitation module, for the competition Solar Decathlon Europe 2014.

Ing. André Blanco Moraga
Ing. Adelina Ortega Rojas

Solar Decathlon 2014
April, 2014

• Index

1. Safety Program Precedents and Aim

In Europe each year more than 50 000 fatalities occur in the construction sector, which is equivalent to that for every ten minutes would be producing an accident in that category.

Safety is a critical item on all construction projects for multiple reasons including protecting the welfare of employees, providing a safe work environment and controlling construction costs.

The assembly and disassembly processes of Trópika, during the Solar Decathlon Europe competition in France, will be in charge of the members of the Tec Team, who are students of 12 different careers, but any of them had worked in construction industry before SDE.

The Safety Plan aims to manage the risks by identification, analysis, evaluation, treatment, communication and ongoing monitoring, thereby ensuring the health and safety of members of the Tec Team during the competition in Versailles. Also this plan is intended to minimize loss, meet regulatory compliance requirements and implement site safety regulations established by SDE Rules.

The Plan is a document that contains the steps to follow in order to minimize risks associated with the construction process. Due to the characteristics of the project is not possible to assess all risks that may arise, however most will be taken into consideration.

The assembly and disassembly processes were designed to perform the work of the safest way possible and minimizing risks that arise.

All team members and potential contractors must follow this Plan at any time during the construction process.

A copy of this document must be on the site of construction available for all present, and every work and worker or people present on construction site shall comply with this regulation anytime.

2. General data

Chart 1 shows general project data, both human resource and physical characteristics of housing Trópika. These data should be of general knowledge of the whole team

Chart 1. General data of the project.

General Data	
Event Promoter	**Solar Decathlon Europe 2014**
Developer	Tec Team
Faculty advisor	Juan Carlos Martí
Health and Safety Coordinator	André Blanco Moraga
Safety Officer	Adelina Ortega
Site Operation General Coordinator	Francisco Rodríguez Bejarano
Nature of the project	
Type of building work	Assembly of prefabricated module
Architecture footprint	50,70 m2
Height	5,8159 m
Length	8,08 m
Width	11,28 m
Assembly duration	10 days
Disassembly duration	5 days

Source: Blanco & Ortega, 2014.

Other general information that every team member has to know is shown in chart 2.

Chart 2. Important information in case of emergency:

Information	Versailles, France
Construction Site	Solar Village, Versaille´s gardens.
Nearest hospital address	Centre Hospitalier André Mignot de Versailles, phone 33139639133

Nearest health center	Clinique la Maye, phone: 33139233333
Fire Department	Caserne des pompiers de Paris, phone: 3314605286
Police Station	Préfecture de police, phone 33153715371
Paramedics-Ambulance	Croix-Rouge francaise, phone: 33130835961

Source: Blanco & Ortega, 2014.

3. General Setups

a) Safety Policy

The Safety Policy of Tec Team is designed to comply with the Standards of the Occupational Safety and Health Administration, and to endeavor to maintain a safe and injury/illness free workplace.

Compliance with the following Safety Policy and all items contained therein is mandatory for all team members. The authorization and responsibility for enforcement has been given primarily to the Project Manager, Juan Carlos Marti. The HS Department, André Blanco and Adelina Ortega, share in this responsibility as well.

It is Tec Team policy that accident prevention be a prime concern of all employees. This includes the safety and well being of our team members as well as the prevention of wasteful, inefficient operations, and damage to property and equipment.

This Safety Policy applies to all Tec Team members, regardless of position within the team. The Safety Rules contained herein apply to anyone who is on a construction site.

Every Team member is expected to comply with the Safety Policy, as well as OSHA Health and Safety Standards.

b) General Prevention Principles

- Avoid risks.
- Evaluate unavoidable risks.
- Combat risks at source.
- Adapt work to manpower.

- Take into account the technical evolution.
- Replace dangerous items with safe ones or less dangerous ones.
- Plan safety measures before the work begins.
- Use collective protection prior to individual ones.
- Give the appropriate instructions to the workers.

c) Assignment of responsibilities

Tec Team, the one in charge of the assembly and disassembly processes, is organized in eleven departments of the different disciplines that the project involves. Each department has a coordinator, responsible for the good performance of his work team. The eleven departments are the following.

Regarding this Safety Program, the departments responsible for the administrative and logistic part are:

- Project Management and Administration Department
- Health and Safety Department
- Construction Department
-

Chart 3. Responsibilities of each department in the Safety Plan

Tec Team Department	**Department conformation**	**Responsibilities**
Project Management and Administration Department	Project Manager	-Give approval for the implementation the Safety Program -Spreading the importance and mandatory compliance with the Safety Program. And promote a culture of safety in the team by example and commitment. -Provide the financial, human and physical resources required for successful implementation of the Safety Program.
	Project Administrator	

Health and Safety Department	Health and Safety Coordinator	-Oversee and monitor program activities, to verify the successful implementation of it. -Work together with the other coordinators of the different areas to maintain adequate communication and thus make a correct implementation, assessment, monitoring and control of the program. -Keep all records by the forms of assessments, inspections and program meetings. -Monitor the proper implementation of the procedures of the Safety Program and ensure that all workers perform their tasks safely in accordance with training received.
	Health and Safety Officer	
Construction Department	General Site Coordinator	-Monitor the proper implementation of the procedures of the Safety Program and ensure that all workers perform their tasks safely in accordance with training received. -Work together with the other leaders of the various procedures, maintain adequate communication and thus make a correct implementation, assessment, monitoring and control of the program.
	Site Officers	
Logistic Department	Logistic Coordinator	-Responsible for monitoring security administrative matters as shifts, entrances and exits of the site, compliance with the construction process.
	Logistic team and Insurance coordinator	
Architecture Department	Architecture Coordinator	-Follow the Safety rules for the design of the house.

	Module design	
	Lobby and accessories	
Photovoltaic Department	Photovoltaic Coordinator	-Responsible of fallow the Safety procedures during the Photovoltaic system installation, maintenance and uninstallation. -Follow the Safety Program specification during all the process.
	Photovoltaic system installers	
Thermofluids Department	Thermofluids Coordinator	-Responsible of fallow the Safety procedures during the Thermofluids system installation, maintenance and uninstallation. -Follow the Safety Program specification during all the process.
	Thermofluids system installers	
Domotic Department	Domotic Coordinator	-Responsible of fallow the Safety procedures during the Domotic system installation, maintenance and uninstallation. -Follow the Safety Program specification during all the process.
	Domotic system installers	
Environment	Sustainability	-Responsible of follow the safety rules all the

Department	Coordinator	time.
	Environment team	-Follow the Safety Program specification during all the process.
Design Department	Design Coordinator	-Follow the Safety Program specification during all the process.

Source: Blanco & Ortega, 2014.

d). Resource Assignment

Economic: To implement the program, all the necessary financial resources must be approved by the Faculty Advisor.

Human: The staff involved in the implementation, monitoring and evaluation of this program are: Faculty advisor, Construction Department, Safety and Health Department.

Physical: This program was designed according to the conditions encountered during the planning stage of the project so the physical resources can be modified according to the development of the project.

4. Objectives

The main goal of the Safety Plan is to prevent and avoid any possible risks and accidents that might appear during the assembly, contest days, disassembly or any subsequent maintenance tasks.

The objectives of this Safety Plan are:

- Evaluate the avoidable and inevitable risks during the construction process and its phases in order to prevent and decrease them.
- Establish the adequate safe working procedures to follow during the competition including the assembly, maintenance, disassembly of Trópika

- Evaluate the training needs of the team members, related to safety in construction.
- Establish the Training Plan According to the training need evaluation.
- Provide the emergency procedures in case of emergency during the assembly and disassembly processes.

With this document, Tec Team aims to be able to carry out in a safe and adequate way each phase of the process without accidents or incidents.

5. Conditions of the site where construction will take place and interesting data related to the prevention of risks during the construction process

a). Constructive process

This assembly process will be divided in 10 phases:

Chart 4.Assembly process.

Construction Phases	Tasks	Corresponding HS Drawing
Previous works	Organization of the areas	#1
Site preparation	Checking the ground level´s	#2
	Topographic demarcation on the ground	#2
Establishment of the foundation system	Footing placing	#2
Establishment of primary structure	Column's placement	#3
	Rafters placement	#4
	Floor tie rafters placement	#5
	Capping rafter's placement	#6
Floor installation	Floor panels's placement	#7
Enclousures	Walls's placement	#8
	Innerwall's placement	#9

	Windows's placement	#10
	Door's placement	#11
Roof installation	Roof rafter's placement	#12
	Roof batten's placement	#13
	Roof deck's placement	#14
	Bathroom roof's placement	#14
	Module's celiling's placement	#15
Electrical installation	On development	
Domitic installation	On development	
Thermofluids instalation	On development	
Hall and ramp construction	Column's placement	#13
	Floor rafter's placement	#6
	Floor enclosure's placement	#14
	Capping rafter's placement	#10
	Ramp placement	#15
	Roof deck's placement	#18
Final details	Marquee's placement	#16
	Railing placement	#17
	Flowerpot placement	#18
	Furniture placement	#17
	Grid placement	#18
	Accessories's placement	#18

Source: Blanco & Ortega, 2014.

Chart 5. Disassembly process

Construction Phases	**Tasks**
Furniture and marquee removal.	Remove marquee
	Railing removal
	Flowerpot removal

	Furniture removal
	Grid removal
	Accessories's removal
Hall and ramp removal	Column's removal
	Floor rafter's removal
	Floor enclosure's removal
	Capping rafter's removal
	Ramp removal
	Roof deck's removal
Electrical uninstallation	Electrical system removal
Domitic uninstallation	Domotic system removal
Thermofluids uninstallation	Thermofluids system removal
Roof uninstallation	Roof rafter's removal
	Roof batten's removal
	Roof deck's removal
	Bathroom roof's removal
	Module's celiling's removal
Enclousures	Walls's removal
	Innerwall's removal
	Windows's removal
	Door's removal
Floor uninstallation	Floor panels's removal
Removal of primary structure	Column's removal
	Rafters removal
	Floor tie rafters removal
	Capping rafter's removal
Removal of the foundation system	Footing placing
Site cleanup	Checking the ground level´s
	Topographic demarcation on the ground
Final works	Organization of the areas

Source: Blanco & Ortega, 2014.

Is important to plan every movement of the process, from the moment the module is going to be placed in the container for its transportation to France until it will be placed again in the container take it back to Costa Rica, because this planning will reduce the possibility of accidents and fails. As our team has no experience in construction works we are going to focus on safety training because the accidents can occur because of this lack of knowledge and experience.

Chart 4 and 5 show the assembly and disassembly process are summarized, the complete processes can be found in Appendix 1 and 2 of this document.

b). Type and characteristics of the materials and elements

Chart 6. Materials and elements.

Parts	Materials	Possible risks	Prevention
Foundation system	Wood Concrete	Collision, hits	PPE, Training signposting, Demarcation
Primary structure	Aluminum Wood	Cuts, collision, hits	PPE, Training signposting, Demarcation
Floor	Wood	Collision, hits,	PPE, Training signposting, Demarcation
Walls	Fiber cement	Collision, hits	PPE, Training signposting, Demarcation
Windows	Glass	Cuts	PPE, Training signposting, Demarcation
Doors	Wood	Collision, hits	PPE, Training signposting, Demarcation
Ceiling	Fiber cement	Collision, hits	PPE, Training signposting, Demarcation
Roof	Aluminum Fiber cement	Collision, hits, cuts	PPE, Training signposting, Demarcation
Ramp	Fiber cement	Collision, hits	PPE, Training

			signposting, Demarcation
Installations	Electric appliances	Electric shock	PPE, Training signposting, Demarcation

Source: Blanco & Ortega, 2014.

c) Site description

Localization

Trópika will be assembly in the Solar Village, located in Versailles, France. In the Solar Village, Trópika will be developed at the lot A, assigned by the organization, this lot dimensions are 20x20m. See figure 1.

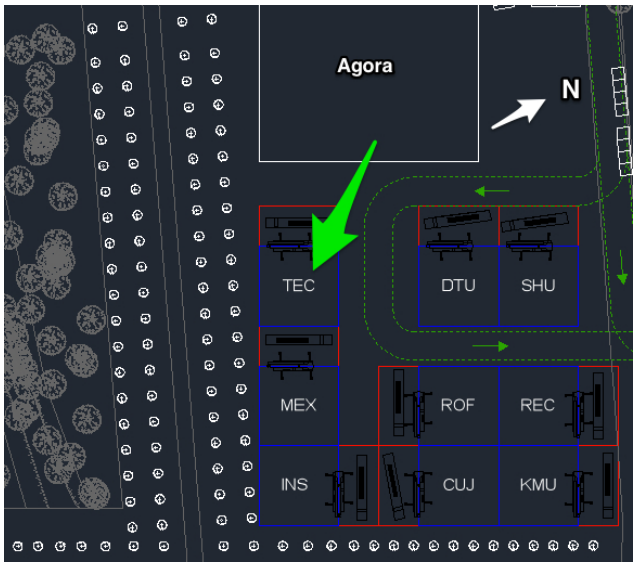


Figure 1. Lot A in the Solar Village, Versailles

Source: Tec Team Logistic Department

Boundaries of lot A:

- Northeastern boundary: lot D
- Southeastern boundary: lot B

- Northwestern boundary: Agora (Theater)
- Southwestern boundary: trees

The elements close to the lot of Trópika can represent different risks for the assembly and

Chart 7. Risks on the construction site.

Risk factor	Possible risk	Prevention
Noise from the Agora	Discomfort for the site workers	Use of personal protective equipment
Trees	Fall of trees or branches, obstacle for machinery	Enclose the lot
Quantity of people on site and around	Disorganization, loss of control of the work, unauthorized persons entering the construction site, increase in incidents and accidents	Setting tasks for site workers, person coordinating the work of others, enclose the lot, using uniform Unlike outsiders, control the access of outsiders
Outdoor works	Robbery	Storage areas with security devices for vulnerable materials

Source: Blanco & Ortega, 2014.

d) Climatology description

Located on the northern side of France, next to Paris and relatively close to the center of the country, Versailles enjoys a fairly protected setting, with fine weather for much of the year.

The summer climate in Versailles is often sunny, warm and enticing. July and August do see highs of more than 25°C / 77°F, some days can be a little overcast with occasional rainy weather

Max Daytime Temperature (°C)	22°C (72°F) in June
Min Night-time Temperature (°C)	11°C (52°F) in June
Hours of Sunshine (Daily)	7 Hours per day in June
Hours of Daylight (Daily)	16 Hours per day in June
Heat and Humidity Discomfort	None in June
Days with some Rainfall	12 Days in June
Monthly Rainfall (mm)	55 mm (2.2 inches) in June
UV Index (Maximum)	7 (High) in June

Figure 2. Versailles climatology prediction of June 2014.

Data collected from: http://www.weather2travel.com/july/france/versailles.php

Max Daytime Temperature (°C)	24°C (75°F) in July
Min Night-time Temperature (°C)	13°C (55°F) in July
Hours of Sunshine (Daily)	8 Hours per day in July
Hours of Daylight (Daily)	16 Hours per day in July
Heat and Humidity Discomfort	None in July
Days with some Rainfall	11 Days in July
Monthly Rainfall (mm)	55 mm (2.2 inches) in July
UV Index (Maximum)	7 (High) in July

Figure 3. Versailles climatology prediction of July 2014.

Data collected from: http://www.weather2travel.com/july/france/versailles.php

The following chart shows the risks to which it is exposed the Tec Team, according to the weather of Versailles to the time of the competition is

Chart 8. Risks for weather conditions.

Risk factor	Possible risk	Prevention

Heat	Insulation, sunburn, dehydration	Drink water frequently, work in shade places, protective clothes, sunglasses, frequently use of sunscreen
Rain	Electric accidents with installation or electric tools, falls and slips, degradation of the land.	Use protective clothes, waterproof plugs.

Source: Blanco & Ortega, 2014.

e). Accesses and paths for vehicle

Below, in figure 6, is shown the route for vehicles and pedestrians inside de Solar Village in Versailles:

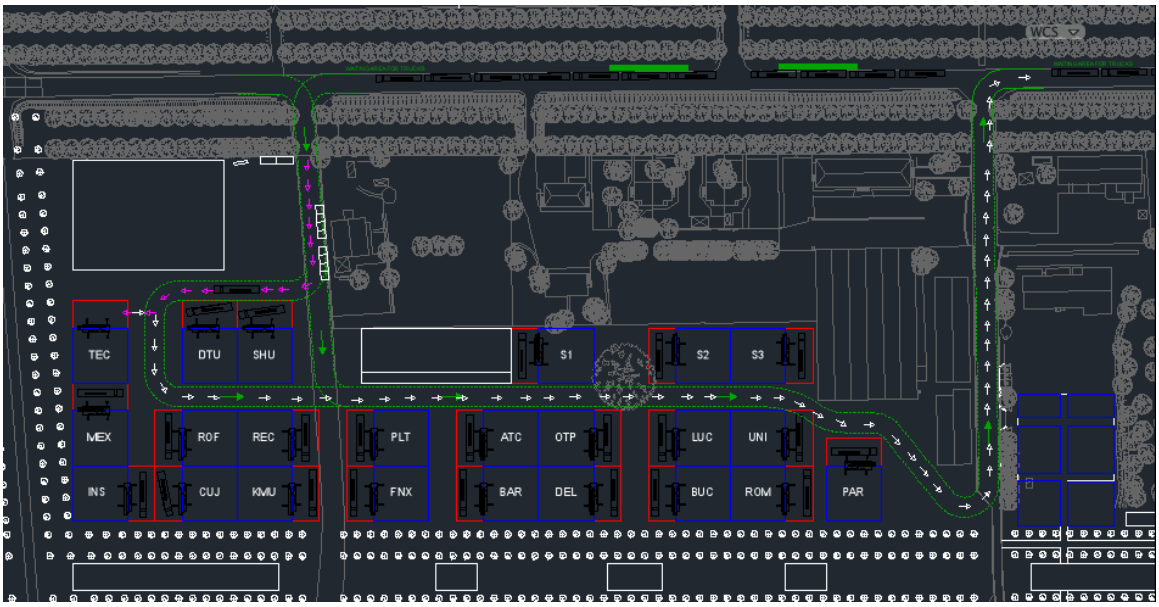


Figure 6. Route inside de Solar Village in Versailles

Source: Tec Team´s Logistic Department.

f). Determining factors for the living module placing.

We wanted to benefit from the characteristics of the lot by designing a proposal that takes full advantage of its surroundings. The lot has free views in every direction so that the four façades are free without any other building next to it, and from the lobby people can admire the natural environment of Versailles.

To protect a neighbor's right to the sun, the housing unit and all site components on a team's lot must stay within the solar envelope according to the rule 5.1. Even though there

are not any other building next to Trópika prototype the proposal respects the solar envelope rule, reason why it is placed in the center of the lot, as shows in figure 7

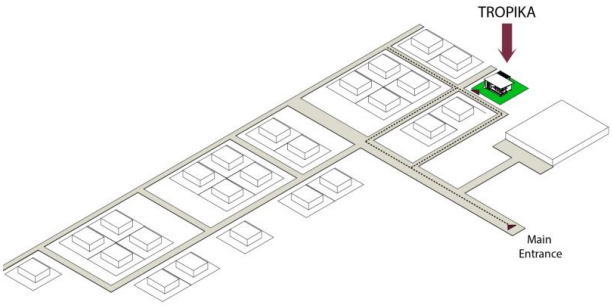


Figure 7. Location of Trópika the Solar Village.

Source: Tec Team´s Logistic Department.

g). Overlaps with the affected services and other circumstances or activities of the environment, able to cause risks during the construction

The close proximity of lots B and D is an important factor to consider, because in these lots will also be carrying out construction work, where there will be heavy machinery, vehicles, and people involved, which in some way can affect our performance causing delays or accidents. For these reasons, we must take into consideration our neighbors.

These situations can create the next risks:

- Collision with other teams machinery or team members.
- Hits by moving or still objects like tools, equipment or parts of the module of the other teams.
- Fall of objects, during loads manipulation.
- Delays because of the traffic or position of the machinery of other teams.

In order to prevent these situations some considerations have to be taken:

- All the team members have to comply with all the rules in Safety Planand Site Operation Plan.
- Organizers or representatives of other teams who come to lot A, must comply with Trópika Safety Program, and follow the instructions of the Safety officer.
- The access will be prohibited for unauthorized persons.
- Respect demarcated areas and pay special attention to signals.

- Pay special attention to crossing, when coming out of demarcated areas towards non demarcated areas, near places with heavy machinery, areas with low visibility, etc.
- No jumping of any fences or any other object meaning a demarcation.
- Warn the workers near you of your presence.
-

h). Auxiliary resources planned for the construction

Chart 9. Auxiliary resources.

Auxiliary resources	**Location**	**When is going to be used**	**Use**	**Activities related**
Tools storage	Storage area	Assembly and dissasembly	Storage the power and hand tools	All activities
Containers	Storage area	Assembly and dissasembly	Storage	All activities required material inside
Scaffolding	Storage area	Assembly and dissasembly	reach high places	Works at heights

Source: Blanco & Ortega, 2014.

Risks

-Hits, fall from heights, ergonomic, falling objects.

Prevention

-Maintain order always in the tool storage and containers.

-Organize things inside the container to reduce the difficulty by removing the elements inside.

-See procedure: HS_10.6 Scaffolding Procedure.

i). Machinery planned for the construction

Below is detailed the necessary machinery for the carrying out of construction work.

Chart 10. Equipment Rental Chart TEC TEAM

Machinery	Cuantity needed
35 ton CRANE.	1
Telehandler	1
Forkliift	1

Source: Blanco & Ortega, 2014.

Risks:

-Collision with vehicles, hits.

Prevention:

-See Heavy equipment safe operation Procedure in part 10, of this document.

-Two members of the team will be trained for being the crane signal person, This team members will be to clearly identify by writing in black-colored capital letters the term "BANKSMAN" on the back of the reflective vest.
More detail of the safety with the machinery Procedure HS_10.3.

j). Construction site installations

For the different types of works the Team is going to need the next installations on the construction site.

Chart 11. Installations in the construction site.

Construction site installation	When is going to be used	Use	Activities related
Electric supply	Construction process	To produce electrical energy	Activities requiring electrical power
Drinking water supply	Construction process	Used to keep	All activities

		hydrated to workers	
Rest area	Construction process	To provide shaded areas for brake time	All activities
Office	Construction process	Plan everyday work and check maps	Logistic works
Waste container	Construction process	Place the wastes	All activities that produce waste
Waste separation slap	Construction process	Separate recycle and different waste materials	All activities that produce waste
Workshop area	Construction process	Assembly parts of Trópika	Assembly pieces and furniture
Storage workshop	Construction process	Storage material	All activities
Construction área	Construction process	Assembly of Trópika	All activities

Source: Blanco & Ortega, 2014.

Risks:

-The principal possible risks are electric shocks and mechanical risks.

Prevention:

-Only authorized persons can work with the electrical installation, connection lines and earth connection.

-Demarcation and signposting have to be checked every day by the HS Coordinator.

k). Characteristics table for the stocks

Chart 12. Characteristic table for the stock

Materials	Characteristic	Dimensions (m)			Weight (Kg)	Transport	Location
		L	W	H			
Laminated wood	Columns	4.8	0.1	0.1	93.3	Forklift	Stock area
Laminated wood	Rafters	7.9	0.25	0.1	96.3	Forklift	Stock area
Sawn lumber	Nailers	6.1	0.1	0.1	29.36	Forklift	Stock area
Wood	Floor	9.6	0.6	0.01	1844	Crane	Stock area

Source: Blanco & Ortega, 2014.

Risk:

-Ergonomics, hits,

Prevention:

-Perform lifts agree with the safety standards

-wear appropriate PPE for each task according to the Appendix 1 and Appendix 2.

6. Activities for risks prevention

To establish a safe constructive process the Health and Safety Department (HS Department) took into account the risks prevention in different aspects:

-To ensure that the Team will be prepared to make his or her tasks in a safety way, every member will receive training in construction safety and special training depending of the tasks that will be develop. At next a summary table presents the training subjects that were taught:

Chart 13. Training topics.

Subject	Responsible
Safety in electrical installation.	TEC's Team advisor
Safety in constructions (prevention labor risk).	TEC's Team advisor
Ergonomics.	TEC's Team advisor
First aid training.	Costa Rica's Red Cross
Extinguisher use.	Costa Rica's Firefighters Institute
Hydraulic tools use.	TEC's Team advisor
Woks at heights.	Woks at heights PPE supplier.

Source: Blanco & Ortega, 2014.

-Every phase of the constructive process has been analyzed to determinate all the risks that are involved to each task. To do so, several interviews were applied to construction companies, research and experts consultations. We determinate analyze and mitigate the risks on the next chart:

Chart 14. Constructive process evaluation.

Risk	Frequency	Impact Level	Risk Level	Individual Protection	Collective Protection	Risk level decrease
Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects.	-Training in electrical installations. -Earthing of the module. -Logout-Tagot preventive method.	H
Different level falls	B	4	E	-Protective equipment for working at heights.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use.	M
Falling objects	C	4	E	-Helmet use.	-Scaffold with skirting. -Crane's hook with safety lock.	M
Collision with vehicles	D	5	E	-Reflective vest.	-Delimited zone for trucks and forklift. -Preventive trucks checks.	L
Overexertion	B	4	E	-	-Manual handling	H

					training. -Work shifts.	
Ergonomic	B	4	E	-Lumbar support belt.	-Training in material handling. -Ergomic tools. -Active breaks.	H
Fire	E	5	E	Emergency kit.	-Extinguishers. -Smoke detectors.	L
Explosion	E	5	E	-	-Training in hazardouzs substances handling. -Logout-Tagot preventive method.	L
Minor Abrasions	A	2	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	H
Hits	A	2	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Cuts	B	3	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Heatstroke	D	4	H	-Sunblock use. -Work clothes made of cotton.	-Hydration stations. -Rest shifts.	L
Burns	D	4	H	-Sunblock use. -Shirts with sleeves	-Sun shelter. -Rest shifts.	L
Same Level Falls	D	2	L	Safety shoes use.	-Tidiness program.	L

Source: Blanco & Ortega, 2014.

-To standardize the procedures that will be done on each task, the safe work procedures were made to implement the safety factor on them. Every member of the Team have to follow these standards because the procedures are analyze to avoid at maximum all the risks and in several situation special permissions has to be applied to start working. The procedures are in the eleven section of this document.

-The hazards communication during the constructive process is very important because everybody have to know the risks that are present on a specific zone as is described on the section 10.a of this document according to signposting.

Solvents and paints identification it is also important to communicate the risks that are implicit on their manipulation, this procedure is also include on the 10.a section.

a) Construction plan: determination of work effective timing

Tec team is going to have three working shifts of 8 hours, including 1 hour for lunch and a 15 minutes break for each shift.

b) Overlaps and incompatibilities in the construction

Chart 15. Assembly schedule.

	Date	16-jun-14			17-jun-14			18-jun-14			19-jun-14			20-jun-14			21-jun-14			22-jun-14			23-jun-14			24-jun-14			25-jun-14		
	Day	1			2			3			4			5			6			7			8			9			10		
	Shift	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Phase																															
1. Previous work		■																													
2. Site Preparation		■																													
3. Foundations		■	■																												
4. Primary structure			■	■	■	■					■	■	■	■																	
5. Floor					■	■																									
6. Enclousures							■	■	■	■				■			■														
7. Roof															■	■															
8. Installations				■		■			■		■	■				■															
9. Access structure																	■	■	■												
10. Finishes & Furniture																	■	■	■	■											

Source: Blanco & Ortega, 2014.

Chart 16. Disassembly schedule.

	Date	15-jul-14			16-jul-14			17-jul-14			18-jul-14			19-jul-14		
	Day	1			2			3			4			5		
	Shift	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Phase																
1. Finishes & Furniture																
2. Access structure																
3. Installations																
4. Roof																
5. Enclousures																
6. Floor																
7. Primary structure																
8. Foundations																

Source: Blanco & Ortega, 2014.

In the charts 15 and 16, can be identify the overlaps by work phases. For the overlap-works we are contemplate by coordination that they will not interfere with each other in order to avoid accidents.

Tasks that cannot be carried out simultaneously:

- Movement of suspended tasks over workers carrying out other tasks.
- Works on higher levels above workers carrying out other tasks.
- Tasks that require electricity while works for the restoration or maintenance of the auxiliary electricity system are being carried out.
- Restoration or maintenance tasks of any element connected to the power supply or that might be switched on (in case of having batteries).
- Watering tasks while works for the restoration or maintenance of the auxiliary electricity system are being carried out.
- No task can be carried out near the location of the vertical enclosure placement.

c). Number of Team members taking part in the construction

Tec Team is going to have 30 students in, Versailles during the assembly and disassembly process, divided in three groups of ten students working in different shifts.

7. Critical work phases for risks prevention

Critical work phases can be found in chart 17 where the color red in the Risk Level column represents extreme risk.

Chart 17. Critical work phases

Activities	Associated risk	Level	Individual	Collective
Previous works	-Ergonomic	E	-Lumbar support belt. -Reflective vest. -Sunblock use. -Work clothes	-Training in material handling. -Ergonomic tools. -Active breaks. -Tidiness program.
	-Collision with vehicles	E		
	-Overexertion	E		
	-Falling objects	E		
	-Falling objects	E		
Establishment of the	-Collision with vehicles	E	-Reflective vest.	-Delimited zone for trucks and
Establishment of primary structure.	-Falling objects	E	-Helmet use. -Reflective vest.	-Scaffold with skirting. -Delimited zone
	-Collision with vehicles	E		
Floor installation	-Falling objects	E	-Reflective vest. -Safety	-Scaffold with skirting. -Crane's hook
	-Collision with vehicles	E		
Enclousures	-Different level falls	E	-Protective equipment for working at heights. -Reflective vest.	-Training in working at heights. -Scaffold with skirting. -Crane's hook
	-Falling objects	E		
	-Collision with vehicles	E		
	-Overexertion	E		
	-Ergonomic	E		
Roof installation	Different level falls	E	-Protective equipment for working at heights. -Reflective	-Work at height protection system and training. -Scaffold with
	Falling objects	E		
	Collision with vehicles	E		
	Overexertion	E		

	Ergonomic	E	vest.	skirting.
Hall and ramp construction	Different level falls	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar	-Training in working at heights. -Scaffold with skirting. -Delimited zone for trucks and
	Falling objects	E		
	Collision with vehicles	E		
	Overexertion	E		
	Ergonomic	E		
Final details	Different level falls	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with
	Falling objects	E		
	Collision with vehicles	E		
	Overexertion	E		
	Ergonomic	E		

Source: Blanco & Ortega, 2014.

8. Risks identification and efficacy evaluation of the adopted protections

a). Risks identification and efficiency evaluation of the adopted protections

The protections adopted to resolve every risk are indicated in Chart 18, risks during the constructing process of the living module. The efficiency of these protections allows us conclude that after the mitigation the qualification of the risk with the applied prevention are high, medium and low.

Chart 18. Risk identification and mitigation during the constructive process of the living module.

Risk	Risk Level	Individual Protection	Collective Protection	Risk level after mitigation
Electrical	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects.	-Training in electrical installations. -Earthing of the electrical system. -Logout-Tagout preventive method.	H
Different level falls	E	-Protective equipment for working at heights.	-Training in working at heights. -Scaffolds. -Lifelines.	M
Falling objects	E	-Helmet use.	-Scaffold with skirting. -Crane's hook with safety lock.	M
Collision with vehicles	E	-Reflective vest.	-Delimited zone for trucks and forklift. -Preventive trucks checks.	L
Overexertion	E	-	-Manual handling training. -Work shifts.	H
Ergonomic	E	-Lumbar support belt.	-Training in material handling.	H

			-Ergomic tools. -Active breaks.	
Fire	E	-	-Extinguishers. -Smoke detectors.	L
Explosion	E	-	-Training in hazardous substances handling. -Logout-Tagot preventive method.	L
Minor Abrasions	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	H
Hits	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Cuts	H	-Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -First aid kit	M
Heatstroke	H	-Sunblock use.	-Hydration stations. -Rest shifts.	L
Burns	H	-Sunblock use.	-Sun shelter. -Rest shifts.	L
Same Level Falls	L	Safety shoes use.	-Tidiness program.	L

Source: Blanco & Ortega, 2014.

9. Collective protections to use.

Collective protection equipment will comply with the current regulations and will follow the next aspects:

Chart 19. Collective protection to use. during the assembly

Risk conditions	Requisite	Collective protection equipment
Fall from heights	Areas with height equal or higher than 1.8 m will have protection equipment against falls. Trópika have anchorage points in the roofs of the module.	Life lines Anchorage points Outside and inside scaffolding Ladders Signposting
Electric contacts		General earthing installation of the site Waterproof plugs
Suspended loads falls	The hooks on the elevation mechanisms will have a safety lock	Auxiliary cords for the safety load orientation Safety slings
Use of machinery	Safety devices will be kept in correct state of work, revising its state in periodically	
Site cleaning	It is considered a collective protection measure of high efficacy	Signposting Ribbons
Traffic of vehicles	Perimeter and protection Minimum height of 90 cm	Fences Cones Plastic fence Ribbons
Fire protection	Visual and manual check	Extinguishers ABC

	every day of the competition. Extinguishers 21A-3-113B efficiency	Smoke detectors
Collective protection equipment in dangerous areas	Limitation of the circulation of vehicles, etc Protection of the weather conditions	Signposting Tents and sun shelters Drinking water Sun screen
Collective protection equipment when working with machinery	No vehicle will be over loaded or will carry an uneven load, every machinery will have an acoustic device when reversing, visible plates where the size and maximum load, etc. will be shown. An everyday revision of the breaking devices and emergency stops will be done.	Signposting

Source: Blanco & Ortega, 2014.

The user´s manual specifications will be available at the construction site, and every worker will have access to it.

10. Individual Protection

a). Aspects to be taken care of from a PPE:

For regulations enforcement purposes the personal protection equipment (PPE) will comply with the RD 773/1997, from May 30th, that establishes the minimum measures relating to the use, conditions and maintenance of the PPE.

•Demand the CE marking.

•Demand the instruction manual.

•Train and inform the worker following those instructions, retraining if is necessary.

•Follow those instructions.

•Keep up with the maintenance, cleaning and repairing without losing or changing its initial safety characteristics.

- Keep a record with the training given to every team member about the use and maintenance of the PPE.
- Every team member will have his own PPE and is going to be under de supervision of the HS officer.
- At the beginning of each work shift HS officer shall ensure that each team member carries the PPE needed to do their jobs otherwise cannot enter the construction site.
- The correct maintenance of the PPE is responsibility of every team member.
- The Safety shoes must include: ankle support, hard toe, dielectrics system and have to be water proof.
- The safety helmet, safety lenses must be Ansi certificated.

b). PPE to use mandatory and required at all times:

Chart 20. Specific PPE for every task.

Activities	Task	Individual Protection	Special individual protection
Previous works	-Clean the construction site. -Arrival of the container to the site. -Install the working areas. -Place the metallic safety fences to delimit the construction site, crane area and other machinery area. -Place tends, and	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Sunblock use.

	safety ribbons to delimit the work areas. -Place the signposting. Download tools. -Assemble basic equipment. -Installation of heavy equipment. -Installing the light equipment.		
Site preparation	-Checking the ground levels. -Adjust footing level out. -Determinate the location of the footings. -Level out the footings.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Sunblock use.
Establishment of the foundation system	-Transport the footings with the forklift to the site. -Place the footings to its place. -Check alignment.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Sunblock use.
Establishment of primary structure	-Transport the columns from container to the site with the forklift. -Attach the column to the crane. -Hoist the column Set columns into the foundations. -Place column's holders. -Transport the rafter to its site with the	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	

	forklift. -Attach the rafter to the crane. -Hoist the rafter with the crane. -Placement of the rafters. -Attach rafters to columns. -Transport the floor's tie rafters with the forklift. -Attach the rafters with the floor tie rafters Attach the columns with the floor tie rafters. -Attach the footings with the floor tie rafter. -Transport the capping rafters with the forklift. -Install the scaffolding. -Hoist the capping rafter into position with the crane. -Attach the capping rafter to the columns.		
Floor installation	-Transport the floor panel to the site with the forklift. -Classify the panels by its size. -Attach the floor panels to each other. -Place the floor panels with the crane. -Attach the floor panels to the rafter.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	
Enclosures	-Placement of the scaffoldings. -Transport the wall panels to the site with the forklift.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Protective equipment for working at heights.

	-Attach the wall panels to the crane. -Wall hoisting. -Place the wall panels between columns. -Attach the wall panels to the columns. -Transport the inner wall to the site with the forklift. -Assemble the inner wall panels. -Inner walls hoisting with the crane. -Place the wall panels. -Attach the inner wall panels with the perimeter. -Transport the windows to the site with the forklift. -Assemble the windows items. -Place each element of the window -Transport the door to the site with the forklift. -Doors installations.		
Roof installation	-Transport the roof rafter to the site with the crane. -Attach the roof rafters to the crane. -Hoist the roof rafter. -Attach the hoist rafter to the columns -Transport the roof battens from the container to the site with the forklift. -Attach the roof battens to the roof rafter. -Transport the roof deck to the site with	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Protective equipment for working at heights.

	the forklift. -Attach roof deck's pieces together. -Attach to the roof battens. -Install the support structure for the bathroom roof. -Install the water tanks. -Transport the bathroom ceiling panels to the site. -Attach the bathroom ceiling panels to the crane. -Hoist the bathroom ceiling panels. -Place the bathroom ceiling panels. -Attach the bathroom ceiling panels to the structure. -Transport the module ceiling panels to the site. -Attach the module's ceiling panels to the crane. -Hoist the module ceiling panels with the crane. -Place the module ceiling panels. -Attach the module ceiling panels to the structure.		
Electrical installation	-Pipes installation under the floor, between the walls and above the ceiling. -Electrical equipment connection. -System verification. -System connection to energy.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects.

Hall and ramp construction.	-Transport hall columns from container to the site with the forklift. -Attach the columns to the crane. -Hoist the hall columns -Place the hall columns -Attach hall columns to footing -Transport the rafter with the forklift. -Place the rafter with the crane. -Attach the rafter to columns -Transport floor enclosures with the forklift. -Attach floor enclousures to the rafter. -Transport the capping rafter -Hoist the capping rafter. -Attach the capping to the column -Transport the ramp to the site. -Assemble the ramp items -Place the ramp -Assemble the roof deck -Place the roof deck -Assemble the garden items -Place the garden items.	-Safety shoes, safety helmet, glasses, reflective vest and gloves use.	-Protective equipment for working at heights.
Final details	-Transport the marquee -Attach the marquee to the capping rafter -Transport the railings -Place the railings. -Place tensors	-Safety shoes, safety helmet, glasses, reflective vest and gloves use	-Protective equipment for working at heights.

	-Transport the flowerpots -Place the flowerpots -Place the components -Transport the furniture -Place the furniture -Transport the grid -Place the grid -Place the components -Transport the metallic letters of the module -Place the metallic letters. -Transport the ramp accessories. -Place the ramp accessories. -Asssemble the ramp.		

Source: Blanco & Ortega, 2014.

Sunblock has to be used at every time during the construction works, team members shall apply it according to the producer´s recommendation.

For more details see appendix 1 and appendix 2 which have the individual protection necessary for every risk.

a). Signposting of the risks

Signposting will comply with the RD 485/1997, document that establishes the minimum regulations for health and safety signaling for working areas. The construction site is considered as a working area. Signposting and demarcation are going to be placed on day 1, before starting any work of construction and will be checked every day before the first shift start.

The signs will be cleaned, maintained and verified when the Safety Officer deemed necessary.

Resistant material to knocks, water and possible environment aggressions.

Adequate dimensions, calorimetrical and photometrical characteristics to guarantee its visibility and comprehension.

Must be installed in locations with the correct illumination, accessible and visible.

Chart 21. Signposting to use.

Type	Needed	Location	Picture
Prohibition	No access for unauthorized persons	In access	
	Non-smoking area	In access	
	No access for pedestrian	In access	
Warnings	Suspended load	In access	
	Electric shock risk	In site Access and next to the power generator/transformer	
	Warning	In access	
	Risk of tripping	In access	
	Falling objects	In access	
Obligation	Obligatory head protection	In access	
	Obligatory foot protection	In access	
	Obligatory eyesight protection	In access	
	Obligatory hearing protection	In access	
	Obligatory hands protection	In access	
	Obligatory face protection.	In dust areas	
	Obligatory high visibility jacket	In access	

Fire-fighting	Fire extinguisher.	Near the fire extinguisher	
First aids	Rescue and relief operations	In the internal perimeter of the lot	
	Guideline to follow in a case of emergency.	Inside the lot, near the first aids bag	
	First aids.	Near the first aids bag	
Others	STOP.	In the vehicles access/exit on site	
	Maximum speed 20 km/h.	In the vehicles access/exit on site	

Source: Blanco & Ortega, 2014.

The necessary signposting for every step of the construction will be illustrated in drawings 1 to 18 of this document.

11. Safe work procedures

• Communication.

None of the established goals will be accomplished if the communication between the safety procedures members is effective. To ensure that all the information will be delivered to the person of interest, the department proposed a strategy that does not interrupted or delay the data transmission.

The communication will be described on the next figure:

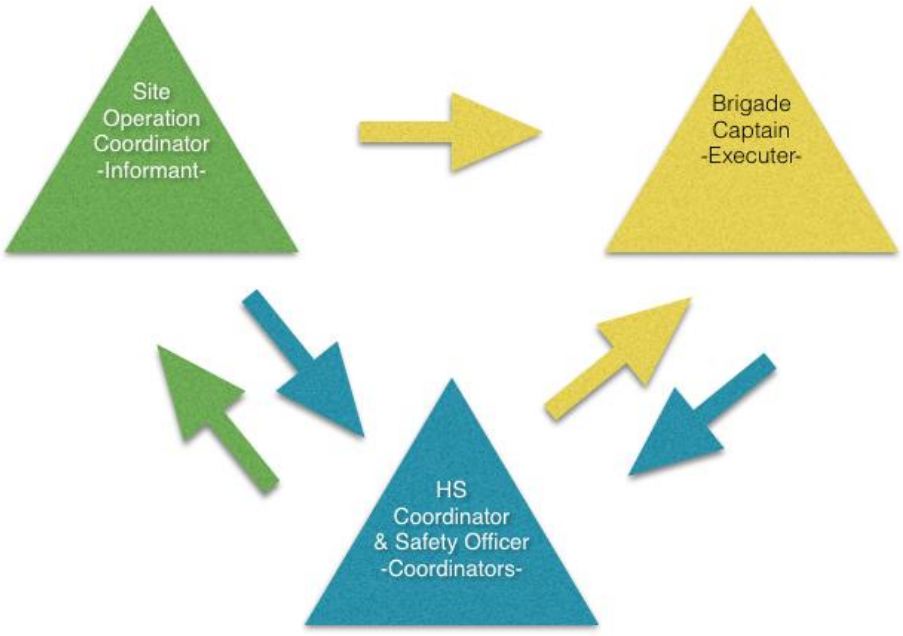


Figure 8. Communication flow during a work procedure.

Source: Blanco & Ortega, 2014.

This way we ensure that the each responsible person will communicate in an effective way and order; this prevents misunderstandings and increases the effectiveness of the procedures.

Below the working procedures, which according to the risk analysis performed, are considered necessary for the team to perform their jobs safely. These procedures should be known to all team members and must be met at all times.

Chart. 21. Access control procedure.

trópika Costa Rica	**Access control Procedure**	**Code: HS_10.1** **Version: 1** **Health and Safety Department**
Contents • Aim of the instruction • Scope • Implications and responsibilities • Equipment needed work		

- Stages of labor and safety key points

Aim of the instruction

This guidance provides advice on the circumstances and manner in which the Tec Team should control the access to the construction site. In order to minimize the risk of having accidents or incidents.

Scope

Take into account the access during the assembly and disassembly of the Trópika, and when the Site Coordinator consider necessary. Every person, Team member and SDE organizers shall comply with this instruction.

Implications and responsibilities

General Site Coordinator:

Approve or refuse the entrance of the Team members and SDE organizers, based on the dangerousness of the jobs that are currently performing in the construction site

HS Officer:

Make sure every person inside the construction site meets all the prerequisites to enter.

Is in charge of maintaining a record of people who have entered the room during the day

Team members and SDE Organizers:

Comply with all the requisites to be inside the construction site and follow all the instructions given by the General Site Coordinator and HS Coordinator.

Equipment needed work

PPE:

A hard hat

Safety glasses

A shirt with sleeves and long trousers

Safety boots with ankle supports.

A reflective jacket or vest

Other:

Control list, with date, work shift number and signature.

Stages of labor and safety key points	
Stage	Safety key point
Previous requirements	• Entrance to the construction site will be limited, only Tec Team members and SDE organizers with the corresponding identification. • General Site Coordinator shall give the approval for the access. • Before entering each person must sign a list with their names and charge also show an ID and keep it visible at all times. • Authorized workers shall be familiarized with this Safety Plan and all the procedures on it. • HS Officer shall give the EPP to every person and give safety instructions. • At the beginning of every shift, team members shall assist to the rest area in order to receive an HS introduction according to the works they are going to perform, also they have to wear the complete PPE, sign the assistance list and wear their identification card. If any of the team members don't comply with those requirements the access to the construction site will be denied.
Inside the lot	• At all times within the site construction people outside the team, must be accompanied by either the coordinator or officer HS. • If any person disrespect the safety rules inside the construction site HS Coordinator or General Site Coordinator have to asked to leave the site immediately.
After	• PPE must be placed in an orderly manner in the place intended for it. • At the end of every work shift Team members shall sign the attendance list with their departure time.

Source: Blanco & Ortega, 2014.

Chart 22. Accident or incident reporting procedure.

trópika Costa Rica	**Accident or incident reporting Procedure**	**Code: HS_10.2** **Version: 1** **Health and Safety Department**

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points

Aim of the instruction

This guidance provides advice on the circumstances and manner in which the Tec Team should be notified of any injuries, diseases and dangerous occurrences.

Scope

All accidents and incidents occurred during the whole competition in France. Means for accident undesired event that results in personal injury or property damage and for incident an unplanned, undesired event that adversely affects completion of a task.

Implications and responsibilities

HS Coordinator:

Investigate the accident and make a report, fill the Accident/Incident Report Form

Insurance coordinator:

Call to call the insurance company to fix details, and keep the Accident/Incident Report Form.

Injured Person:

To ensure that an Accident/Incident Report Form is completed and brought to the attention of the person responsible for reporting the accident.

Equipment needed work

Accident/Incident Report Form (Appendix 3).

Insurance card and number.

Stages of labor and safety key points

Stage	Safety key point
Immediately	All injury accidents, however minor, must be reported to the HS Coordinator Seek first aid or medical attention as required HS Coordinator classify the event according to the severity of the event and proceeds to send the person to the nearest health center
As soon as possible	HS Officer fill the Accident/Incident Report Form and make the investigation with the help of the injured person or witnesses Give the Accident/Incident Report Form to the Insurance Coordinator. Insurance Coordinator makes the call to the insurance company.
After	Implement the recommendations on the report (HS Coordinator and General Site Coordinator) to reduce the risk of happening again.

Source: Blanco & Ortega, 2014.

Chart 23. Heavy equipment safe operation procedure.

	Heavy equipment safe operation Procedure	**Code: HS_10.3** **Version: 1** **Health and Safety Department**

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed to work
- Stages of labor and safety key points
- Supervision
- References

Aim of the instruction

Improper procedures used by operators and team members can cause injury, disability, or death. By understanding and following safe operating procedures for use of heavy equipment, we can prevent injury for yourself and your Coworkers. Tec Team will follow OSHA 510 Standards for Construction Industry and SDE Organizers additional rules.

Scope

Team members are responsible of their knowledge of the rules and OSHA standards that will be given in the Health and Safety trainings. All heavy equipment operators shall be trained and certified in order to work in a safe and effective way.

Implications and responsibilities

HS Officer:

Ensure that the equipment operator complies with the requirements. HS coordinator is also a supervisor.

Banksman:

Give instructions to the equipment operator.

Equipment Operator:

Follow the safety instructions at every time.

Equipment needed to work

Boots or safety shoes

Eye/face protection

Hard hat

Hearing protection

Gloves

Signaling

Stages of labor and safety key points

Stage	Safety key point

Previous phase	• Ensure that all operators have been trained on the equipment they will use • Do not modify the equipment's capacity or safety features without the manufacturer's written approval • Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines • Check vehicles at the beginning of each shift to ensure that the parts, equipment, and accessories are in safe operating condition. Repair or replace any defective parts or equipment prior to use. All vehicles must have: ✓ A service brake system, an emergency brake system, and a parking brake system ✓ Working headlights, tail lights, and brake lights ✓ An audible warning device (horn) ✓ Intact windshield with working windshield wipers
Stage of performance of the work	• Follow Banksman instructions at any time • Do not operate vehicle in reverse with an obstructed rear view unless it has a reverse signal alarm capable of being heard above ambient noise levels or a signal observer indicates that it is safe to move • Vehicles loaded from the top (e.g., dump trucks) must have cab shields or canopies to protect the operator while loading • Ensure that vehicles used to transport workers have seats, with operable seat belts, firmly secured and adequate for the number of workers to be carried • Equipment should have roll-over protection and protection from falling debris hazards as needed • Prior to permitting construction equipment or vehicles onto an access roadway or grade, verify that the roadway or grade is constructed and maintained to safely accommodate the equipment and vehicles involved • Do not modify the equipment's capacity or safety features without the

	manufacturer's written approval • Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines

Supervision

To ensure that unsafe acts are minimized it is essential that supervision is effective. The supervisor therefore needs to:

- Check that the Method Statement is being worked to
- Check that the method is as safe as possible
- Check that people are kept clear of hazardous areas
- Check that the al the machinery is being used correctly
- Check that tasks are only carried out by authorized people
- Challenge unsafe practices
- Record and arrange for the repair of any damage they see or have reported
- Have the authority and ability to stop a task if they feel it is unsafe
- Report and record unsafe behavior (including near misses).

Forklift

- Check prior to begin working: tires, oil level, oil leaks, water, gas, antifreeze, breaks, clutch, lights, lighting, fire extinguisher, pitchfork operation, slope and elevation systems.
- Before moving check if there is no person or obstacles around. Keep safety distance.
- Do not turn, break or accelerate sharply.
- Load transportation: pick it up and raise it 15cm. above ground. Circulate with the mast sloped at its maximum.
- Unload: place the forklift in front of the area and in the correct position, raise the load up to the height needed keeping the breaks on, move the forklift until the load is located above the designated area for unloading, situate the pitchfork in a horizontal position, unload the load, and back away slowly.
- Try to move forward if there is enough visibility, if the load does not allow it, the circulation must be carried out in reverse.
- Never circulate with the pitchfork raised.
- Do not circulate with any parts of the body outside the cabin.
- Do not exit the forklift while moving. Do not exit the forklift jumping, use the running board.
- Use the seat belts and follow the site and traffic signals.
- Do not transport people on the forklift. Do not race.
- Do not circulate over unprotected cables, do not manipulate or repair any of the forklift systems while in motion or when not having the knowledge or authorization to do so.
- When leaving the forklift: leave it in a correct area, with the hand break on, take away the contact keys, and always leave with the forklift in the lowest position

possible.

Crane

- Will have to previously know the task and the working process to be carried on and will need permission to begin.
- Needs good visual communication with the person signaling at any time and follow its instructions.
- Do not work perched on the crane´s cabin. Always work from its work spot.
- Do not handle loads above other workers.
- Do not work with the crane in case of breakdown or anomalies.
- Do not manipulate the buttons, electrical system or any other element of the crane while connected. Disconnect from the electric panel and signal it in order to prevent accidental reconnection.
- Ensure crane has been adequately maintained, pre-use checks carried out and has current report of thorough examination
  Do not leave suspended loads on the crane when works are finished.
- Do not raise loads that weight more or equal to the limit stated by the manufacturer.
- Check and use only raise elements in correct conditions.
- Wind speed to be checked with hand held anemometer by Supervisor before lift starts. Lift to be aborted if wind speed exceeds 15 mph

Telehandler

- All personnel to wear high visibility clothing
- Ensure personnel are fully briefed on need to keep clear of load during lifting and telehandler during travelling
- Ensure telehandler is made secure from unauthorised access or operation
- Ensure weight of load is known and accurate
- Ensure telehandler has been adequately maintained, pre-use checks carried out and has current report of thorough examination
- Route to be planned and overhead obstacles marked with goal posts and signs
- Operator and banksman to be advised of any overhead risks
- Wind speed to be checked with hand held anemometer by Supervisor before lift starts. Lift to be aborted if wind speed exceeds 15 mph

References

OSHA's Hazard Exposure and Risk Assessment Matrix for Hurricane Response and Recovery Work: Heavy Equipment and Powered Industrial

OSHA's Powered Industrial Trucks e-tool

OSHA's Construction Industry | Cranes and Derricks in Construction Final Rule -

Frequently Asked Questions Safe Use of Telehandlers In Construction

Source: Blanco & Ortega, 2014.

Chart 24. Safe use of hand tools and power tools procedure.

trópika Costa Rica	**Safe use of hand tools and power tools Procedure**	**Code: HS_10.4** **Version: 1** **Health and Safety Department**

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points
- References

Aim of the instruction

This guidance provides advice on the circumstances and manner in which the Tec Team should use the power and hand tools.

Scope

Only those members knowledgeable in the safe operation of any potentially dangerous tool will be allowed access. Jobsite electric tools to include: drills, sander, circular saw, grinders, mechanical screwdrivers. Jobsite hand tools to include: screwdrivers, tape measure, spanners, socket wrench, pliers, wire cutters, clamps, hammers, level, hand wrenches, and paint brushes.

Implications and responsibilities

HS Coordinator:

Assisting supervisors in identifying hazardous conditions in regards to hand/power tools; Inspecting areas to ensure that this policy is being adhered to and Providing safety awareness training, as needed.

General Site Coordinator:

Ensuring employees are trained to use tools properly and in accordance with the manufacturer's instructions, keep all tools in good condition with regular maintenance and replacing all damaged tools.

Worker:

Use the right tool for the job; notify any bad condition founded in the tools.

Equipment needed work

A hard hat

Safety glasses

A shirt with sleeves and long trousers

Safety boots with ankle supports.

Depending on the tool jacket or vest and gloves, ask the HS Coordinator or Officer.

Stages of labor and safety key points

Stage	Safety key point
Previous phase	• Examine each tool for damage before use • Utilize the proper protective equipment given by the HS Officer • Follow all maintenance instructions and read the manual of the tool before use it. • Participate in safety training
Stage of performance of the work	Power tools: • Never carry a tool by the cord or hose • Never remove prongs from any cords • Never stand in or near water when using tools • Always use a Ground Fault Circuit Interrupter (GFCI) with electrical tools if working in a wet environment • Never "yank" the cord or the hose to disconnect it from the receptacle

	• Keep cords and hoses away from heat, oil and sharp edges • Replace all frayed and/or damaged extension cords. Do not try to tape cords • Disconnect tools when not in use, before servicing and when changing accessories such as blades, bits and cutters • All observers shall be kept at a safe distance away from the work area • Secure work with clamps or a vise, freeing both hands to operate the tool • Avoid accidental starting. The worker shall not hold a finger on the switch button while carrying a plugged-in tool. • Tools shall be maintained with care. They shall be kept sharp and clean for the best performance. Follow instructions in the user's manual for maintenance, lubricating and changing accessories • Maintain good footing and balance • Avoid loose fitting clothes, ties or jewelry such as bracelets, watches or rings, which can become caught in moving parts • Use tools that are either double-insulated or grounded (three-pronged) • Keep work area well lit when operating electric tools • Ensure that cords and hoses do not pose as a tripping hazard; and • All portable electric tools that are damaged shall be removed from use and tagged "Do Not Use". This shall be done by supervisors and/or employees. • Hand tools • Floors shall be kept as clean and dry as possible to prevent accidental slips with or around dangerous hand tools • Around flammable substances, sparks produced by iron and steel hand tools can be a dangerous ignition source. Where this hazard exists, spark-resistant tools made from brass, plastic, aluminum or wood shall be used.
After	• Operate tools in specified areas, and store tools in a specific area when not

	in use to prevent damage and abuse. • Report any damage to the General Site Coordinator.
References OSHA{s Safety and Health Topics | Hand and Power Tools Alberta Construction Safety Association (s. f.). Safety Practice: Power and Hand Tool Use	

Source: Blanco & Ortega, 2014.

- Chart 25. Safe hand lifting procedure.

trópika Costa Rica	**Safe hand lifting Procedure**	**Code: HS_10.5** **Version: 1** **Health and Safety Department**

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points
- References

Aim of the instruction

This guidance provides advice on the circumstances and manner in which the Tec Team should do the manual lifting. All OSHA standard requirements and procedures will be followed. Almost, the load will not exceed 25 kilos/ person.

Scope

All hand lifting where the load will not exceed 25 kilos/ person.

Implications and responsibilities

General Site Coordinator:

Give the instructions of the work.

HS Officer:

Monitoring that lifting works are conducted properly and correct if not.

Equipment needed work

A hard hat Safety glasses A shirt with sleeves and long trousers Safety boots with ankle supports. Jacket or vest Use gloves that aid in holding slippery objects
Stages of labor and safety key points

Stage	Safety key point
Previous	• Evaluate the next factors and take into account the comments of each one: <u>Weight of Objects</u> Lifting loads heavier than about 50 pounds will increase the risk of injury and place great stress on muscles, discs, and vertebrae. <u>Awkward Postures</u> Bending while lifting forces the back to support the weight of the upper body in addition to the weight you are lifting. Bending while lifting places strain on the back even when lifting something as light as a screwdriver. Bending moves the load away from the body and allows leverage to significantly increase the effective load on the back. This increases the stress on the lower spine and fatigues the muscles. Reaching moves the load away from the back, increases the effective load, and places considerable strain on the shoulders.

	Carrying loads on one shoulder, under an arm, or in one hand, creates uneven pressure on the spine. Poor housekeeping limits proper access to objects being lifted, and forces awkward postures. <u>Frequency and Duration Lifting</u> Holding items for a long period even if loads are light, increases risk of back and shoulder injury, since muscles can be starved of nutrients and waste products can build up. Repeatedly exerting, such as when pulling wire, can fatigue muscles by limiting recuperation times. Inadequate rest periods do not allow the body to rest. <u>Handholds</u> Inadequate handholds (Figure 11) make lifting more difficult, move the load away from the body, lower lift heights, and increase the risk of contact stress and of dropping the load.
During	• Move items close to your body and use your legs when lifting an item from a low location • Avoid twisting, especially when bending forward while lifting. Turn by moving the feet rather than twisting the torso. • Keep your elbows close to your body and keep the load as close to your

	body as possible • Keep the vertical distance of lifts between mid-thigh and shoulder height. Do not start a lift below mid-thigh height nor end the lift above shoulder height. Lifting from below waist height puts stress on legs, knees, and back. Lifting above shoulder height puts stress on the upper back, shoulders, and arms. • Break down loads into smaller units and carry one in each hand to equalize loads. Use buckets with handles, or similar devices, to carry loose items. • Keep the load close to the body. When lifting large, bulky loads, it may be better to bend at the waist instead of at the knees in order to keep the load closer to your body. • Ask for help when is necessary • Rotate tasks so employees are not exposed to the same activity for too long. • Work in teams; one employee lifts and holds items while the other assembles. • Take regular breaks and break tasks into shorter segments. This will give muscles adequate time to rest. Working through breaks increases the risk of musculoskeletal disorders (MSDs), accidents, and reduces the quality of work because employees are overfatigued. • Move materials from containers with poor handholds or without handholds into containers with good handholds. • Wear proper personal protective equipment (PPE) to avoid finger injuries and contact stress. Ensure that gloves fit properly and provide adequate grip to reduce the chance of dropping the load.
References OSHA eTool: Solutions for Electrical Contractors - Materials Handling: Heavy Lifting NIOSH: Ergonomic Guidelines for Manual Material Handling	

Source: Blanco & Ortega, 2014

Chart 26. Scaffolding use procedure.

trópika Costa Rica	**Scaffolding use Procedure**	**Code: HS_10.6** **Version: 1** **Health and Safety Department**

Contents

Aim of the instruction

The purpose of this safety policy and procedure is to establish guidelines for the protection of Tec Team members who work on scaffold work surfaces.

Scope

Scaffolds shall be erected, moved, dismantled, or altered only under the supervision of a competent person and will have guardrails and toe boards installed. When scaffolding hazards exist that cannot be eliminated, then engineering practices, administrative practices, safe work practices, Personal Protective Equipment (PPE), and proper training regarding Scaffolds will be implemented.

Implications and responsibilities

General Safe Coordinator:

Ensure implementation of Tec Team's safety policy and procedure on Scaffolds.

Safety Coordinator:

Ensure that the equipment complies with safety specifications

Worker:

Report immediately any unsafe act or condition to his or her supervisor.

Equipment needed work

A hard hat

Safety glasses

A shirt with sleeves and long trousers

Safety boots with ankle supports A reflective jacket or vest Tool holder	
Stages of labor and safety key points	
Stage	Safety key point
Scaffold Erection	• Check the structure and : Safety accessories, guardrails , toeboards • The scaffolding must be assembled with all the elements provided for configuration required. Do not use other than those provided. Do not modify the technical elements. • When assembling and disassembling scaffolding, if the collective protection personal is no longer assured, personal protection devices become mandatory. Access to the work area should be prohibited unauthorized persons. • The scaffold must always be perfectly horizontal. • The climatic conditions should not compromise the safety of workers.
Working phase	• Any scaffold, including accessories such as braces, brackets, trusses, screw legs, ladders, couplers, etc., damaged or weakened from any cause must be repaired or replaced immediately, and shall not be used until repairs have been completed. • Scaffolds shall not be moved while employees are on them • Eligible expenses by scaffolding must not be exceeded (charge distributed over the structure and supported by bearings). • Guardrails must always be in place, even when working against a wall. Never use enhancement to work on the set (chair, stool, scale ...). • During the use of the scaffolding, the media wheels are locked and blocked wheels. • Always access levels from the inside of the scaffold, never outside. Access doors must be closed automatically after each pass. Nothing should obstruct opening or closing.

	• The scaffold must not be used to support lifting devices such as hoists, winches, ducting materials... • Do not approach flying electric conductors or uninsulated. • Do not use boards or planks to access the bearings, do not bridge with the building scaffolding or another. • Outriggers must always be in place, arranged diagonally the base of the rectangle. • Move the scaffolding manually two people on solid, level ground (slope 3 % max.) with stabilizers deployed. The scaffold must be emptied of its equipment and its occupants. The path must be free of obstructions on the ground or air.
References OSHA: Safety requirements for scaffolding OSHA: *A Guide to Scaffold Use in the Construction Industry*	

Source: Blanco & Ortega, 201

Chart 27. Trucks movements inside la lot procedure.

trópika Costa Rica	**Trucks movements inside the lot Procedure**	**Code: HS_10.7** **Version: 1** **Health and Safety Department**
Contents • Aim of the instruction • Scope • Implications and responsibilities • Equipment needed work • Stages of labor and safety key points		
Aim of the instruction This guidance provides advice on the circumstances and manner in which the Tec Team should coordinate the trucks movements inside the lot.		

Scope
Includes the entrance and movements of trucks inside the lot during assembly and disassembly process.
Implications and responsibilities General Site Coordinator: Must approve the entry of trucks at construction site with written permission Safety Officer: Monitor that no accidents occur
Equipment needed work Written entrance permission Signposting

Stages of labor and safety key points

Stage	Safety key point
Previous to entrance	General Site Coordinator check that the truck driver comply with all the requirements Realize a previous analysis of the truck's movements between the HS Team Coordinator, Site Coordinator and the driver of the truck
Entrance	Truck's speed will adapt to the step of a man one person must walk in front of the truck in order to guide the movements of the trucks, establish the maximum speed of the vehicles and avoid the accidents with people and the rest of vehicles and/or with the different elements

Source: Blanco & Ortega, 2014.

Chart 28. Work at heights procedure

trópika Costa Rica	**Work at heights Procedure**	**Code: HS_10.8** **Version: 1** **Health and Safety Department**

Contents

Aim of the instruction

The objective of this procedure is to ensure that all Tec Team members working at the construction sites are protected from the hazards of falls from height or being affected by falling objects.

Scope

The requirements of this procedure are mandatory for all Tec Team members on the site involving. This document applies for works over 0.8 m.

Implications and responsibilities

General Site Coordinator:

Ensure all persons using personal fall protection systems are trained in the safe and correct use of that system including initiating a rescue plan after a worker has fallen.

HS Officer:

Ensure that the potential of an object or person to fall is managed as per this procedure.

Ensure there are written procedures and equipment available for the safe retrieval of a person who has fallen.

Ensure that the user of a fall protection system does not work alone.

Team members and SDE Organizers:

Inspect harnesses and lanyard assemblies prior to every use.

Ensure that all the equipment is used properly.

Equipment needed work

PPE:

- A hard hat
- Safety glasses
- A shirt with sleeves and long trousers
- Safety boots with ankle supports.
- A reflective jacket or vest
- Work at heights equipment

Stages of labor and safety key points

Stage	Safety key point
Previous requirements	• General Site Coordinator check that all workers are trained in the safe and correct use of that system including initiating a rescue plan. If there is a risk of an object falling on to persons working below then one of the following falling object risk management methods shall be implemented: • Time method – planning or otherwise managing work so that tasks creating an overhead work situation do not occur at the same time for different work groups. • Distance Method – planning or otherwise managing work so that tasks creating an overhead work situation do not occur in what is reasonably foreseeable and demarcated as the cordoned area. If there is a risk of a person falling the control measures involve a fall arrest harness system • Team members have to inspect before start any work: • Anchor points • Harnesses and accessories • Lanyards and accessories • Static lines and accessories • Rope systems and accessories • Mobile work platforms and attachments • Under no circumstances shall a person work under or be positioned under a suspended load.

At work time	• No person shall work in a position where there is potential for an un-arrested fall from a height that is likely to cause injury. • Fallow all the instructions given in the ¨Work at heights Training¨.
After	• Put the equipment in its corresponding place. • Notify any damage in the equipment to the HS officer.
References UK Healthy and Safe Executive: *Working at height* OSHA: Fall Protection	

Source: Blanco & Ortega, 2014.

Chart 29. Safe hoisting and rigging.

trópika Costa Rica	**Safe** **Hoisting and Rigging**	**Code: HS_10.9** **Version: 1** **Health and Safety** **Department**

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points
- References

Aim of the instruction

The following guidelines are to help plan lifts so that potential hazards can be identified and controlled.

Scope

The requirements of this procedure are mandatory for all Tec Team members and apply to all lifts performed on the site.

Implications and responsibilities

General Site Coordinator:

Ensure the proper use of lifting and rigging. Coordinating movements, logistics and attachment to this issue.

Ensure that the equipment and accessories needed are available.

Ensure that equipment is properly set up and positioned.

Ensure that a signaler is assigned, if required, and identified to the equipment operator.

Direct the lifting operation to ensure that it is done safely and efficiently

HS Coordinator:

Ensure that the personnel involved have received proper and current training and qualification for the procedure

Stop the job when any potentially unsafe condition is recognized.

Brigade member SDE Organizers:

Direct emergency stabilization operations if an accident or injury occurs.

Equipment needed work

PPE:

- A hard hat
- Safety glasses
- A shirt with sleeves and long trousers
- Safety boots with ankle supports.
- A reflective jacket or vest

Stages of labor and safety key points

Stage	Safety key point
Planning	• Characterize the load in terms of dimensions, weight, and center of gravity • Characterize the task in terms of lifting, rotation, speeds, and travel directions • Evaluate hazards to determine consequences resulting from collision, upset, or dropping the load • Determine how to rig the load using good rigging practices. • Ensure that the attachment points and load can withstand the forces created by the rigging gear attachment • Select equipment and rigging based

	on: the type, category of lift, a minimum capacity of lifting equipment (hoist, crane, slings, lifting fixture, etc); and on the identified load, task, and hazards. • Ensure that sling angles are considered when determining forces on rigging equipment and the load.
Preparing and Testing	• Verify that all equipment, fixtures, and accessories are operative, up-to-date on required periodic inspections, and in good condition before the operation begins • Perform all equipment pre-use inspections • Perform a test lift using similar or dummy loads • Prepare the area where the load is being moved to (for example, clear the area, ensure that dunnage is • in place) • Clear lift path of obstructions • Ensure that all personnel are trained on the types of equipment they will be using • Ensure that all personnel fully understand the requirements of the lift and their role in the operation
Performing the Lift	• Ensure all personnel involved in the lift understand the plan • Provide the task qualified supervision specified in the planning process • Vacate all non-essential personnel from the building or adjacent area (optional) Ensure a signaler is assigned, if required • Identify the crane operator • Follow specific instructions/procedures for attachment of the rigging gear to the load. Use proper rigging techniques. Examples include padding sharp corners; orientation of chocker hitches for “rolls”, orientation of hooks, no binding of hoist rings, etc. • Slowly raise the crane to take the slack out of the rigging without actually lifting the item. Allow the rigging gear to

	settle into place, checking for twists and binding. Make sure that padding has remained in place and all slings are protected from sharp edges. Begin to raise the item to verify balance and check the braking system by watching that the load does not sink. If load is not balanced, lower the load and adjust. Repeat as necessary until the load is evenly balanced. • Stop the job when any potentially unsafe condition is recognized
Reference Department of Energy Standard 1090, "Hoisting and Rigging" (DOE-STD-1090-2007), "DOE-STD-1090-2007; Hoisting and Rigging Standard (Formerly Hoisting and Rigging Manual)" SLAC Environment, Safety, and Health Manual (SLAC-I-720-0A29Z-001)	

Source: Blanco & Ortega, 2014.

Chart 30. Confined Spaces Procedure

trópika Costa Rica	**Confined Spaces**	**Code: HS_10.10** **Version: 1** **Health and Safety Department**
Contents • Aim of the instruction • Scope • Implications and responsibilities • Equipment needed work • Stages of labor and safety key points • References		
Aim of the instruction		

The following guidelines are to manage the risks associated with working in confined spaces.

Scope

The requirements of this procedure are mandatory for all Tec Team members and apply to all the works under the floor, which because of it characteristics is considered as a confined spaces.

Implications and responsibilities

General Site Coordinator:

Fill the permit with the entrant.

Ensure that the works are being done according to the safety standards

HS Coordinator:

Know space hazards including information on the mode of exposure, signs or symptoms and consequences.

Verify emergency plans and specified entry conditions such as permits, procedures and equipment before allowing entry.

Verify that rescue services are available and that the means for summoning them are operable.

Take appropriate measures to remove unauthorized entrants.

Ensure that entry operations remain consistent with the entry permit and that acceptable entry conditions are maintained.

Check and Sign the permit-required.

Stop the work if there is not a permit signed.

Terminate entry and cancel permits when entry operations are completed or if a new condition exists.

Brigade member SDE Organizers:

Direct emergency stabilization operations if an accident or injury occurs.

Equipment needed work

PPE:

- A hard hat
- Safety glasses
- A shirt with sleeves and long trousers
- Safety boots with ankle supports.

• A reflective jacket or vest	
Stages of labor and safety key points	
Stage	Safety key point
Permit required	Before entering the HS Coordinator have to sign the written permit, which have to contain: • Name of permit space to be entered, authorized entrant(s), eligible attendants and individuals authorized to be entry supervisors. • Name and signature of HS Coordinator. • Purpose of entry and known space hazards. • Measures to be taken to isolate permit spaces and to eliminate or control space hazards. • Name and telephone numbers of rescue and emergency services and means to be used to contact them. • Date and authorized duration of entry. • Acceptable entry conditions. • Communication procedures and equipment to maintain contact during entry. • Special equipment and procedures, including personal protective equipment and alarm systems. • Any other information needed to ensure employee safety.
During the work	Authorized entrants are required to: • Know space hazards.

	• Use appropriate PPE properly.
	• Maintain communication with attendants.
	• Exit from the permit space as soon as possible when:
	  ▪ Ordered by the authorized person.
	  ▪ He or she recognizes the warning signs or symptoms of exposure.
	  ▪ A prohibited condition exists.
	• Alert the attendant when a prohibited condition exists or when warning signs or symptoms of exposure exist.
	
	The attendant is required to:
	
	• Remain outside the permit space during entry operations.
	• Perform non-entry rescues when specified by the employer's rescue procedure.
	• Know existing and potential hazards, including information on the mode of exposure, signs or symptoms, consequences and physiological effects.
	• Maintain communication with and keep an accurate account of those workers entering the permit space.
	• Order evacuation of the permit space when:
	  • A prohibited condition exists.
	  • A worker shows signs of

	physiological effects of hazard exposure. • An emergency outside the confined space exists. • The attendant cannot effectively and safely perform required duties. • Ensure that unauthorized people stay away from permit spaces or exit immediately if they have entered the permit space. • Inform authorized entrants and the entry supervisor if any unauthorized person enters the permit space. • Perform no other duties that interfere with the attendant's primary duties.
End of the work	• Terminate entry.
Reference CCOHS, Confined Space - Program OSHA, Permit-required confined spaces 1910.146	

Source: Blanco & Ortega, 2014.

Chart 31. Hazardous Substances Procedure

trópika Costa Rica	**Hazardous Substances**	**Code: HS_10.11** **Version: 1** **Health and Safety Department**
Contents • Aim of the instruction • Scope		

- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points
- References

Aim of the instruction

The following guidelines are a guide to handling in a correct way hazardous substances in the construction of Trópika.

Scope

The requirements of this procedure are mandatory for all Tec Team members and apply to all hazardous substances used during the assembly and disassembly of Trópika.

Implications and responsibilities

General Site Coordinator:

Ensure the proper use manipulation and use of the hazardous substances.

Ensure that the resources and materials needed are available.

HS Coordinator:

Ensure that the personnel involved have received proper and current training and qualification for the procedure.

Inspect storage, transport and handling are according to the manufacturer instructions.

Keep MSDS accessible and ensure that are known by the involved team members.

Brigade member SDE Organizers:

Direct emergency stabilization operations if an accident or injury occurs.

Equipment needed work

PPE:

- A hard hat
- Safety glasses
- A shirt with sleeves and long trousers
- Safety boots with ankle supports.
- A reflective jacket or vest
- Gloves

Stages of labor and safety key points

Stage	Safety key point
Basic previous	• Labeling all Hazardous products as 'Hazardous materials' in English and Spanish. • All waste classified as hazardous should be isolated and stored as per the MSDS provided by the manufacturer. • Locations should be identified on the construction site to store the wastes and the items should be segregated and stored in the bins accordingly. • Fire Extinguisher should be accessible.
Specific substances	<u>admixtures, sealants, adhesives solvents etc.:</u> • Every worker should use respiratory protective equipment during working with chemical admixture products, sealants, adhesives, solvents etc. • Avoid any kind of skin contact with the chemicals used. • Wash well with soap and warm water or use special cleansers, especially after direct contact with chemicals, and before drinking and eating. • Install effective exhaust ventilation to prevent air contamination; add local exhaust ventilation if necessary. • Do not inhale or smell the chemicals when the cans are opened. • Disposal of containers of chemical products, materials applied with chemical products etc should be done

	by segregating and collecting these separately as hazardous waste. These should then be given to an authorized agency for disposal. Provided by SDE organization. • These materials should never be burnt. Paints, pigments, dyes and primers: • Every worker should use respiratory protective equipment during working with chemical admixture products, sealants, adhesives, solvents etc. • Avoid any kind of skin contact with the chemicals used. • Lead-based paint should be avoided completely. • Wash well with soap and warm water or use special cleansers, especially after direct contact with paints, pigments, etc., and before drinking and eating. • Do not inhale or smell the chemicals when the cans are opened. • Disposal of containers of paints, pigments, dyes and primers, other products used for its application, or any other products applied with these products should be done by segregating and collecting these separately as hazardous waste. These should then be given to an authorized agency for disposal. Provided by SDE

	organization.
Reference OSHA: *Draft model training program for hazard communication.*	

Source: Blanco & Ortega, 2014.

Chart 32. **Control of hazardous energy procedure**

	Control of hazardous energy	**Code: HS_10.12** **Version: 1** **Health and Safety Department**
Contents • Aim of the instruction • Scope • Implications and responsibilities • Equipment needed work • Stages of labor and safety key points		
Aim of the instruction This procedure aims to protect team members who must do service or maintenance on machines or equipment and who could be injured by an unexpected start-up or release of hazardous energy. Service or maintenance includes erecting, installing, constructing, repairing, adjusting, inspecting, setting up, testing, cleaning, and dismantling machines or equipment. This policy will ensure that machinery or equipment is stopped, isolated from all hazardous energy sources, and properly locked or tagged out		
Scope This policy applies to all Tec Team members who may be exposed to hazardous energy during service or maintenance work. Uncontrolled energy includes potential, kinetic,		

flammable, chemical, electrical, and thermal sources.

Implications and responsibilities

General Site Coordinator:

Enforce the use of lockout and tag out devices when employees do service or maintenance work and may be exposed to hazardous energy.

Fill the permit to the work.

HS Coordinator:

Ensure that the personnel involved have received proper and current training and qualification for the procedure

Stop the job when any potentially unsafe condition is recognized.

Sign the permit of the work

Brigade member SDE Organizers:

Direct emergency stabilization operations if an accident or injury occurs.

Equipment needed work

PPE:

- A hard hat dielectric.
- Safety glasses
- A shirt with sleeves and long trousers
- Safety dielectric boots with ankle supports.
- A reflective jacket or vest

Stages of labor and safety key points

Stage	Safety key point
Basic rules	• All energy sources to fixtures, equipment and/or machinery shall be locked out or tagged out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. • Note that isolating a piece of equipment from its source may not eliminate all potential hazards. Stored energy may be present within the

	equipment or machinery. • Do not attempt to operate any switch, valve or other energy isolation device when it is locked or tagged out. • Never remove a lock or tag for another associate. Only the associate placing the lock or tag may remove it. If there is a need to remove another associate's lock or tag in an emergency, only the HS Coordinator may do so after making every effort to contact the owner of the lock or tag.
Before they begin service or maintenance work	1. Inform all affected employees of equipment shutdown. 2. Shut down equipment. 3. Isolate or block hazardous energy. 4. Remove any potential (stored) energy. 5. Lockout or tagout the energy sources. 6. Verify the equipment is isolated from hazardous energy and de-energized.
remove lockout or tagout	1. Remove tools and replace machine or equipment components. 2. Inform coworkers about energy-control device removal. 3. Ensure all workers are clear of the work

	area. 4. Verify machine or equipment power controls are off or in a neutral position. 5. Remove the lockout or tagout device. 6. Re-energize equipment

Source: Blanco & Ortega, 2014.

Alcohol and drugs

When one of the team members notices a person inside the lot that is under the influence of alcohol or drugs must report it immediately to the Tec Team Safety Officer, who shall make a written report and request the person to leave the site to prevent accidents. Take the person to a safe place and report the situation to Juan Carlos Marti, Project Manager.

At no time alcohol or illegal drugs are allowed on the site.

12. **Machinery and auxiliary resources**

Every safety user´s manuals from manufacturer of the machinery, tools and auxiliary resources are going to be available thus each team member knows and will fulfill the terms of these.

The manuals will be available for all team members but under the custody of the HS Coordinator. Is responsibility of every team member have read the manual of the machinery and auxiliary resources that is going to manipulate during all the process.

13. Planned Measures in case of accident

a) First aids

The first aid procedure will be the proposed in part 10.2.17 of this document nevertheless the all the members of the team have the knowledge of basic first aid procedures. A brigade will be in charge of that matter on every shift. They will be informed of the stipulated procedure on the General Coordination Plan. Knowing what action needs to be taken to control an emergency can make the difference between life and death, that is why half of Tec Team members are going to receive a 40 hours Basic First Aid Course given by EICPSA, a consultant company specialized in that subject.

The course topics are:

- Legal and ethical issues
- Anatomy Basics
- Body Systems
- Scene Rating
- Review of patient
- Review from head to toe
- Vital Signs
- Soft tissue injuries
- Bleeding
- Control of bleeding and bandages
- Musculoskeletal Injuries
- Shock
- Burns
- Poisoning
- Heat emergencies
- Medical Emergencies
- Imminent delivery

b) First aids bag

Is important to remind the presence of a Medical Center on Solar Village.

Considerations of the portable first-aid bag:

- It must contain only first-aid material.
- It must be orderly.
- Used material must be replaced, as well as the date of expire must be checked.
- Its content must be in accordance with the training level of the first-aider (user).

The contents of the firs aids bag according to the Spanish and French standards are:

Adhesive tape	Scissors	Moist Wipes
Alcohol wipes or ethyl alcohol	Elastic bandage	Pairs of Gloves
Antiseptic solution	First aids manual	Plastic bag
Assorted Washproof Plasters	Blanket	Sterile gauze
Safety pins	Hemostatic dressing	Sterile saline wipes
	Hemostatic pads	Triangular bandage

c) Preventive medicine

Every team member who is going to be part of the construction process has to pass a medical examination in which the Doctor ensures they are able to perform works in construction.

The medical examination is going to consist in three parts:

1. Electrocardiogram
2. Medical physical review
3. Blood tests review

Team members also are going to perform a physical test where experts on the area are going to determinate the physical condition of each one. This test consist will take in consideration endurance, speed, balance and agility.

d) Accident victim evacuation

The evacuation of injured people will be in charge of trained persons. That is the reason why we call the emergency number on chat 2 of this document, stabilize the victim, and wait for the ambulance to arrive to give the victim to professional hands. Emergency Plan can be found on part 18 of this document.

14. Risks identification for possible later works.

For possible latters works we have identify some risks such as:

Chart 33. Risk identification for possible later works.

Risk	Activity
Minor abrasions	Setup of the elements on the container.
Collision with vehicles	During the transport of the container.
Hits	Setup of the elements on the container.

Source: Blanco & Ortega, 2014.

All these risk will be prevented with training and safety courses to the team members this way they also are going to be aware of risky situations when something unplanned happen.

15. Useful plans and information for possible later works

After the disassembly phase there will be a reunion with the team so we can analyze and quantify if is necessary to do later works. Those tasks will be consider by the Site Operation Coordinator and the H&S Coordinator to determinate how those jobs will be develop, will have in consideration the safety of the Team members.

16. Formation and information about safety

Formation and information are primary in this process in order to reduce the probability of accidents and incidents during the assembly and disassembly of Trópika. The next plan explains with more detail the training received by every team member.

Chart 34. Safety Training Plan

trópika Costa Rica	**Safety Training Plan**	**Version: 1** **Safety Department**

Contents

Introduction

Training is one of the most important components within Tec Team´s safety management system. It gives team members an opportunity to learn their jobs properly, bring new ideas into the construction site, reinforce existing ideas and practices, and it helps to put our Safety Program into action.

Every Teac Team member will benefit from safety training through fewer workplace injuries and illnesses, reduced stress, and higher morale. Productivity, and competitiveness will increase.

Purpose and mission of the plan

The purpose of this plan is to establish the safety training the assembly and disassembly of the habitation module.

The mission is to keep every member of the team safe; this will be achieved by giving the knowledge of safety to all the members.

Management commitment

We Tec Team will provide the necessary funds and scheduling time to ensure effective safety training is provided. Both management and employees will be involved in developing the program.

To most effectively carry out their safety responsibilities, all employees must understand

- Their role in the program.
- The hazards and potential hazards that need to be prevented or controlled.
- The ways to protect themselves and others.

We will achieve these goals by:

- Educating everyone on the natural and system consequences of their actions.
- Educating all Team members on their safety management system responsibilities.
- Educating all Team members about the specific hazards and control measures.
- Training all employees on safe work procedures and practices.

Our training program will focus on safety concerns that determine the best way to deal with a particular hazard. When a hazard is identified, we will first try to remove it entirely. If that is not feasible, we will then train workers to protect themselves, if necessary, against the remaining hazard.

Team members

At a minimum, Team members must know the general safety rules of the worksite, specific site hazards and the safe work practices needed to help control exposure, and the individual's role in all types of emergency situations. We will ensure all Team members understand the hazards to which they may be exposed and how to prevent harm to themselves and others from exposure to these hazards.

Team members must know they are responsible for complying with all company safety rules, and that most accidents will be prevented by their safe work practices. They must be very familiar with any personal protective equipment required for their jobs. They must know what to do in case of emergencies.

Everyone in the team needs to understand that they are not expected to start working a new assignment until they have been properly trained. If a job appears to be unsafe, they will report the situation to the General Site Coordinator.

Safety Coordinators and supervisors

Coordinators will be given special training to help them in their leadership role. They will be taught to look for hidden hazards in the work under their supervision; insist on the maintenance of the physical protection in their areas; and reinforce employee hazard

training through performance feedback and consistent enforcement when necessary.
We will commit necessary resources to ensure supervisors understand the responsibilities below and the reasons for
them:

• Detecting and correcting hazards in their work areas before they result in injuries or illnesses
• Providing physical resources and psychosocial support that promote safe work
• Providing performance feedback and effective recognition and discipline techniques
• Conducting on-the-job training

General Site Coordinator and Project Manager

All Site Coordinators and Project Manager must understand their responsibilities within our Health and Safety Program. The subject can be covered periodically as a part of regular management meetings. Managers will be trained in the following subject areas:

• Their responsibility to communicate the Safety Program goals and objectives to team members;
• Their role that includes making clear assignments of Safety Program responsibilities, providing authority and resources to carry out assigned tasks, and holding subordinate managers and supervisors accountable
• Actively requiring compliance with mandatory Safety and Safety Program policies and rules.

Training will emphasize the importance of General Site Coordinator and Project Manager visibly showing their commitment to the Safety program. They will be expected to set a good example by scrupulously following all the safety rules themselves.

Contributors

For the training Tec Team will count with the collaboration of experts in Safety area such as Teachers of the career of Occupational Safety and Environmental Health Engineering of Tecnológico de Costa Rica, Representatives of the association of engineers in occupational safety and environmental health (AISHLA) and the Safety, Health and Environment Program for Central America (SALTRA).

Time and requirements			
Topics	**Description**	**Requirements**	**Time**
Safety in electrical installation.	• General requirements • Specific purpose equipment	Expert in electrical installation Classroom for 30 persons	5 hours
Safety in constructions (prevention labor risk).	• Health and Safety introduction • Definitions • PPE • Signaling • Tools, hand and power • Scaffolds • Fall protection • Heavy equipment operation	Expert in Safety: SALTRA, (Safety, Health and Environment Program for Central America) and AISLHA, (Occupational Safety and Environmental Hygiene Engineer's Association) Classroom for 30 persons	20 hours
Ergonomics.	• Material handling	Expert in ergonomics for construction works Classroom for 30 persons	3 hours
First aid training.	• Legal and ethical issues • Anatomy Basics • body Systems • Scene Rating • Review of patient • Review from head to toe • Vital Signs	EICPSA, company from by red cross members and nourses First aid materials for the practices	24 hours

	• Soft tissue injuries • Bleeding • Control of bleeding and bandages • Musculoskeletal Injuries • Shock • Burns • Poisoning • Heat emergencies • Medical Emergencies • Imminent delivery	Spacious place for simulations Classroom for 30 persons	
Extinguisher use.	• Types of fire • Types of extinguishers • Parts of the extinguisher • Practice of extinguisher use	Expert in fire prevention Spacious place for simulations Classroom for 30 persons	3 hours
Emergency responce	• Emergency telephone numbers and who may use them • Emergency exits and how they are marked • Evacuation routes • Signals that alert the need to evacuate • Procedure in case of different emergencies	Classroom for 30 persons	5 hours

Health and Safety Training Plan Evaluation

HS Coordinator and General Site Coordinator will evaluate training through the following methods:

- Observing employee skills
- Surveys and interviews to determine employee knowledge and attitudes about training
- Reviewing the training plan and lesson plans
- Comparing training conducted with hazards in the workplace
- Reviewing training documents
- Comparing pre-and post-training injury and accident rates

Documentation of Training

Keep a record, both digital and printed, assistance to training, to verify the involvement of the team. It consists of a list indicating the subject of training, responsible person, date

and time of beginning and end, this list shall be signed by the attendees at the beginning and end of the training.

Source: Blanco & Ortega, 2014.

17. Emergency Plan during the assembly and disassembly phases.

Emergency Plan

- Purpose and mission of the plan.

The purpose of this plan is to establish the themes and time of the safety training needed for the assembly and disassembly of the habitation module.
The mission is to keep every member of the team safe; this will be achieved by the designation of responsible persons of manage the situation.

- Personnel Classification.

The Tec Team's personnel is divided by departments that have specific tasks to develop during the constructive process. Thirty persons are responsible of the assembly and disassembly of the module. The distribution of members per department is detailed on the next chart:

Chart 35. Team member's distribution per department.

Name	Department	Responsabilities during constructive

		process
Juan Carlos Martí	Project Manager & Faculty Advisor	brigade member
Bryan Navarro	Team Leader, Sponsorship Manager and Administration.	brigade member
Hugo Sánchez	Domotics Coordinator	brigade member
Fabricio Bonilla	PV & Electric Coordinator	**brigade member**
Nicole Tames	Architecture Coordinator	Bankswoman, windows installation
Silvia Solano	Sustainability Coordinator	brigade member
Verónica Ortiz	Construction Coordinator	Construction manager, site operation manager brigade member
André Blanco	Health & Safety Coordinator	Health and safety coordinator
Randy Céspedes	Thermofluids Coordinator	Water system installation
Ana Laura Salazar	Logistic Coordinator	brigade member
Andrey Sanabria	Design Member	Woker
Marco Hidalgo	Design Member	Banksman, windows installation
Tito Solano	Design Member	brigade member
Enmanuel Salazar	Architecture Member	Banksman
Priscila Hernández	Architecture Member	brigade member
Estephanía Largaespada	Architecture Member	Bankswoman
Orlando Mata	Administration Member	worker
Maricela Blanco	Administration Member	worker
Francisco Rodríguez	Construction Member	Site operation coordinator
Daniel Rojas	Construction Member	Banksman
Daylin Vega	Sustainability Member	brigade member
Natalia Bonilla	Sustainability Member	brigade member
Adelina Ortega	Health & Safety Member	Safety officer, brigade member
David Vaglio	Thermofluids Member	chimney intallation

Jorge Calderón	Thermofluids Member	brigade member
Erik Soto	Domotics Member	brigade member
José Andrés Sandí	Domotics Member	worker
William Retana	Domotics Member	worker
Adrián Sánchez	Domotics Member	brigade member
Javier Carvajal	Domotics & PV-Electric Member	electric installation
Allan Vado	PV & Electric Member	solar panels installation
Cynthia Taylor	PV & Electric Member	brigade member
Isaac Morales	Logistic Member	windows installation
Carlos Morales	Logistic Member	Banksman, windows installation

Source: Blanco & Ortega, 2014.

- Authorities and responsible personal in case of emergency.

The names highlighted in black are the members of the group with the more responsibilities during the assembly and disassembly of the habitation module because the Site Operation Coordinator and the Site Officer are in charge of the management of the tasks that are necessary to accomplish the objective. The Health and Safety Coordinator and the Health and Safety Officer are in charge that every task will be done in a safety manner, they will have to supervise that every person is doing their job as the safety procedure says. In case of an accident and/or incident, the Health and Safety Coordinator and Officer will have to do an investigation to determinate the source of it and control it.
In case of emergency the communication between the personnel is important but the reaction can be slow if there are not people select for specific tasks in case of an evacuation, fire, earthquake, accident, incident, health issues, etc. So, the Health and Safety Department have designated a group of people that take the lead in an emergency. At least three members of the emergency brigade (highlighted in green) will be present during each shift to ensure a fast control and management of the situation. All the members of the brigade have already received CPR, first aids and rescue training; this way we ensure that they will take care the situation in the most professional way.

- Work schedule.

The members of the team will be divided in three groups in shifts of 8 hours per day, that time include 1 hour for lunch and 15 min for break.

- Production Process Description.

During the constructive process each person has a specific task to develop, as the project progresses the tasks assigned where evaluated so the person to develop them is competent. For the specific description of the tasks refer to Chart 35.

- Risks categorization and vulnerabilities analysis.

During the constructive process a lot of risks will be present all the time, it is important to categorize every one of those risk so that way we will have a better comprehension of our future environment.

- Risks generated by others.

Chart 36. Control of risks generated by others to the Tec Team.

Risk	Individual protection	Collective protection
Crane Collision	Reflective vest.	Delimitation of the Tec Team area with fences. Coordination with the neighbor teams for avoid interferences.
Fire	Training in extinguisher use.	Fire extinguisher, smoker detectors.
Robbery	The tools will be lock on a safety box when not in use, the storage area will have be lock also and our site will always be in charge on a member of the Team.	
Truck Collision	Reflective vest.	Delimitation of the Tec Team area with fences. Coordination with the neighbor teams for

Risk	Individual protection	Collective protection
		avoid interferences.
Entrance of non-authorized persons	Signposting will be visible for all persons so they will be warned of the prohibition of the entrance, the site will always be in charge on a member of the Team.	

Source: Blanco & Ortega, 2014.

- Risks generated by the environment.

- Chart 37. Control of risks generated by the environment.

Risk	Individual Protection	Collective Protection
Strong winds	The HS coordinator, safety officer and/or the workers will inform when is risky to work on that weather conditions.	
Rain	Impermeable coat use.	The HS coordinator, safety officer and/or the workers will inform when is risky to work on that weather conditions.
Sun Burns	Sunblock lotion use.	It will be provide shelter from the sun.
Earthquake	Safety reunion point. Brigade on each shift to guide the people.	

Source: Blanco & Ortega, 2014.

- Risks generated on others.

- Chart 38. Control of risks generated on others.

Risk	Individual Protection	Collective Protection
Crane collision	Reflective vest use, banksman training.	Delimitation of the Tec Team area with fences. Coordination with the neighbor teams for avoid interferences.
Fire	Training in extinguisher use.	Fire extinguisher, smoker detectors.

Source: Blanco & Ortega, 2014.

- Self-generated risks.

- Chart 39. Control of risks generated by our self's.

Risks	Individual Protection	Collective Protection
Electrical	-Dielectric gloves, shoes and tools. -Prohibition of carrying metallic objects.	-Training in electrical installations. -Earthing of the electrical system. -Logout-tagout preventive method.
Different Level Falls	-Protective equipment for working at heights.	-Training in works at heights. -Scaffoldings. - Lifelines. -
Falling Objects	-Helmet use.	-Scaffoldings with skirting. -Crane's hook with safety lock.
Collision with vehicles	-Reflective vest.	-Delimited zone for trucks and forklift. -Preventive truck checks.

Risks	Individual Protection	Collective Protection
Overexertion	-	-Manual handling training. -Work shifts.
Ergonomic	-Lumbar support belt on heavy materials lift.	-Training in material handling. -Manual handling training. -Active breaks.
Fire	-	-Extinguishers. -Smoke detectors.
Explosion	-	-Hazardous substances handling safety officer supervision.
Minor Abrasions	-Use of safety shoes, helmet, glasses and gloves.	-Training in material handling. -First aid kit.
Hits	-Use of safety shoes, helmet, glasses and gloves.	-Training in material handling. -First aid kit.
Cuts	-Use of safety shoes, helmet, glasses and gloves.	-Training in material handling. -First aid kit.
Heatstroke	-Sunblock use.	-Hydration stations. -Rest shifts.
Burns	-Sunblock use.	-Sun shelter. -Rest shifts.

Risks	Individual Protection	Collective Protection
Same Level Falls	-Safety shoes use.	-Tidiness program.

Source: Blanco & Ortega, 2014.

• Operational Plan.

The aim of the HS Department is to keep everyone safe during an emergency, to ensure this vision the specific activities, resources and responsible persons where analyzed on the next chart:

• Chart 40. Operational Plan of the Emergency Plan.

Objectives	**Activities**	**Resources**	**Responsables**
Keep everybody's health and safety during an emergency.	-Train the group in first aid procedures. -Train the group about the risks during the assembly and disassembly. -Form an emergency brigade. -Establish the emergency routes.	Trainings from several experts: -First aids: EICPSA, company from by red cross members and nurses. -Safety training: SALTRA, Safety, Health and Environment Program for Central America and AISLHA, Labor Safety and Environmental Hygiene Engineer's Association. -Banksman training: JAPDEVA, the main port management	HS Coordinator and Safety Officer.

Objectives	Activities	Resources	Responsables
		company in Costa Rica. -H&S Department members.	
Investigate the source of the possible emergencies.	-Establishment of the accident/incident investigation form.	H&S Department members.	HS Coordinator and Safety Officer.
Evaluate the emergency plan	-Generate data from an emergency simulation.	H&S Department members.	HS Coordinator and Safety Officer.

Source: Blanco & Ortega, 2014.

• Communication.

None of the established goals will be accomplished if the communication between the emergency plan members is effective. To ensure that all the information will be delivered to the person of interest, the department proposed a strategy that does not interrupted or delay the data transmission.

The communication will be described on the next figure:

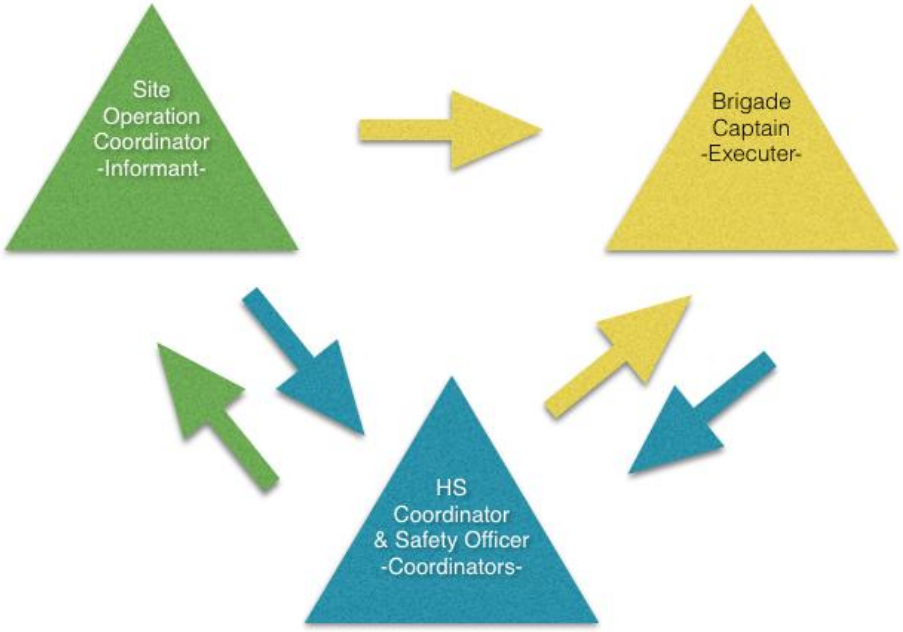


Figure 8. Communication flow during an emergency.

Source: Blanco & Ortega, 2014.

This way we ensure that the each responsible person will communicate in an effective way and order, this prevents misunderstandings and increase the effectiveness of the plan.

- Procedures

The procedures in case of emergency during the assembly and disassembly are important to keep all the team members safe in case of an incident or an accident.

During the assembly and disassembly of the project the emergency plan will be available to every member of the team. There will always be a signposting indicating the point of reunion. In every shift always will be a member of the brigade. The signposting will be described on the H&S drawings: 1-18.

On the next chart the emergency evacuation plan is described:

Chart 41. Emergency procedure during an evacuation.

trópika Costa Rica	**Emergency Evacuation Plan**	**Version: 1** **Health and Safety Department**

Contents:

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points

Aim of the instruction:

This procedure is a guide to follow in case of a necessary evacuation during the assembly and disassembly phase of the project.

Scope:

This procedure looks for a safety manner to do an emergency evacuation of the Tec Team from a risky place to a safe one.

Implications and responsibilities:

General Site Coordinator:

Ensure that every person receive the alert of evacuation.

HS Officer:

Make sure that everyone is doing the evacuation in a safety manner and going to the right safety place.

Team members and SDE Organizers:

Every member of the team must follow the instructions of the HS Officer and the HS coordinator.

Equipment needed to work:

Personal Equipment Protection:

Safety helmet.

Safety glass.

Reflective vest.

Safety gloves.

Safety shoes.

Others:

Whistle.

Stages of labor and safety key points.	
Stage	**Safety key point**
During the emergency.	Everybody must remain clam. The HS Officer must let everyone know that an emergency has occurred and evacuation is necessary by blowing the whistle. The HS Officer must evaluate the safe gathering point to ensure still safe and guide everyone there. The General Site Coordinator must make sure everyone is present; if someone is missing he/she must notify and tell the HS Officer.
After the evacuation.	The HS officer, the General Site Coordinator and the brigade coordinator must look for a person if is missed. In case of a medical emergency the victim will be stabilized by the emergency brigade and inform the organization about the situation and wait until professional attendance.

Source: Blanco & Ortega, 2014.

Also, we included the procedure in case of fire during the assembly and disassembly phases. It is important to remember that a brigade will be trained in the extinguisher use. On the next chart the emergency procedure in case of fire will be stipulate.

Chart 42. Emergency procedure in case of fire.

trópika Costa Rica	**Emergency procedure in case of fire.**	Version: 1 Health and Safety Department

Contents:

Aim of the instruction:

This procedure is a guide to follow in case of fire.

Scope:

This procedure looks for a safety manner of extinguish an outbreak of fire by the Tec Team.

Implications and responsibilities:

General Site Coordinator:

Ensure that every person receive the alert of fire.

HS Officer and HS Coordinator:

Make sure that the situation can be controlled with the fire extinguisher.

Team members and SDE Organizers:

Every member of the team must follow the instructions of the HS Officer.

Equipment needed for emergency attendance:

Safety helmet.

Safety glass.

Reflective vest.

Safety gloves.

Safety shoes.

Others:

Whistle.

Fire extinguisher.

Stages of labor and safety key points

Stage	Safety key point
During the fire	-Everybody must remain clam. -The leader of the brigade must assign someone to inform the HS Officer about the

	situation. -A member of the brigade must look for a fire extinguisher and try to control the fire outbreak. -If the situation was not controlled the Safety Officer must evaluate the situation and decide if evacuate or try to control the fire.
After the fire.	-The General Site Coordinator must inform the HS Coordinator about the beginning of the situation and an investigation must be done to determinate the source and control it.

Source: Blanco & Ortega, 2014.

Emergency Brigade:

During an emergency the task of the emergency brigade is to stabilize any injured person, maintain the proper order of evacuation of the members and keep everyone in calm, every member of the brigade has the proper training to rescue and/or make a professional attendance of any person under any health complication. The brigade members will have direct communication with the HS Coordinator, Safety Officer and the Site Operation Coordinator.

- Evacuation Route.

During an emergency everyone must know where the reunion point is, but even if the people know the exact location, the brigade members will guide them. When the habitation module is finished, the evacuation route will be the next:

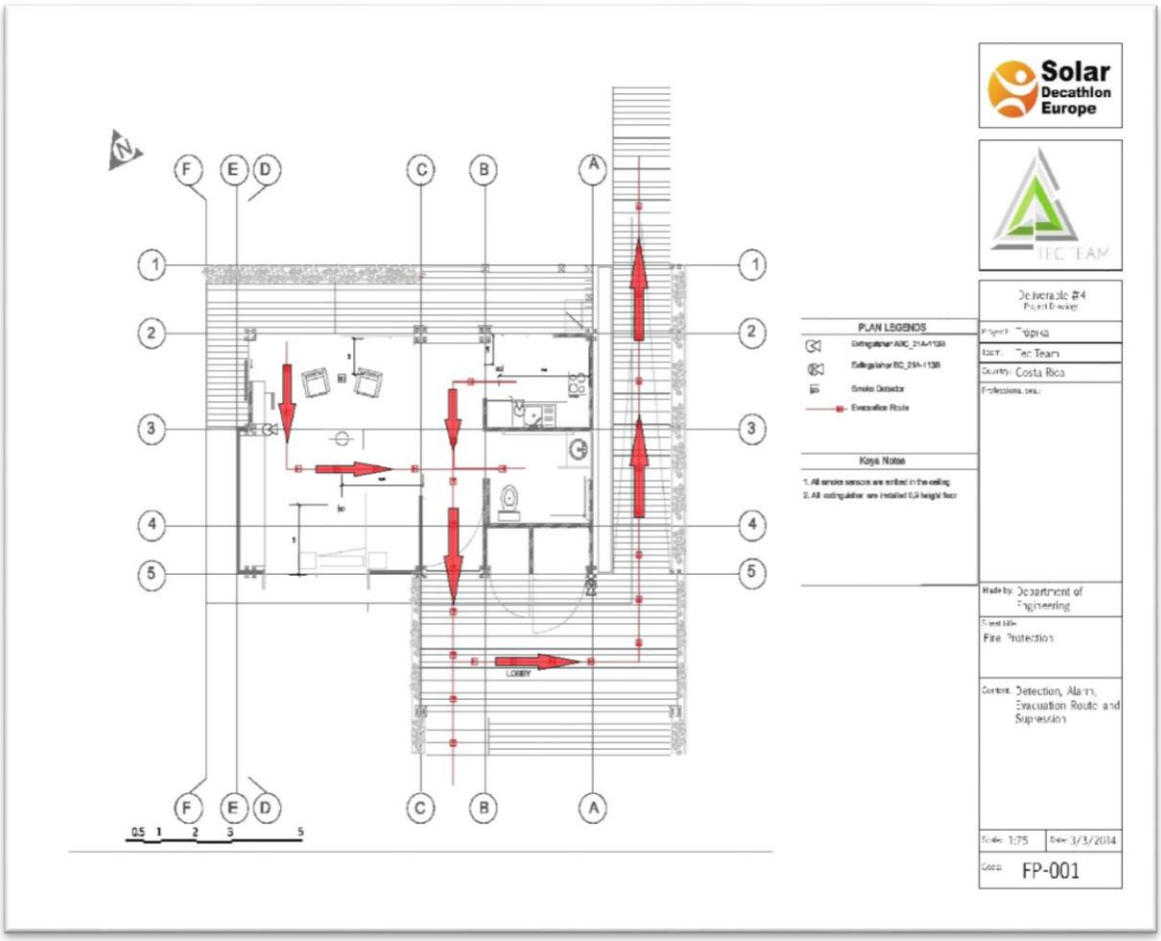


Figure 9. Evacuation Route.

18. Adopted system for the level of safety control during works

At every moment of the construction process the HS Coordinator or a Safety

Officer will be on duty. Their responsibilities are:

- Checking out deliverables
- Realizing inspections during the construction
- Training the workers before every shift
- Checking the compliance with the HS Plan
- Organize and distribute the PPE and collective equipment
- Control the right habits like the cleaning, order, coordination
- Answer any questions about Health and Safety
- Check every member´s identification and sign in the assistance table
- Communicate with the HS Coordinator or Safety Officer in charge of the previous shift

Also in every shift is going to be at least one person trained in first aids and Extinguisher use.

Every day after the work shifts start HS Coordinator or Safety Officer with the Construction Coordinator will be the first to go in the lot in order to check everything is correct like:

- General and prototype earthling installation
- Circuit breaker with selective calibrator (with a qualified worker)
- Signaling
- Fire extinguishers
- First aid kit

- Scaffolding
- Auxiliary plastic ribbons

Moreover he must check the general conditions of the lot:

- Cleaning
- Order

In case of fire the team integrated a fire protection system:

Fire protection system

The housing module has been equipped with 3 smoke brand Schneider Electric, model ARGUS Smoke Detector (catalogue code MTN547020). There is battery-powered smoke detector for early detection of smouldering fires and open fires with development of smoke indoors. Sensibility accordance with EN 14604. This device has a signal approximately 85dB (A) at 3m distance. ARGUS smoke detector has an independent source 9V monobloc battery and has a dimensions 112 x 44 mm (Ø x H). The type protection is IP 42. That are located in the zones with more risk of fire, these areas are:

- Kitchen
- Flexible area
- Machinery room

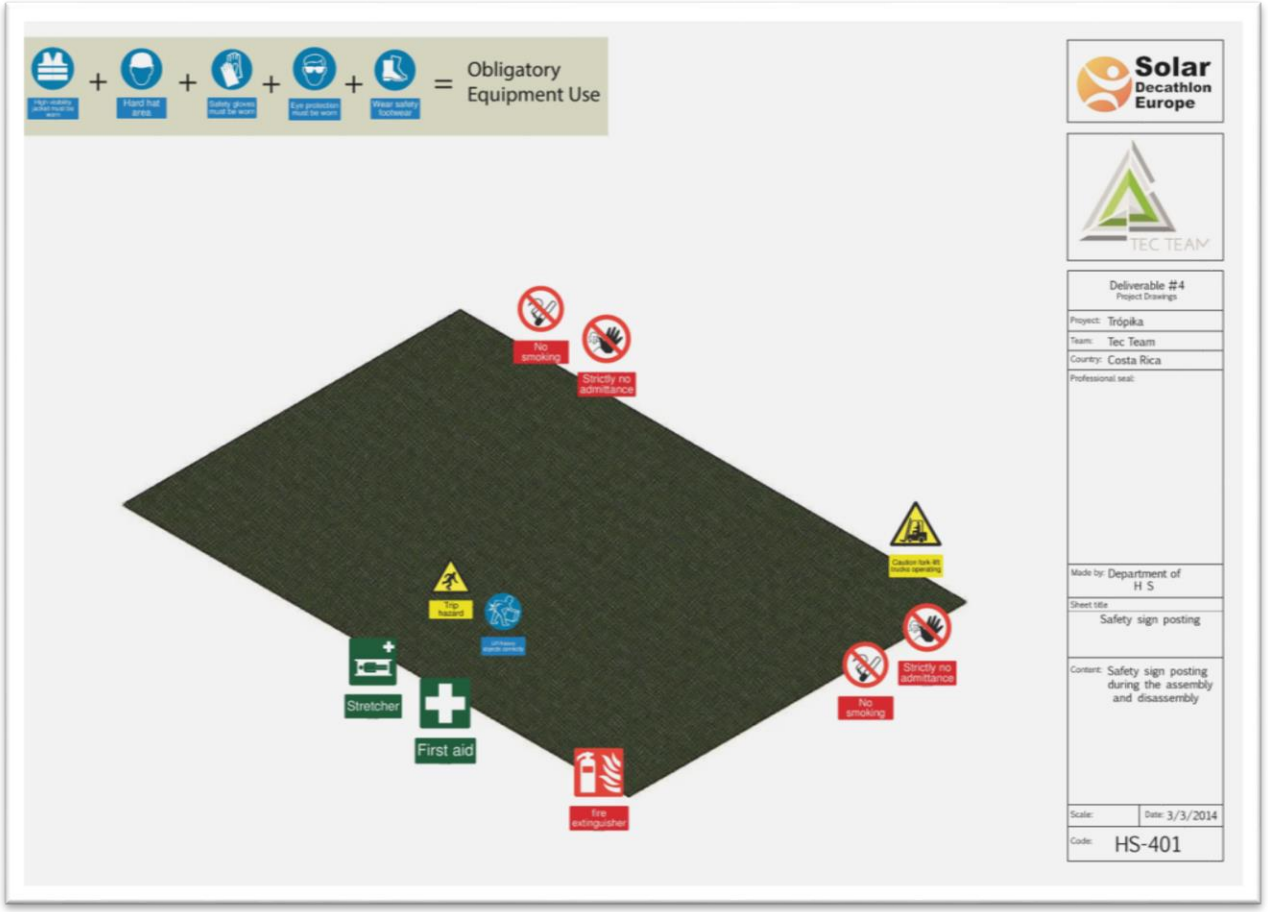
We will equip three extinguishers in the house, those are located in:

- The kitchen: in this area food will be prepared, that implies high temperatures and oil, which means that is the critique zone of our habitation module. To ensure that the habitants of the module can suppress an outbreak of fire, an extinguisher (ABC_21A-113B, 10 lbs, 0.9 m of height.) will be place on the kitchen.
- In the laundry room (BC_21A-113B, 10 lbs 0.9 m of height.) to ensure a better response in case of emergency will be located outside of it.
- Living room: extinguisher (ABC_21A-113B, 10 lbs 0.9 m of height.) will be placed in the living room to ensure a better response in case of fire in that area.

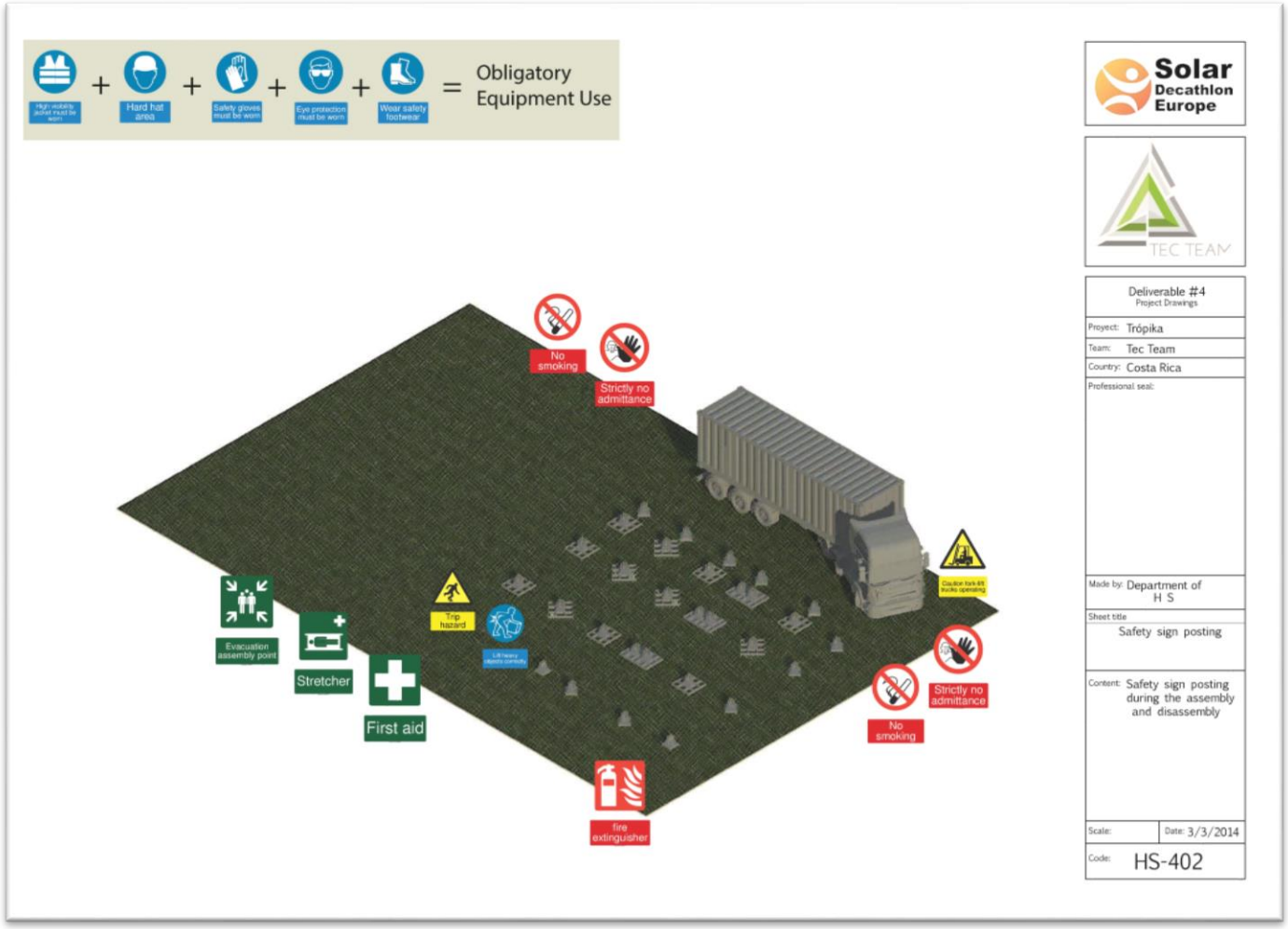
- Storage area: a water extinguisher (A_21A-113B, 2 1/2 gallons 0.9 m of height) will be supply in case of fire.

19. Drawings

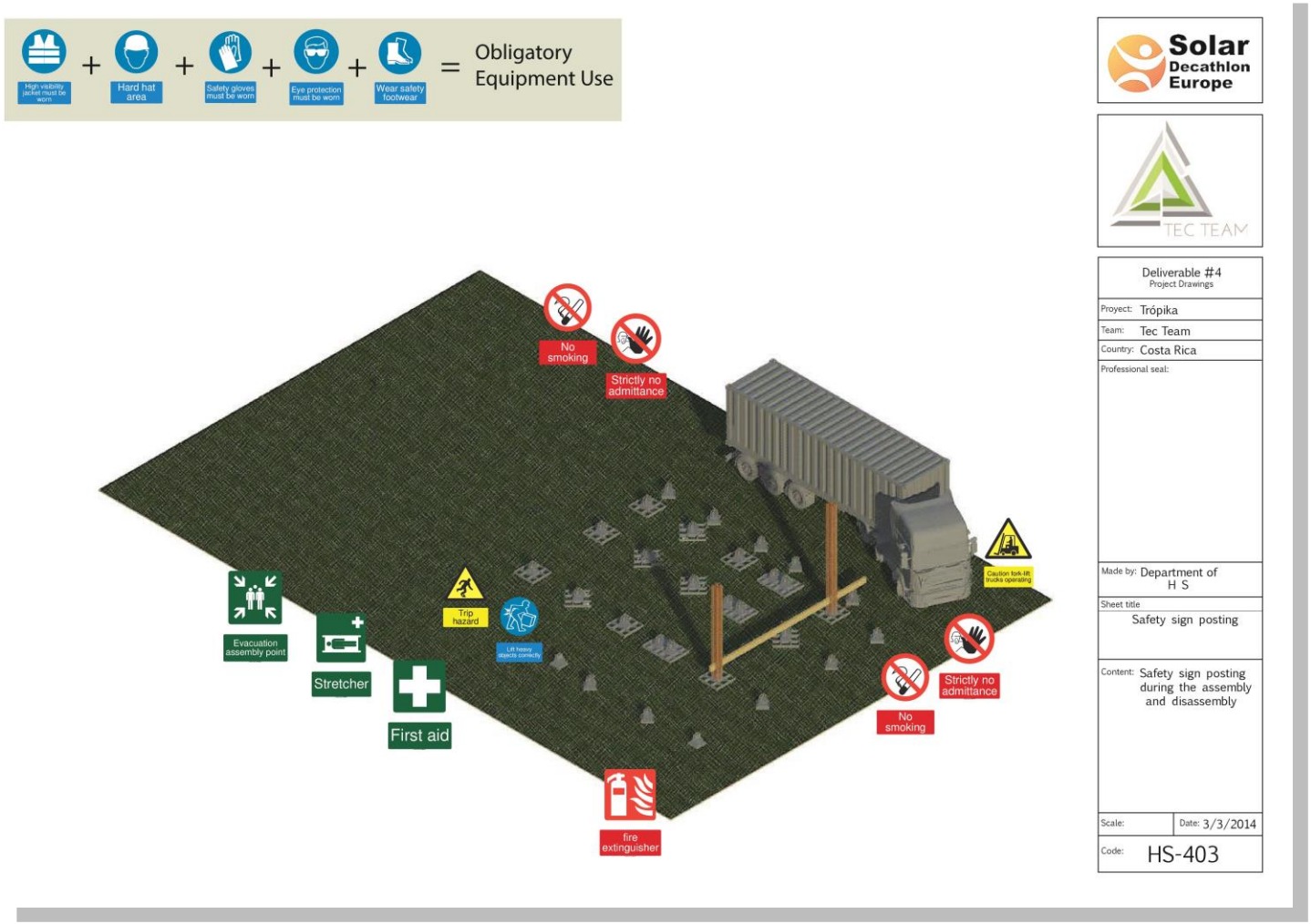
- Drawing #1. Site preparation.



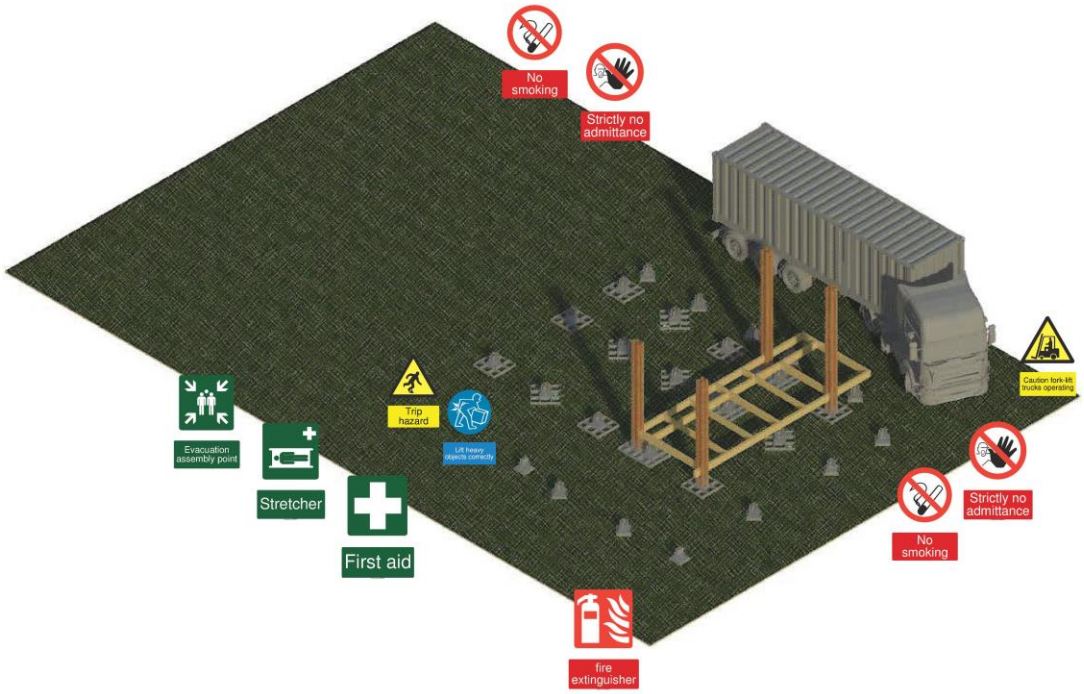
Drawing #2. Footing installation.



- Drawing #3. Column's placement



- Drawing #4. Rafter's placement.



Solar Decathlon Europe

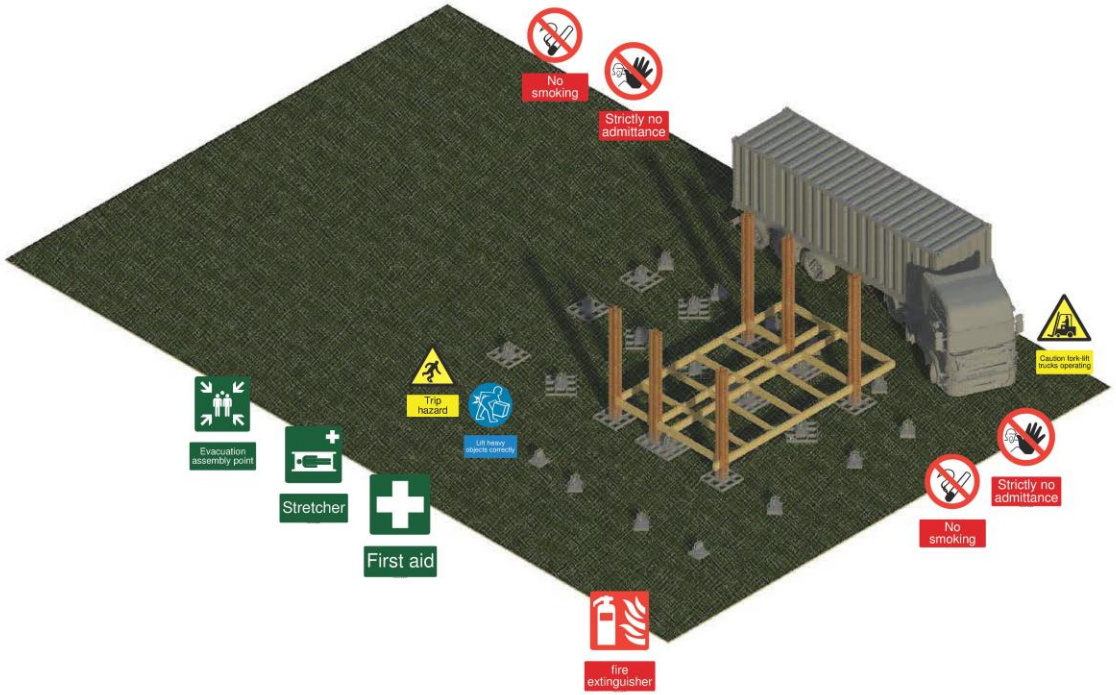
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-405

- Drawing 5. Floor tie rafters placement



Solar Decathlon Europe

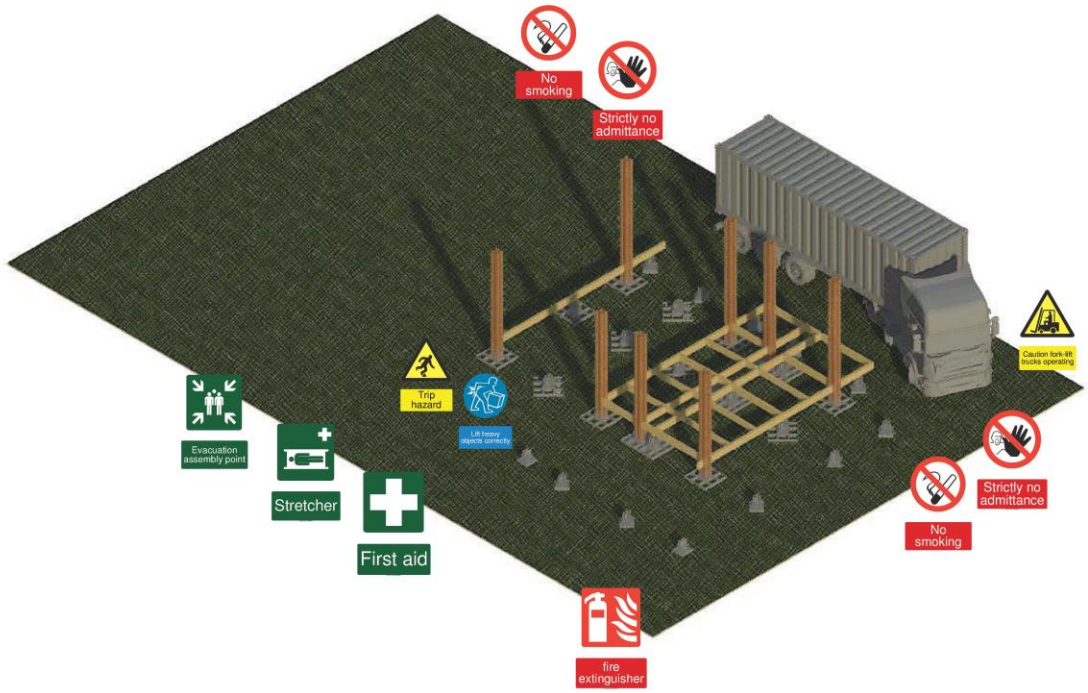
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-407

- Drawing 6. Capping rafter's and floor rafter's placement.



Solar Decathlon Europe

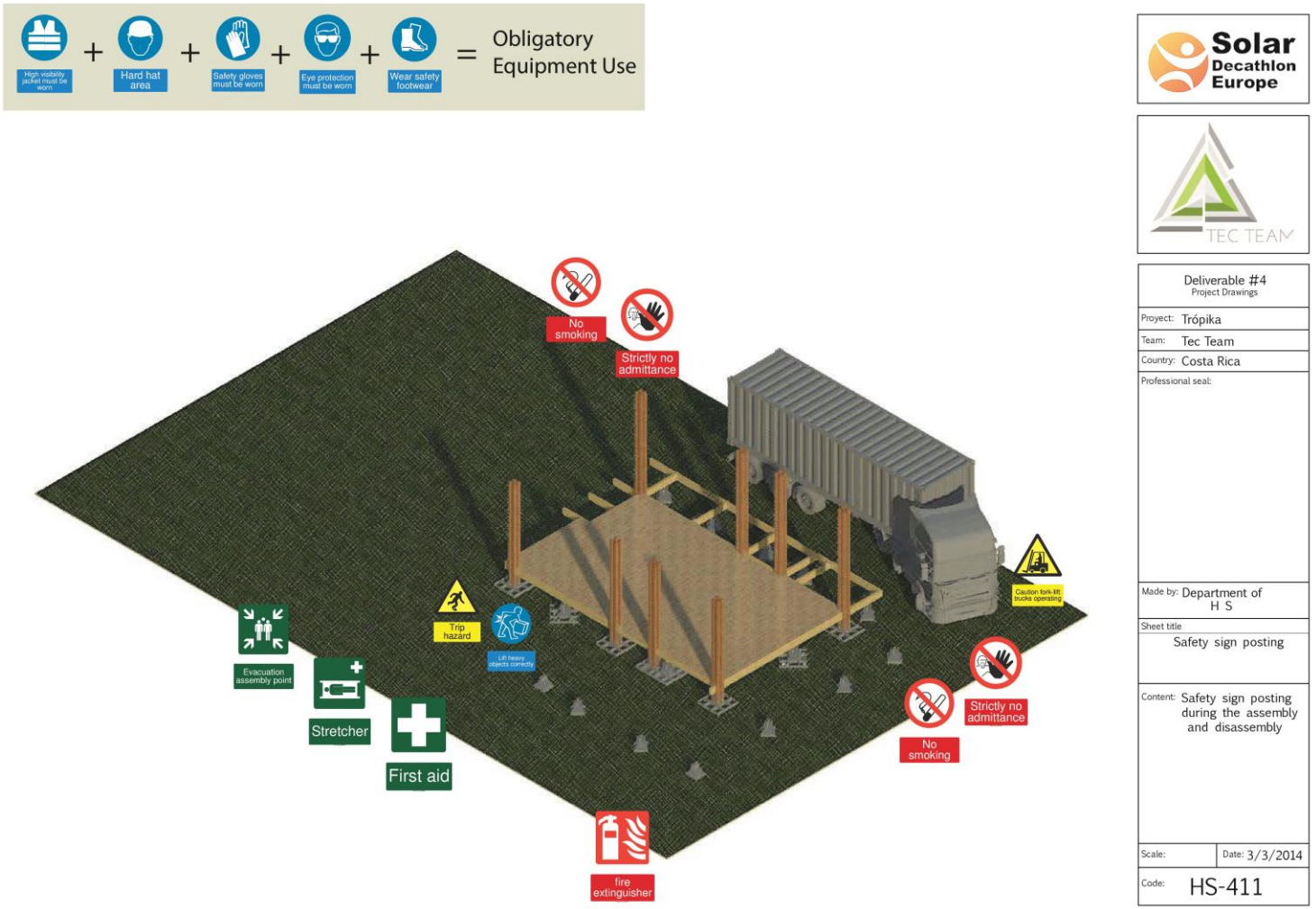
TEC TEAM

Deliverable #4
Project Drawings

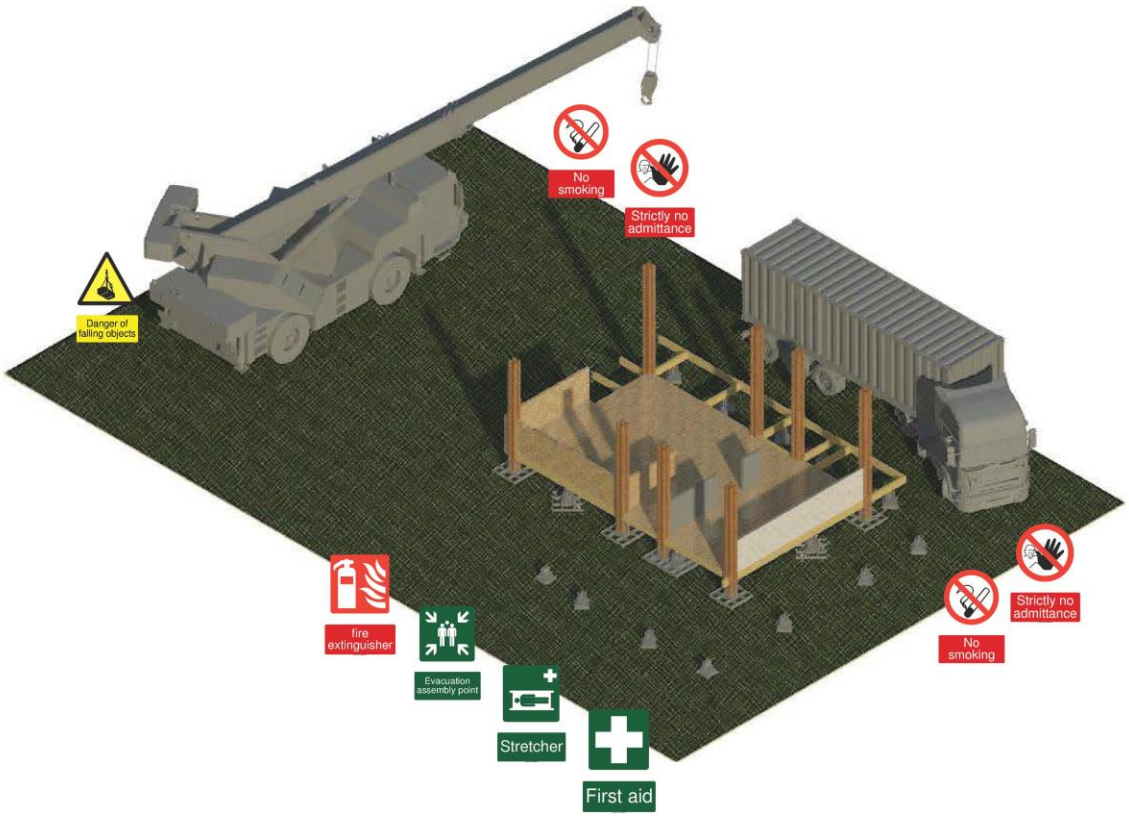
Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-408

- Drawing 7. Floor panels's placement.



- Drawing 8. Walls's placement.



Solar Decathlon Europe

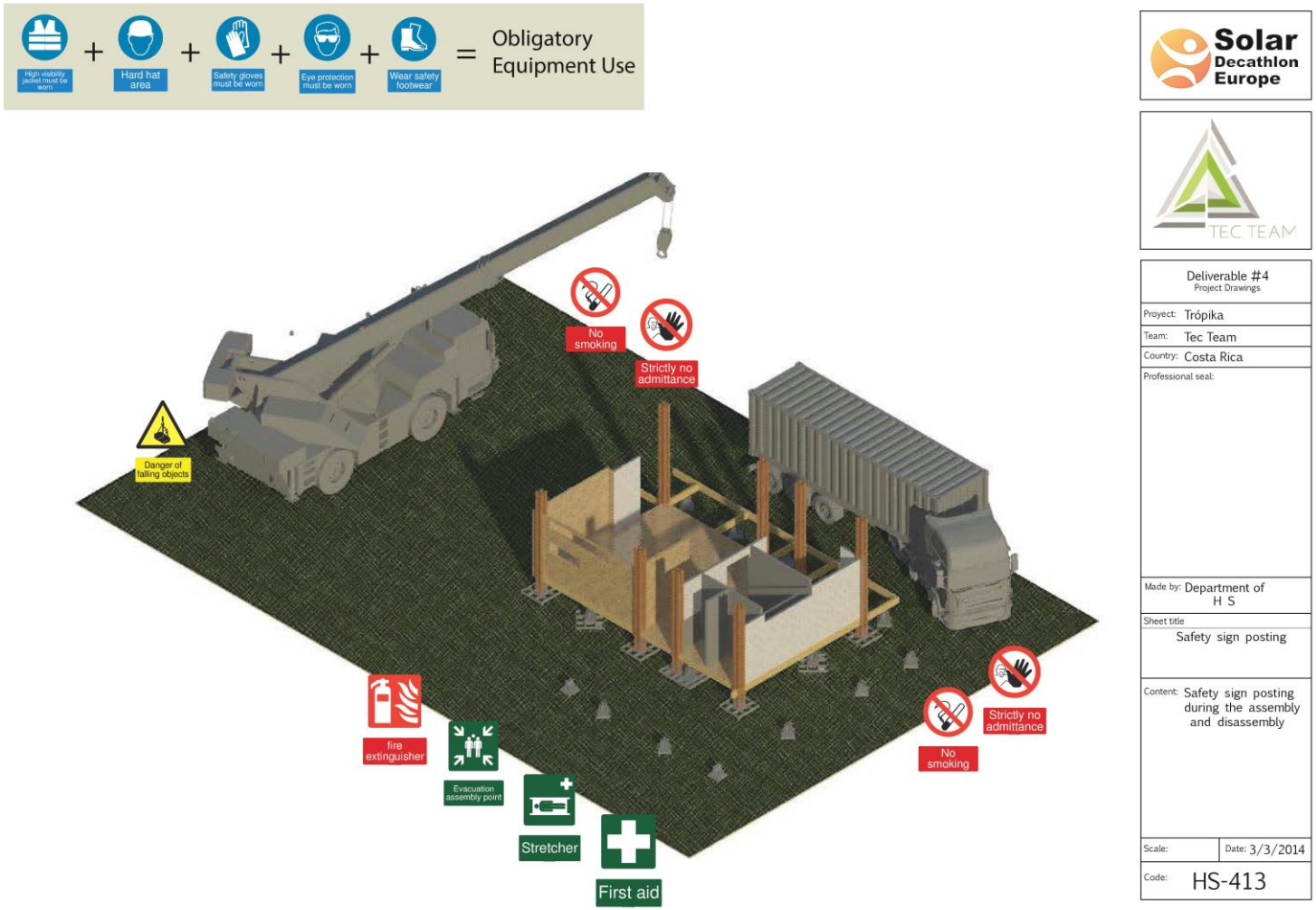
TEC TEAM

Deliverable #4
Project Drawings

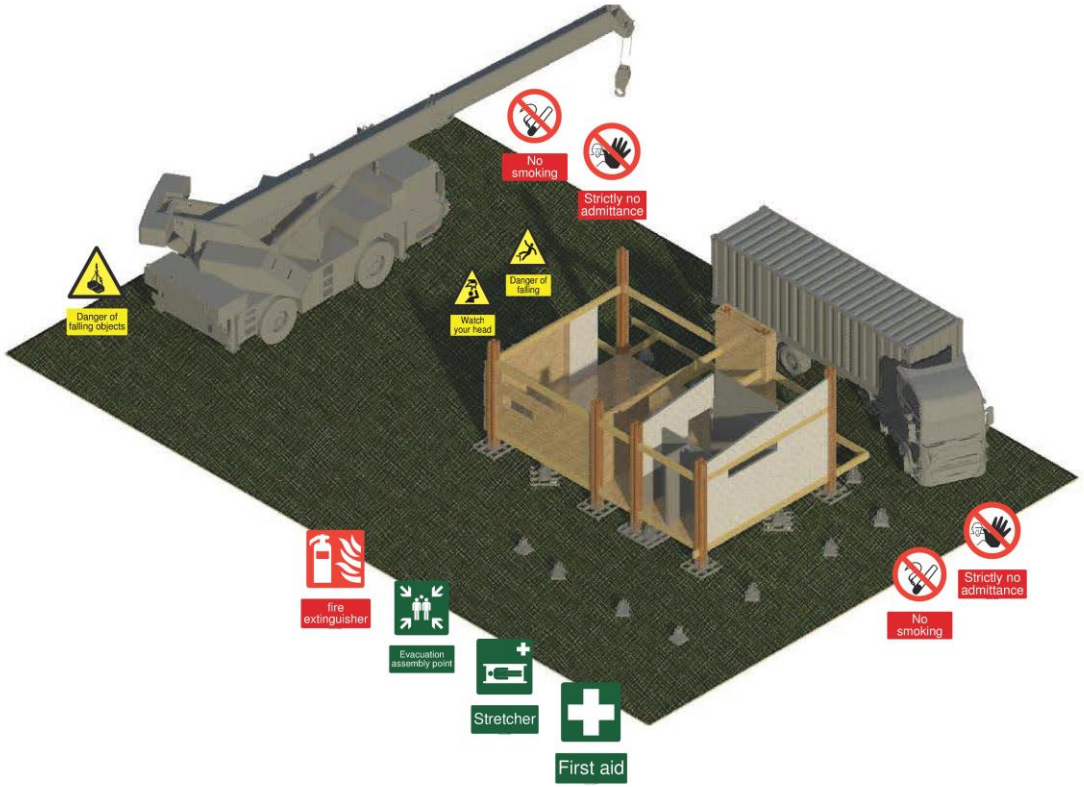
Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-412

- Drawing 9. Innerwall's placement



- Drawing 10. Window´s and capping rafter placement



Solar Decathlon Europe

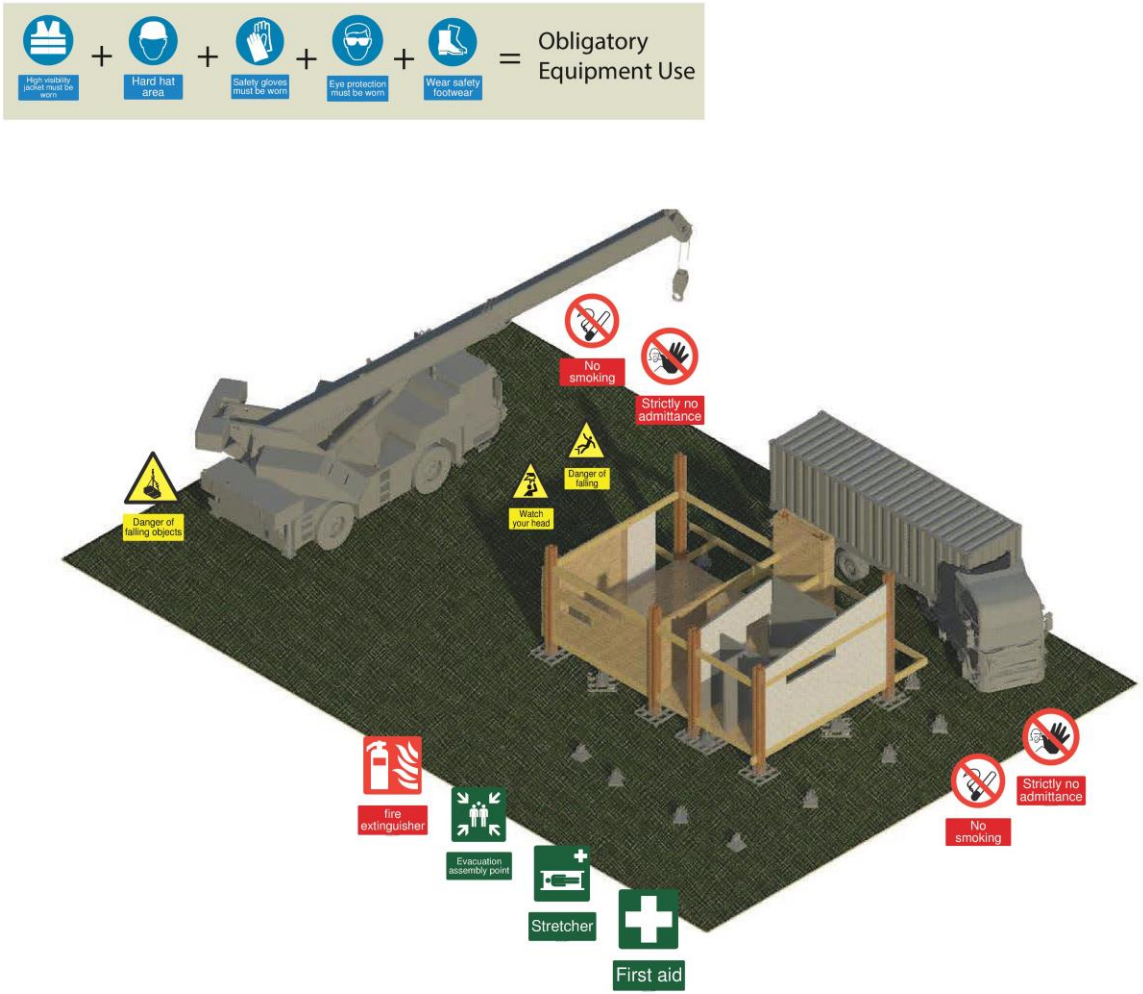
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-416

- Drawing 11. Door's placement



Solar Decathlon Europe

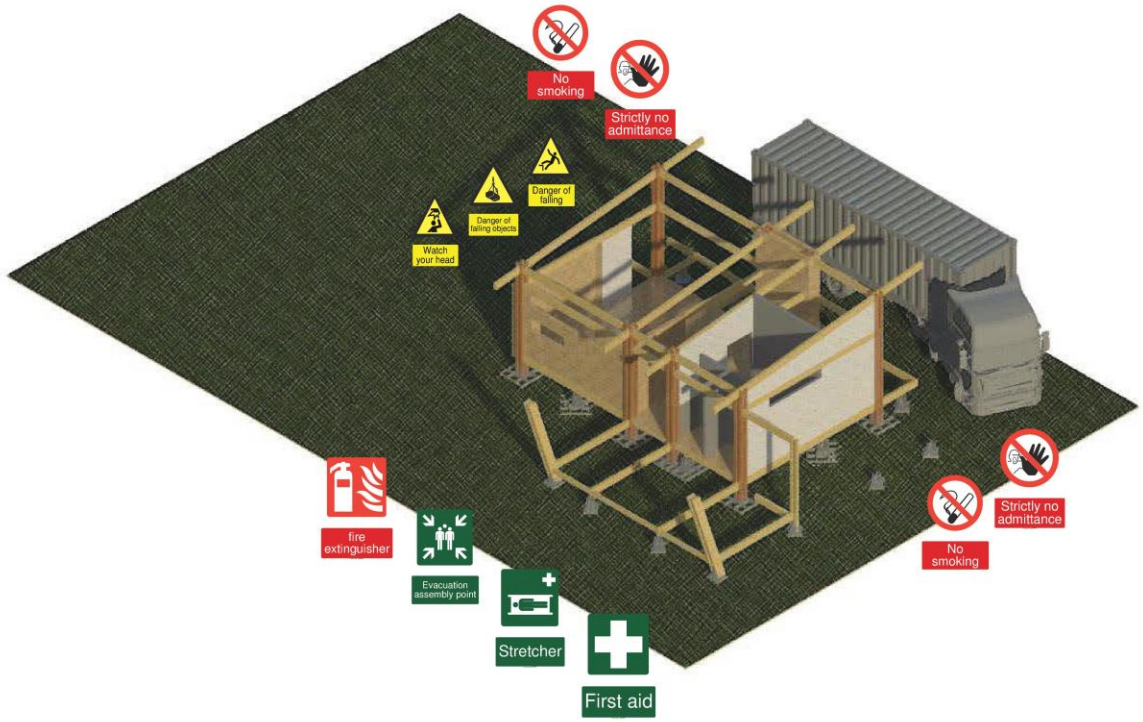
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-417

- Drawing 12. Roof rafter's placement



Solar Decathlon Europe

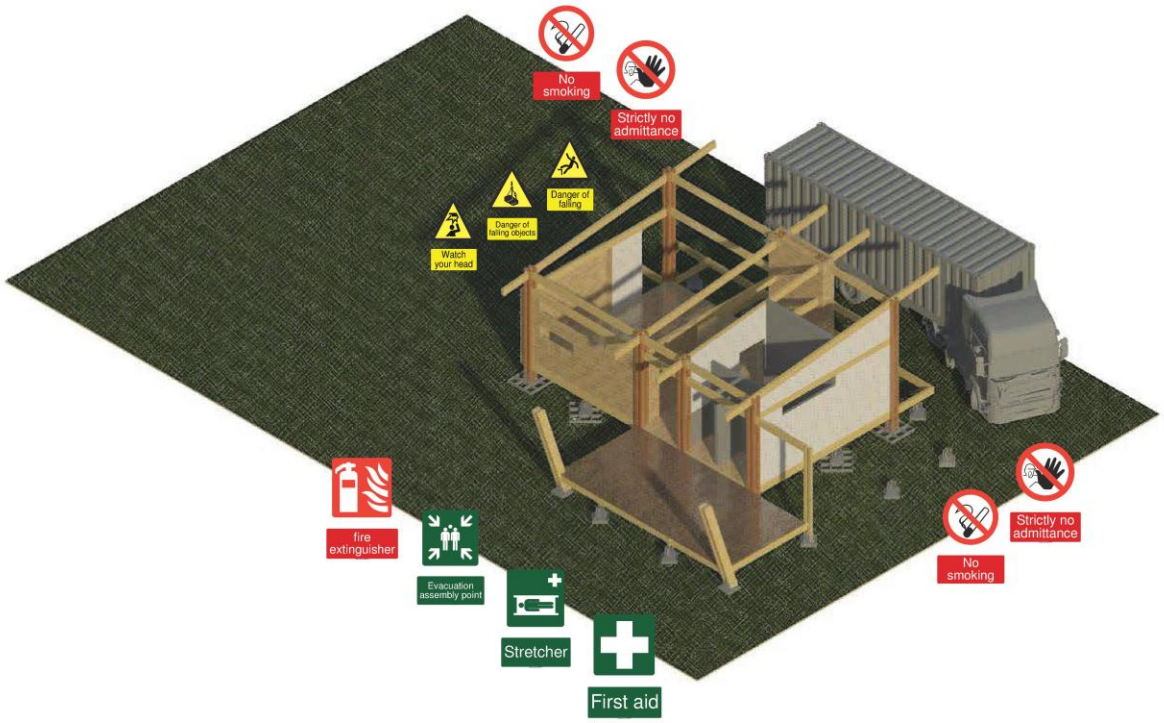
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-419

- Drawing 13. Roof batten's and Column's placement



Solar Decathlon Europe

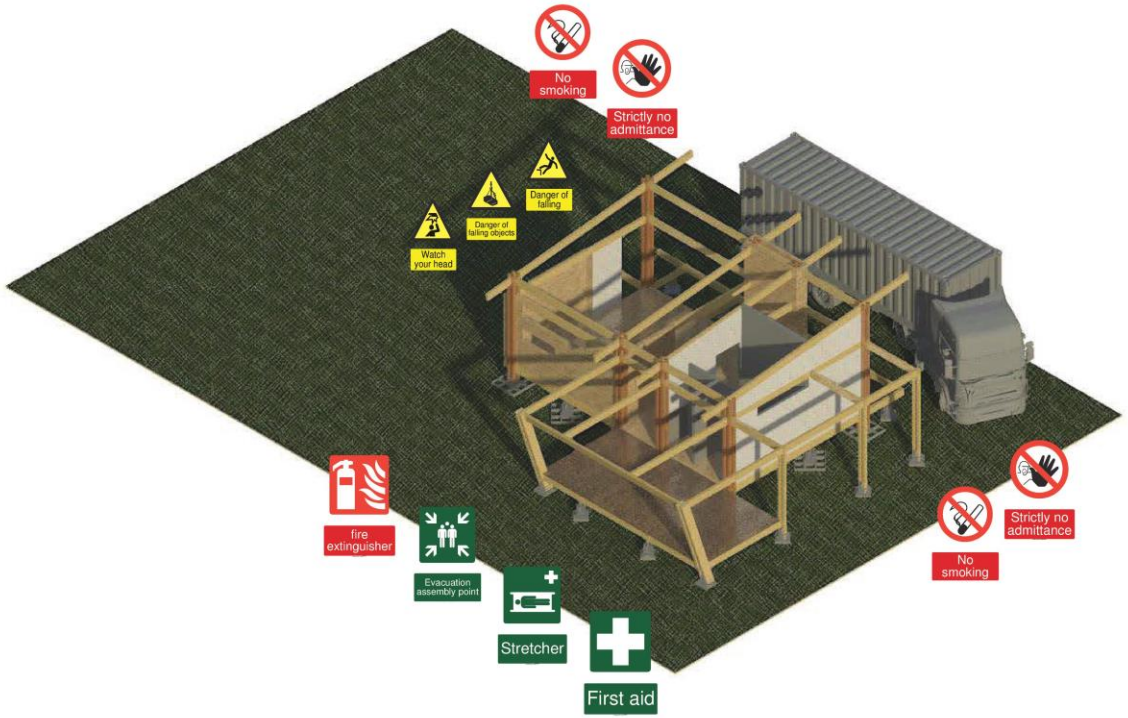
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-420

- Drawing 14. Roof´s deck, Bathroom´s roof' and Floor´s enclosure's placement



Solar Decathlon Europe

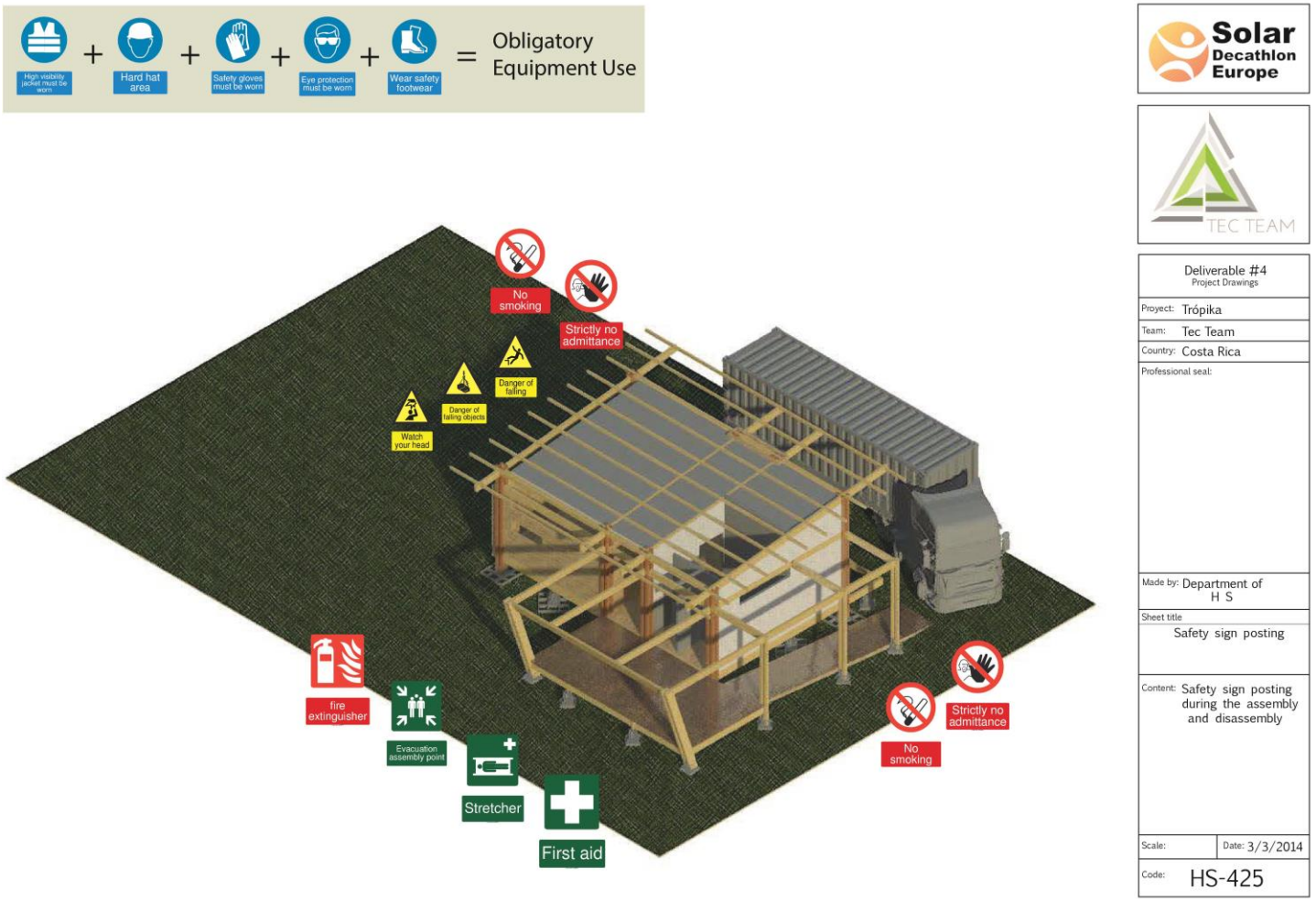
TEC TEAM

Deliverable #4
Project Drawings

Proyect: Trópika
Team: Tec Team
Country: Costa Rica
Professional seal:

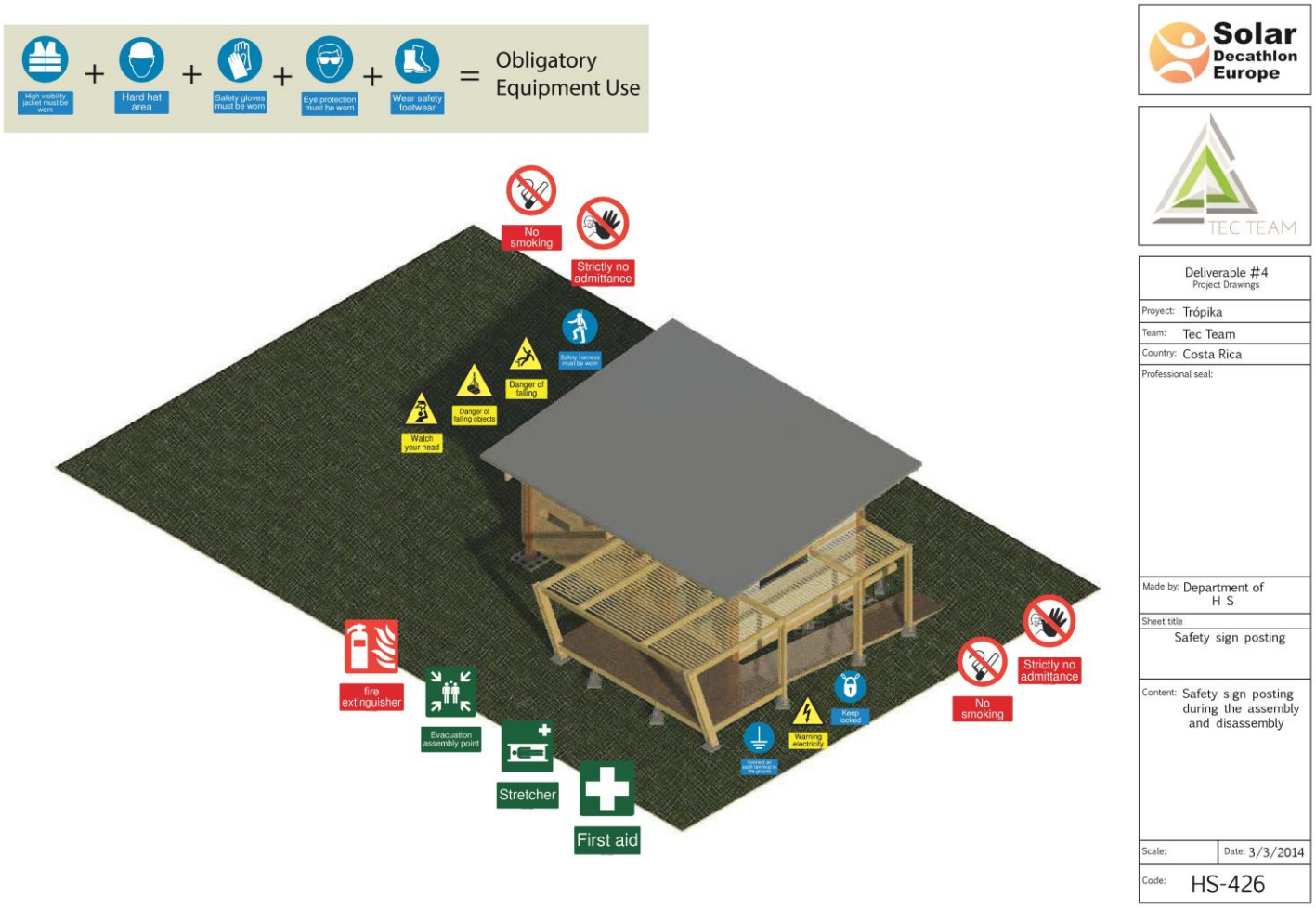
Made by: Department of H S
Sheet title: Safety sign posting
Content: Safety sign posting during the assembly and disassembly
Scale:
Date: 3/3/2014
Code: HS-422

- Drawing 15. Ramp placement

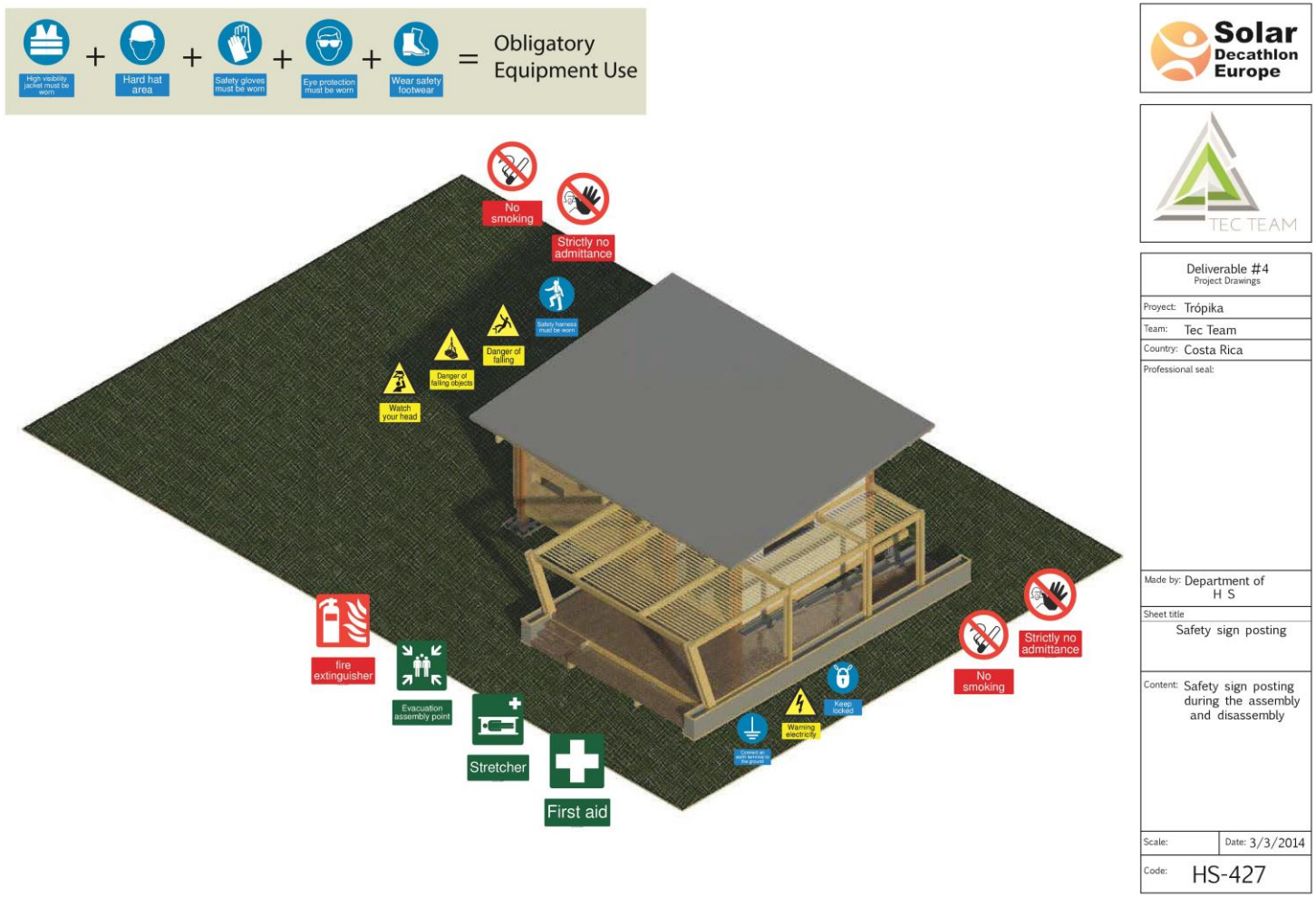


-

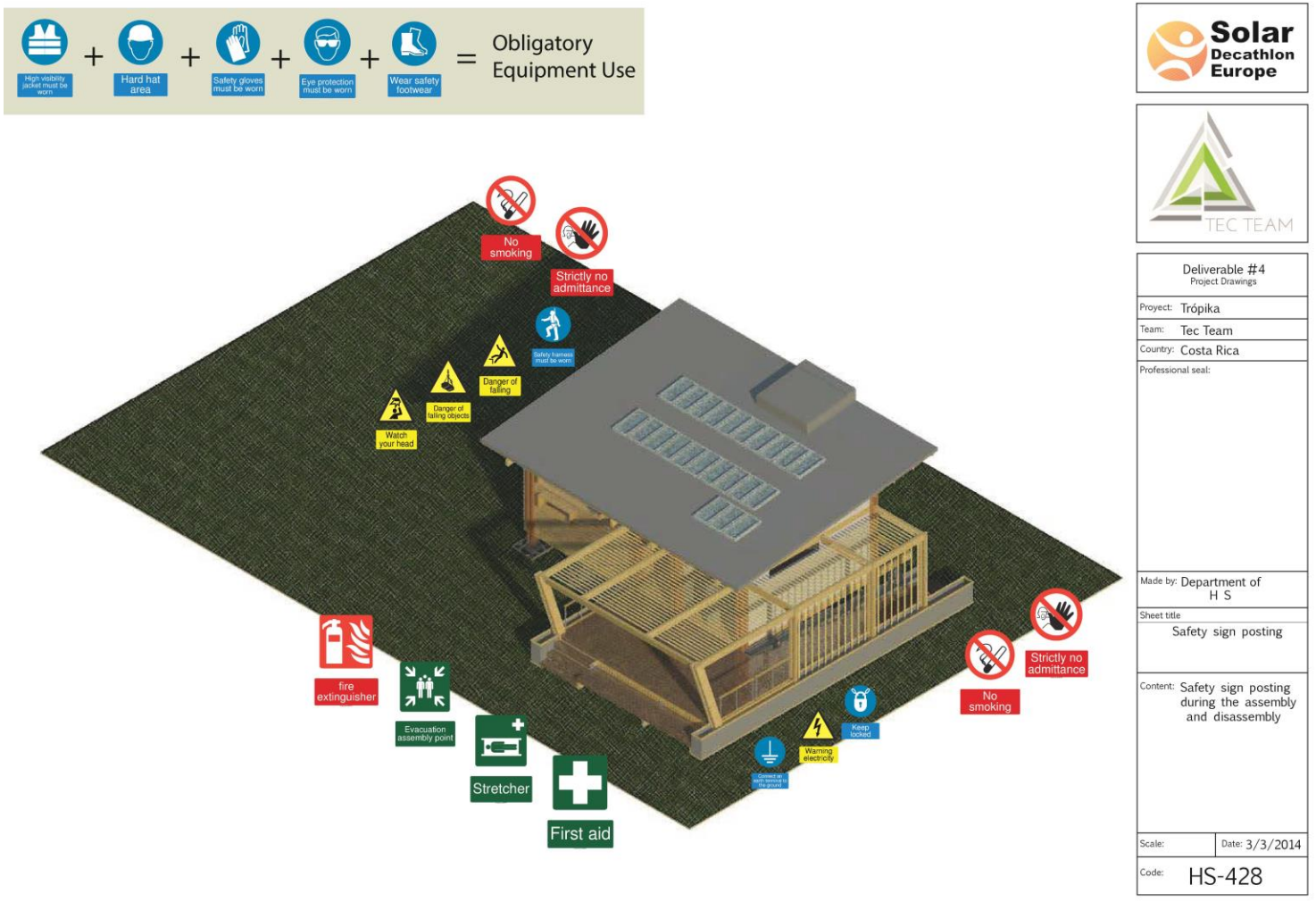
- Drawing 16. Marquee's placement



- Drawing 17. Railing and Furniture placement.



- Drawing 18. Flowerpot, Grid and Accessorie's placement



20. Appendix

Appendix 1. Risk analysis of each task from the assembly process.

Activities	Task	Associated risk	Risk Analysis			Individual Protection	Collective Protection
			Frecuency	Impact	level		
Previous works	-Clean the construction site. -Arrival of the container to the site. -Install the working areas. -Place the metallic safety fences to delimit the construction site, crane area and other machinery area. -Place the tends, and safety ribbons to delimit the work areas. -Place the signposting. Download tools. -Assemble basic equipment. -Installation of heavy	Ergonomic	B	4	E	-Lumbar support belt. -Reflective vest. -Sunblock use. -Work clothes made of cotton. -Shirts with sleeves. -Safety shoes, safety helmet, safety glasses and gloves use.	-Training in material handling. -Ergonomic tools. -Active breaks. -Tidiness program. -Delimited zone for trucks and forklift. -Preventive trucks check. -Hydration stations. -Rest shifts. -Sun shelter. -Scaffold with skirting. -Crane's hook with safety lock. -Active breaks. -First aid kit
		Same Level Falls	D	2	L		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Heatstroke	D	4	H		
		Burns	D	4	H		
		Falling objects	C	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Falling objects	C	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		

	equipment. -Installing the light equipment.						
Site preparation	-Checking the ground levels. -Adjust footing level out. -Determinate the location of the footings. -Level out the footings.	Same Level Falls	D	2	L	-Safety shoes, safety helmet, safety glasses and gloves use.	-Tidiness program.
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Establishment of the foundation system	-Transport the footings with the forklift to the site. -Place the footings to its place. -Check alignment.	Collision with vehicles	D	5	E	-Reflective vest. -Sunblock use. -Work clothes made of cotton.	-Delimited zone for trucks and forklift. -Preventive trucks checks. -Hydration stations. -Rest shifts. -Tidiness program.
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
Establishment of primary structure	-Transport the columns from container to the site with the forklift. -Attach the column to the crane. -Hoist the column	Falling objects	C	4	E	-Helmet use. -Reflective vest. -Safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks.
		Collision with vehicles	D	5	E		

	Set columns into the foundations. -Place column's holders. -Transport the rafter to its site with the forklift. -Attach the rafter to the crane. -Hoist the rafter with the crane. -Placement of the rafters. -Attach rafters to columns. -Transport the floor's tie rafters with the forklift. -Attach the rafters with the floor tie rafters Attach the columns with the floor tie rafters. -Attach the footings with the floor tie rafter. -Transport the capping rafters with the forklift. -Install the	Hits	A	2	H		-Training in material handling. -First aid kit.
		Minor Abrasions	A	2	H		

	scaffolding. -Hoist the capping rafter into position with the crane. -Attach the capping rafter to the columns.						
Floor installation	-Transport the floor panel to the site with the forklift. -Classify the panels by its size. -Attach the floor panels to each other. -Place the floor panels with the crane. -Attach the floor panels to the rafter.	Falling objects	C	4	E	-Reflective vest. -Safety shoes, safety helmet, safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit
		Collision with vehicles	D	5	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
Enclousures	-Placement of the scaffoldings. -Transport the wall panels to the site with the forklift. -Attach the wall panels to the crane. -Wall hoisting.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		

	-Place the wall panels between columns. -Attach the wall panels to the columns. -Transport the inner wall to the site with the forklift. -Assemble the inner wall panels. -Inner walls hoisting with the crane. -Place the wall panels. -Attach the inner wall panels with the perimeter. -Transport the windows to the site with the forklift. -Assemble the windows items. -Place each element of the window -Transport the door to the site with the forklift. -Doors	Minor Abrasions	A	2	H	helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts.
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		

	installations.						
Roof installation	-Transport the roof rafter to the site with the crane. -Attach the roof rafters to the crane. -Hoist the roof rafter. -Attach the hoist rafter to the columns -Transport the roof battens from the container to the site with the forklift. -Attach the roof battens to the roof rafter. -Transport the roof deck to the site with the forklift. -Attach roof deck's pieces together. -Attach to the roof battens. -Install the support structure for the	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		

	bathroom roof. -Install the water tanks. -Transport the bathroom ceiling panels to the site. -Attach the bathroom ceiling panels to the crane. -Hoist the bathroom ceiling panels. -Place the bathroom ceiling panels. -Attach the bathroom ceiling panels to the structure. -Transport the module ceiling panels to the site. -Attach the module's ceiling panels to the crane. -Hoist the module ceiling panels with the crane. -Place the module ceiling						

	panels. -Attach the module ceiling panels to the structure.						
Electrical installation	-Pipes installation under the floor, between the walls and above the ceiling. -Electrical equipment connection. -System verification. -System connection to energy.	Electrical	B	5	E	-Dielectric gloves, shoes and tools. -Prohibition about carrying metallic objects. -Safety shoes, safety helmet, safety glasses and gloves use.	-Training in electrical installations. -Earthing of the electrical system. -Logout-Tagout preventive method. -Lifelines. -Ladders use. -Tool's belt. -Training in material handling. -First aid kit.
		Different level falls	B	4	E		
		Falling objects	C	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Hall and ramp construction.	-Transport hall columns from container to the site with the forklift. -Attach the columns to the crane. -Hoist the hall columns -Place the hall columns -Attach hall columns to	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		

	footing -Transport the rafter with the forklift. -Place the rafter with the crane. -Attach the rafter to columns -Transport floor enclosures with the forklift. -Attach floor enclousures to the rafter. -Transport the capping rafter -Hoist the capping rafter. -Attach the capping to the column -Transport the ramp to the site. -Assemble the ramp items -Place the ramp -Assemble the roof deck -Place the roof deck -Assemble the garden items -Place the garden items.	Hits	A	2	H	and gloves use. -Sunblock use. -Work clothes made of cotton.	trucks checks. -Manual handling training. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		

Final details	-Transport the marquee -Attach the marquee to the capping rafter -Transport the railings -Place the railings. -Place tensors -Transport the flowerpots -Place the flowerpots -Place the components -Transport the furniture -Place the furniture -Transport the grid -Place the grid -Place the components -Transport the metallic letters of the module -Place the metallic letters. -Transport the ramp accessories. -Place the ramp accessories.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Delimited zone for trucks and forklift. -Manual handling training. -Work shifts. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		

	-Asssemble the ramp.						

Appendix 2. Risk analysis of each task from the disassembly process.

Activities	Task	Associated risk	Risk Analysis			Individual Protection	Collective Protection
			Frecuency	Impact	level		
Furniture and marquee removal.	-Remove the marquee from the capping rafter -Remove the railings. -Transport the railings to the container. -Remove tensors. -Transport the flowerpots. -Remove the furniture. -Transport the furniture to the container. -Remove the grid. -Transport the grid -Remove the metallic letters	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Delimited zone for trucks and forklift. -Ergonomic tools. -Active breaks. -Training in material handling. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		

	of the module. -Remove the ramp accessories. -Disassembly the ramp.						
Hall and ramp disassembly.	-Disassemble the garden items. -Remove the garden items. -Disassemble the roof deck. -Remove the roof deck. -Remove the ramp. -Disassemble the ramp items. -Transport the ramp to the container. -Remove the capping from the column. -Hoist the capping rafter. -Transport the capping rafter. -Remove floor enclosures from	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Manual handling training. -Ergonomic tools. -Active breaks. -Training in material handling. -First aid kit -Hydration stations. -Rest shifts. -Tidiness program.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		

	the rafter. -Transport floor enclosures with the forklift to the container. -Attach the rafter from the columns. -Remove the rafter with the crane. -Transport the rafter with the forklift to the container. -Remove hall columns from footing. -Remove the hall columns. -Hoist the hall columns. -Remove the columns with the crane. -Transport hall columns to the container.						
Electrical des-installatio	-Pipes uninstall. -Electrical equipment	Electrical	B	5	E	-Dielectric gloves, shoes and tools.	-Training in electrical installations. -Earthing of
		Different level falls	B	4	E		

n	disconnection.	Falling objects	C	4	E	-Prohibition about carrying metallic objects. -Safety helmet, safety glasses and gloves use.	the electrical system. -Logout-Tag out preventive method. -Lifelines. -Ladders use. -Tool's belt. -Training in material handling. -First aid kit.
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Roof des-installation	-Remove the module ceiling panels from the structure. -Hoist the module ceiling panels with the crane. -Transport the module ceiling panels to the container. -Remove the bathroom ceiling panels from the structure. -Hoist the bathroom ceiling panels. -Transport the bathroom	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit. -Hydration stations.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		

	ceiling panels to the container. -Remove the water tanks. -Remove the support structure from the bathroom roof. -Remove the roof battens. -Remove the roof's deck. -Transport the roof deck to the container. -Remove the roof battens from the roof rafter. -Transport the roof battens to the container with the forklift. -Remove the roof rafters from the crane. -Transport the roof rafter to the container.						-Rest shifts.

Enclosures	-Doors unistall. -Transport the door to container. -Remove each element of the window. -Disassembly the windows items. -Transport the windows to the container. -Remove the inner wall panels. -Remove the wall panels. - Disassembly the inner wall panels. -Transport the inner wall to the container. -Remove the wall panels from the columns. -Wall hoisting. -Transport the wall panels to the crane.	Different level falls	B	4	E	-Protective equipment for working at heights. -Reflective vest. -Lumbar support belt. -Safety shoes, safety helmet, safety glasses and gloves use. -Sunblock use. -Work clothes made of cotton.	-Training in working at heights. -Scaffolds. -Lifelines, anchorage points and ladder use. -Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -Ergonomic tools. -Active breaks. -First aid kit -Hydration stations. -Rest shifts.
		Falling objects	C	4	E		
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Heatstroke	D	4	H		

Floor installation	-Remove the floor panels from the rafter. -Remove the floor panels with the crane. -Transport the floor panel to the container.	Falling objects	C	4	E	-Reflective vest. -Safety shoes, safety helmet, safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit
		Collision with vehicles	D	5	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
Establishment of primary structure	-Remove the capping rafter from the columns. -Hoist the capping rafter. -Remove the scaffolding. -Remove the columns from the floor tie rafters. -Transport the floor's tie rafters. -Remove rafters from the columns. -Remove the rafters.	Falling objects	C	4	E	-Helmet use. -Reflective vest. -Safety glasses and gloves use.	-Scaffold with skirting. -Crane's hook with safety lock. -Delimited zone for trucks and forklift. -Preventive trucks checks. -Training in material handling. -First aid kit.
		Collision with vehicles	D	5	E		
		Hits	A	2	H		
		Minor Abrasions	A	2	H		

	-Hoist the rafter. -Transport the rafter to the container. -Remove column's holders. -Remove columns from the foundations. -Transport the columns from container to the container.						
Establishment of the foundation system	-Transport the footings to the container.	Collision with vehicles	D	5	E	-Reflective vest. -Sunblock use. -Work clothes made of cotton.	-Delimited zone for trucks and forklift. -Preventive trucks checks. -Hydration stations. -Rest shifts. -Tidiness program.
		Heatstroke	D	4	H		
		Same Level Falls	D	2	L		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
Final works	-Uninstall the light equipment. - Uninstall of heavy equipment. -Disassembly the basic	Same Level Falls	D	2	L	-Lumbar support belt. -Safety shoes use. -Reflective vest. -Sunblock	-Training in material handling. -Ergonomic tools. -Active breaks. -Tidiness program.
		Collision with vehicles	D	5	E		
		Overexertion	B	4	E		

	equipment. -Remove the signposting. -Remove the tends, safety ribbons and fences that delimit the work areas. -uninstall the working areas. -Departure of the container from the site. -Clean the construction site.	Heatstroke	D	4	H	use. -Work clothes made of cotton. -Shirts with sleeves. -Safety shoes, safety helmet, safety glasses and gloves use.	-Delimited zone for trucks and forklift. -Preventive trucks check. -Manual handling training. -Hydration stations. -Rest shifts. -Sun shelter. -Scaffold with skirting. -Crane's hook with safety lock. -Training in load handling. -First aid kit.
		Burns	D	4	H		
		Falling objects	C	4	E		
		Ergonomic	B	4	E		
		Minor Abrasions	A	2	H		
		Hits	A	2	H		
		Cuts	B	3	H		
		Ergonomic	B	4	E		

Appendix 3. Accidents and incidents Report

Accidents and incidents Report Authors: André Blanco M & Adelina Ortega R.	trópika Costa Rica
Personal data	
Student _____ Other _____ Name:_____ ID: _____ Department or Company:_____	

General data		
Date : _____		
Time: _____ am ___ pm ___		
Place :_____		
Accident or Incident		
Detailing how the event occurred (as happened, work being done, body part affected, where site conditions occurred, etc..) Basic causes (all causes that if have been eliminated would have prevented the accident):		
Corrective actions		
Actions	Respondable	Date of ejecution
Tecnic actions		
Formative and informative actions		
Administrative actions		

21. References

Alberta Construction Safety Association (s.f.). *Safety Practice: Power and Hand Tool Use* Recovered el February 15 2014, from http://www.acsa-safety.org/assets/SWP00014.pdf

Canadian Center for Occupational Health and Safety (2012). *Confined Space - Program : OSH Answers* Recovered April 9 2014, from http://www.ccohs.ca/oshanswers/hsprograms/confinedspace_program.html

Environment, Safety, Health and Quality Division (2013). *Hoisting and Rigging* Recovered February 15 2014, from http://wwwgroup.slac.stanford.edu/esh/hazardous_activities/hoisting_rigging/policies.htm

Healthy and Safe Executive (2005). *Working at height* Recovered el February 10 2014, from http://www.hse.gov.uk/toolbox/height.htm

National Institute for Occupational Safety and Health (2007). *Ergonomic Guidelines for Manual Material Handling* Recovered February 8 2014, from http://www.dir.ca.gov/dosh/dosh_publications/mmh.pdf

Occupational Safety & Health Administration (s. f.). *OSHA's Hazard Exposure and Risk Assessment Matrix for Hurricane Response and Recovery Work: Heavy Equipment and Powered Industrial Truck Use* Recovered February 5 2014, from https://www.osha.gov/SLTC/etools/hurricane/heavy-equip.html#gr

Occupational Safety & Health Administration (s. f.). *OSHA's Powered Industrial Trucks e-tool* Recovered el February 15 2014, from https://www.osha.gov/SLTC/etools/pit/

Occupational Safety & Health Administration (2012, May 10). *Construction Industry | Cranes and Derricks in Construction Final Rule - Frequently Asked Questions* Recovered February 15 2014, from https://www.osha.gov/cranes-derricks/faq.html

Occupational Safety & Health Administration (s. f.). *OSHA's Hazard Exposure and Risk Assessment Matrix for Hurricane Response and Recovery Work: Heavy Equipment and Powered Industrial Truck Use* Recovered February 5 2014, from https://www.osha.gov/SLTC/etools/hurricane/heavy-equip.html#gr

Occupational Safety & Health Administration (2010). *Safety and Health Topics | Hand and Power Tools* Recovered February 5 2014, from https://www.osha.gov/SLTC/handpowertools/

Occupational Safety & Health Administration (s. f.). *Ergonomics eTool: Solutions for Electrical Contractors - Materials Handling: Heavy Lifting* Recovered February 5 2014, from https://www.osha.gov/SLTC/etools/electricalcontractors/materials/heavy.html

Occupational Safety & Health Administration (2010). *Safety requirements for scaffolding. - 1910.28*Recovered February 8 2014, from https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9720&p_table=STANDARDS

Occupational Safety & Health Administration (2002). *A Guide to Scaffold Use in the Construction Industry* Recovered February 9 2014, from https://www.osha.gov/Publications/osha3150.pdf

Occupational Safety & Health Administration (s. f.). *Fall Protection* Recovered el February 9 2014, from https://www.osha.gov/doc/outreachtraining/htmlfiles/subpartm.html

Occupational Safety & Health Administration (s. f.). *Permit required confined spaces 1910.146* Recovered April 8 2014, from https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9797&p_table=STANDARDS

Occupational Safety & Health Administration (2010). *Draft model training program for hazard communication* Recovered April 8 2014, from https://www.osha.gov/dsg/hazcom/MTP101703.html

London Construction Plant-hire Association (2011). *Safe Use of Telehandlers In Construction* Recovered February 5 2014, from http://www.vertikal.net/uploads/tx_filelinks/sfpsg-the-safe-use-of-telehandlers-in-construction-110210.pdf

U.S. Department of Energy (2007). *Doe standard hoisting and rigging* Recovered February 5 2014 from http://wwwgroup.slac.stanford.edu/esh/eshmanual/references/hoisting1090-2007.pdf

Weather2Travel (2013). *Versailles Weather in July 2014, France for Holidays* October 25 2013, from http://www.weather2travel.com/july/france/versailles.php

VIII. BIBLIOGRAPHY.

Aedo, I., Yu, S. & Díaz, P. (2012). Personalized Alert Notifications and Evacuation Routes in Indoor Environments Sensors, 1, p7804, 24p.

Banchs, R., González, P., llacuna, J. & Pujol, L. (2004). *Exposición itinerante sobre seguridad en la construcción.* Recuperado el 28 de Mayo del 2013, de http://www.insht.es/InshtWeb/Contenidos/Documentacion/TextosOnline/ErgaFP/2004/ErFP40_04.pdf

Bestratén, M. & Marrón, M. (s. f.). NTP 560: Sistema de gestión preventiva: Procedimiento de elaboración de las instrucciones de trabajo. Recuperado el 01 de Junio del 2013, de http://www.insht.es/InshtWeb/Contenidos/Documentacion/FichasTecnicas/NTP/Ficheros/501a600/ntp_560.pdf

Cejas, M. & Acosta, J. (2009). *Capacitación y formación profesional: Ejes claves en el desarrollo del trabajador* Carabobo: Universidad de Carabobo.

Chinchilla, N. (2008, 24 de Junio). *El TEC representará a Costa Rica en una competencia de clase mundial - Blog de Noticias TEC*Recuperado el 17 de Agosto del 2013, de http://www.tec.ac.cr/prensa/blog/Lists/Entradas%20de%20blog/Post.aspx?List=4d953c52-6ce3-44c7-8b4e-eecade55dccc&ID=395

City Elevator Ltd. (2009). *Occupacional Health and Safety Program Manual* Recuperado el 02 de Junio del 2013, de http://cityelevator.ca/safety/CITY%20ELEVATOR%20Safety%20Program.pdf

Cortés, D. J. (2007). *Seguridad e higiene del trabajo: Técnicas de prevención de riesgos laborales*. Madrid: Tébar.

Crutchfield, J. (2007). *Job Hazard Analysis: A Guide for Voluntary Compliance and Beyond* Manuscrito no publicado.

Estándar Australiano. (1999). *AS/NZS 4360:1999 Administración de Riesgos.*

Fondo de prevención y atención de emergencias (2012). Guía para elaborar planes institucionales de respuesta a emergencias. Recuperado el 28 de Mayo del 2013, de http://www.fopae.gov.co/portal/page/portal/sire/manuales/documentos/PEB/ANEXO%204%20GUIA%20ELABORAR%20PIRE.pdf

Galgano, A. (1995). *Los Siete Instrumentos de la Calidad Total* España: Díaz de Santos.

Hernández, R., Fernández, C. & Baptista, P. (2010). Metodología de la Investigación (5 ed.) Perú: Mc Graw Hill.

Holt, A. S. J. (2008). *Principles of construction safety*. Chichester, GBR: Wiley.

INTECO. I. d. (2000). INTE 31-09-09-00 Guía para la elaboración del programa de salud y seguridad en el trabajo. San José: INTECO.

Jin, R. & Chen, Q. (2013). Safety Culture Safety Management, 1, p60, 11p.

KAMA, Inc. (2009). On the docket Safety Compliance Letter, 1. Recuperado el 30 de Abril del 2013, de https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=47838652&site=ehost-live

Krajewski, L. (2000). *Administración de operaciones: estrategia y análisis* (5 ed.) Mexico: Pearson Education.

López, A. (Ed.). (2000). *Seguridad y salud en el trabajo de construcción: el caso de Bolivia, Colombia, Ecuador y Perú* (No. 129) Lima, Peru: Oficina Internacional del Trabajo.

Macdonald, D. (2004). *Practical Industrial Safety, Risk Assessment and Shutdown Systems* Jordan Hill, GBR: Newnes.

Martínez, P. (2006). *El método de estudio de caso: Estrategia metodológica de la investigación científica Pensamiento y Gestión,* 20, 165-193.

Naghi, M. (2005). Metodología de la Investigación (2 ed.) México: Limusa.

NIOSH (2007). *Mining Safety and Health Research at NIOSH: Reviews of Research Programs of the National Institute for Occupational Safety and Health* Washington, DC, USA: National Academies Press.

OSHA (1989). *OSHA Training and Reference Materials Library - Elements of an Effective Safety and Health Program.* Recuperado el 28 de Mayo del 2013, de https://www.osha.gov/dte/library/safety_health_program/slide1.html

OSHA (2010). *Equipo de Protección Personal* Recuperado el 28 de Mayo del 2013, de http://www.osha.gov/OshDoc/data_General_Facts/ppe-factsheet-spanish.pdf

Ricolfe, J. (2004). *Brainstorming o Torbellino de Ideas en la Práctica.* España: Ediciones Deusto.

Rubio, J. (2005). *Manual para la formación de nivel superior en prevención de riesgos laborales*España: Díaz de Santos.

Solar Decatlhom Europe (2013). *Solar decathlon Rules* Recuperado el 08 de Abril del 2013, de http://www.solardecathlon2014.fr/en/news/rules-v2-available

Suraji, A., Sulaiman, K., Mahyuddin, N., & Mohamed, O. (2006). Rethinking construction Safety:: An introduction to total safety management. Journal of Construction Research, 7(1/2), 49-63.

US Department of Labor. Evacuation Plans and Procedures eTool: What is an Emergency ActionPlan Recuperado el 14 de marzo del 2013, de: http://www.osha.gov/SLTC/etools/evacuation/eap.html

Vaidogas, E. (2010). *Business of Safety: Managing Occupational and Industrial Risks* (2 ed.) Vilnius, LTU: Vilnius Gediminas Technical University Press.

Williams, S. (2006). *Health and safety in construction* (tercera ed.) Norwich,UK: Health and Safety Executive.

IX. APPENDIX.

Appendix 1. Project chronogram.

Activity Number	Name of the activity	Duration (days)	Beginning
1	Assignment of faculty advisor.	1	15/7/13
2	Documents organization.	5	16/7/13
3	**Firts deliverable.**	1	5/8/13
4	Experts appointments.	15	20/8/13
5	Construction engineer interview.	3	25/8/13
6	CNE interview.	2	28/8/13
7	Brainstorming.	2	2/9/13
8	Risks categorization per work phase matrix.	22	24/9/13
9	Review of elaborated procedures in case of emergency.	5	10/9/13
10	Review of elaborated safe work procedures.	5	15/9/13
11	Review of elaborated first aids procedures.	5	20/9/13
12	Review of the construction drawings.	30	30/10/13
13	Application of inquiry about knowledge in safety during the construction process.	5	20/9/13
14	Data analysis.	15	10/9/13
15	**Second deliverable**	1	1/11/13
16	Making of the RAM.	30	2/11/13
17	Make the safe work procedures.	30	
18	Make the procedures in case of emergency.	30	1/12/13
19	Make the training plan.	30	1/12/13
20	Establish the training dates.	15	1/12/13
21	Develop the emergency plan.	30	1/1/14
22	Develop all the program components.	30	3/3/14
23	**Third deliverable**	1	4/4/14
24	**Program improvements.**	5	11/4/14
25	**Project presentation.**	1	-

Source: Blanco & Ortega, 2013

Appendix 2. Project budget.

Activity	Value	Meassure unit	Costs	
			Students	TEC
Professional work	₡350.000.00	Months	₡20.000.000.00	-
Transport	₡ 2.000.00	Days	₡1.000.000 .00	-
Food	₡ 3.000.00	Days	₡500.000.00	-
Impress	₡50.00	Unit	₡15.000.00	-
CD	₡500.00	Unit	₡1500.00	-
Internet	₡10.000.00	Months	₡120.000.00	
Professional support	₡3000.00	Hours	-	₡5.000.000.00
Individual costs			**₡19.636.500.00**	**₡5.000.000.00**
Incidentals (10%)			**₡1.563.650.00**	**₡500.000.00**
Total cost of the project			**₡26.700.150. 00**	

Source: Blanco & Ortega, 2013

Appendix 3. Risks analysis of the project.

The Australian risks management standard AS/NZS 4360:1999, is the tool that we are going to use to make the risk analysis of the project.

To begin we need to define some charts with the probability of occurrence and an impact scale, both associated to the Project risks.

Chart 1. Impact descriptive scale.

Level	Descriptor	Details
1	Insignificant	-5 to 10 hours delay. -Stop of 1 activity. -1 injured person.
2	Minor	-24 hours delay. -Stop of half of activities. -2 to 5 injured persons.
3	Moderate	-24 to 48 hours delay. -Half of activity stoped.

		-5-10 injured persons.
4	Mayor	-2 to 4 days delay. -Stop of half activities. -10 to 15 injured person.
5	Catastrophic	-5 or more days delay. -Stop of all activities. -15 or more injured persons or someone dead.

Source: Blanco & Ortega, 2013

Qualitative criteria for the risks probabilities are stablished on the next chart:

Chart 2. Occurrence of probability descriptive scale.

Nivel	Descriptor	Descripción
A	Almost certain	It is spected that occur the mayority of the times.
B	Probably	Probablemente ocurrirá en la mayoría de las circunstancias.
C	Possible	Pudo ocurrir en algún momento
D	Unlikely	Podría ocurrir en cualquier momento
E	Rare	Puede ocurrir sólo en circunstancias excepcionales

Source: Austarlian standart AS/NZS 4360:1999

Once the impact level and the probability of occurrence are assigned, the risk level is determinated with the next chart:

Chart 3. Risk analysis matrix.

Probability	Impact				
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	L	H	H

Source: Austarlian standart AS/NZS 4360:1999
E= extrem, requires immediate attention.
H= hight, requires manager attention.
M= moderate, manager must be informed.
L= low, rutine administration.

Chart 4. Project risks analysis.

Risk	Impact values	Probability values	Risk level
Project cancel	5	E	High
Financial problems.	5	E	High
Design delay.	3	B	High
Lack of primary material for the habitation module.	5	C	Extrem
Lack of safety knowledge.	3	D	Moderate
Lack of personnel	3	D	Moderate
Damage material during transportation.	3	E	Low
Fire	5	E	Extrem
Accidents	5	C	Extrem
Language barrier	5	C	Extrem
Schedule failure	5	C	Extrem
Project cancel	2	B	Hight
Financial problems.	3	E	Low
Design delay.	5	E	Extrem

Lack of primary material for the habitation module.	3	A	Extrem
Lack of safety knowledge.	2	C	Moderate

Source: Austarlian standart AS/NZS 4360:1999

Chart 5. Risk mitigation measures.

Risk	**Mitigation method**
Project cancel	-
Financial problems.	Seek for more sponsors.
Design delay.	Progress checks
Lack of primary material for the habitation module.	Design someone as the responsible persons for this task.
Lack of safety knowledge.	Trainning in safety matters.
Lack of personnel	Stablish leaders of every department that inform this kind of problem and look for someone.
Damage material during transportation.	Good packaging, preventing all kind of situations.
Fire	Extinguishers and special container for dangerous materials.

Accidents	Trainning in safety matters and certificated personal equipment.
Language barrier	French lessons
Schedule failure	Semanal progress cheks.

Source: Blanco & Ortega, 2013

Appendix 4. Interview to construction companies.

Interview **Subject: Risk during constructive process of habitation module**. Author: André Blanco M & Adelina Ortega R.	trópika Costa Rica
Interview objective	
This interview is made for collect information to determinate the risks during the constructive process and ways to mitigate them.	
General information	
Company Name: _____ Date of Application:_____ Interviewer :_____	
Questions	

According to your experience in the construction section, which are the risk that the workers are exposed to?
Which risks are the more common to occur?
Can you tell us the main stages of your construction process?
In which stage are more risks?
Which risks do you consider have more impact?
What system do you use to mitigate the risk your workers are exposed to?

Source: Blanco & Ortega, 2013

Appendix 5. Evaluation Matrix of potential hazards by work phase.

Matrix
Evaluation of potential risk by work phase
Elaboración: André Blanco M & Adelina Ortega R.

trópika Costa Rica

Objective

This matrix aims to make a relation between every work phase and it corresponding hazard, with the frequency and impact.

Work phase	Activity	Riks				
		Risk	Frequency	Impact	Risk level	PPE
A phase	a.1					
	a.2					
	a.3					
B phase	b.1					
C phase	c.1					
	c.2					

Observaciones:

Corrective actions		
Actions	Respondable	Date of ejecution
Tecnic actions		
Formative and informative actions		
Administrative actions		

Source: Blanco & Ortega, 2013

Appendix 6. Guide for the development of a Safety work procedure

trópika Costa Rica	**Guide Development of a Safety work procedure**	Code: HS_10.1 Version: 1 Health and Safety Department

Contents

- Aim of the instruction
- Scope
- Implications and responsibilities
- Equipment needed work
- Stages of labor and safety key points

Aim of the instruction

This guide contains the main aspects that must contain a safe work procedure. Be taken into account security aspects to maintain the integrity and health of the people who carry out different jobs

Scope	
Implications and responsibilities	
Equipment needed work	
Stages of labor and safety key points	
Stage	Safety key point

Source: Blanco & Ortega, 2013

Appendix 7. Guide for the development of an Emergency Response Plan.

Guide **Development of an Emergency Response Plan.** **Authors: André Blanco M & Adelina Ortega R.**	
Objectives	
This guide aims to generate the format for the document that define the responsibilities and basic procedures to be followed by Tec Team members In case of an emergency or disaster	
Sections	

Executive Summary Purpose of the Plan/Mission Statement Authorities and Responsibilities of Key Personnel Types of Emergencies that Could Occur (Capabilities and Vulnerabilities) Managing Response Operations **Emergency Management Elements** Operational Plan Direction and Control Communications Life Safety Property Protection Procedures or action cards Administration and Logistics **Support Documents** Emergency Call Lists Building and Site Maps Drawings with evacuation routes are required.

Source: Blanco & Ortega, 2013

Appendix 8. Emergency Response Plan fulfillment Check list

Emergency Response Plan fillfilment Check list. **Authors: André Blanco M & Adelina Ortega R.**	trópika Costa Rica	
Objectives		
This guide aims to generate the format for the document that define the responsibilities and basic procedures to be followed by Tec Team members In case of an emergency or disaster		
Check list		
Sections	**Yes**	**No**
Executive Summary		
Purpose of the Plan/Mission Statement		
Authorities and Responsibilities of Key Personnel		

Types of Emergencies that Could Occur (Capabilities and Vulnerabilities)		
Managing Response Operations		
Emergency Management Elements		
Operational Plan		
Direction and Control		
Communications		
Life Safety		
Property Protection		
Procedures or action cards		
Administration and Logistics		
Support Documents		
Emergency Call Lists		
Building and Site Maps		
Drawings with evacuation routes are required.		
Comments		

Source: Blanco & Ortega, 2013

Appendix 9. Survey of security expertise for construction work during the assembly and disassembly of Trópika.

Survey of security expertise for construction work during the assembly and disassembly of Trópika. Author: André Blanco M & Adelina Ortega R.	trópika Costa Rica
Objective	
Below is a set of questions that seek to collect information in order to find the knowledge of Tec Team members regarding safety during the construction process of the housing Trópika. The data are confidential and for educational use, so it is requested to answer the questions truthfully.	
Preguntas	

1. Which of the following hazards considers that may be present during the process of assembly and disassembly of the living module Trópika?

Falls at same level
Falls to different level
Cuts
Hits
Bruises
Trapping
Musculoskeletal Trauma
Electrocution
Collision with HGVs
Radiation Exposure
Exposure to hazardous substances
Explosion
Fire
Exposure to extreme temperatures
physical efforts

Otro (especifique)

2. Which of the following personal protective equipment you think are important for the performance of work at heights?

Harness
Anchor Point
Plugs
Safety Glasses
Helmet
Lifeline
Gloves

3. Do you know the basic safety precautions for working at heights?

a. Yes
b. No

Explain

4. Do you know what are lock out-tag out systems?

a. Yes
b. No

Explain

5. Do you know the safety measures to be taken in to work with electrical lines and Installations?

a. Yes
b. No

Explain

6. ¿Conoce las características debe tener el equipo de protección personal y herramientas para realizar trabajos con electricidad?
a. Yes
b. No

Give examples

7. What considerations should be taken into account to make the manual material handling?

8. What personal protective equipment do you consider is needed to use during the process of assembly and disassembly?

Helmet
Safety Shoes
Plugs
Respirators
Gloves
Safety Vest
Glasses
masks

Other (specify)

9. What types of signage know?

10. Order the following training topics to low interest from 1 to 10.

Work at heights
Risks in construction work
Use of Personal Protective Equipment
Using hand and power tools
electrical Hazards
Manual Loads handling
Visual indication
Fire prevention and protection
Use of vehicles and equipment in the construction process

Source: Blanco & Ortega, 2013

Appendix 10. Guide for the development of a Safety Program based on Solar Decathlon 2014 Regulation V. 2.1.

Guide for the development of a Safety Program based on Solar Decathlon 2014 Regulation V. 2.1. **Authors: André Blanco M & Adelina Ortega R.**	
Format	
1. Safety Program Precedents and Aim 2.General data 3.General Provisions a).Safety Policy b) General Prevention Principles c). Assignment of responsibilities d). Resource Assignment 4.Objectives 5.Conditions of the site where construction will take place and interesting data related to	

the prevention of risks during the construction process

a). Constructive process

b). Type and characteristics of the materials and elements

c) Site description

d) Climatology description

e). Accesses and paths for vehicle

f). Determining factors for the living module placing.

g). Overlaps with the affected services and other circumstances or activities of the environment, able to cause risks during the construction

h). Trades whose intervention is affected by the risks prevention

i). Auxiliary resources planned for the construction

j). Machinery planned for the construction

k). Construction site installations

l). Characteristics table for the stocks

6.Activities for risks prevention

a). Construction plan: determination of work effective timing

b). Overlaps and incompatibilities in the construction

c). Number of Team members taking part in the construction

7. Critical work phases for risks prevention

8. Risks identification and efficacy evaluation of the adopted protections

a). Location and identification of the areas where the works involving special risks will be developed

b). Risks identification and efficiency evaluation of the adopted protections

9. Collective protections to use.

10.Individual protection resources to use

a). Signposting of the risks

11.Safe working procedures

12.Machinery and auxiliary resources

13.Planned Measures in case of accident

a) First aids

b).First aids bag

c) Preventive medicine

d) Accident victim evacuation

14. Risks identification for possible later works.

15.Useful plans and information for possible later works

16.Adopted system for the level of health and safety control during works

17.Formation and information about health and safety

18. Emergency Plan during the assembly and disassembly phases.

19. Drawings

20. Appendix

21. References

Source: Blanco & Ortega, 2013

Appendix 11. Checklist on compliance with the requirements of a Safety Program based on Solar Decathlon 2014 Regulation V. 2.1.

Checklist on compliance with the requirements of a Safety Program based on Solar Decathlon 2014 Regulation V. 2.1. Author: André Blanco M & Adelina Ortega R.	

Objectives

The main purpose of this checklist is to keep control of compliance with the requirements of Solar decathlon 2014 Regulation V. 2.1. for the elaboration of a safety program.

Requirement	**Yes**	**No**	**Notes**
1. Health and Safety Program Precedents and Aim			
2.General data			
3.General Provisions			
a).Safety Policy			
b) General Prevention Principles			
c). Assignment of responsibilities			
d). Resource Assignment			
4.Objectives			
5.Conditions of the site where construction will take place and interesting data related to the prevention of risks during the construction process			
a). Constructive process			
b). Type and characteristics of the materials and elements			
c) Site description			
d) Climatology description			
e). Accesses and paths for vehicle			
f). Determining factors for the living module placing.			
g). Overlaps with the affected services and other circumstances or activities of the environment, able to cause risks during the construction			
h). Trades whose intervention is affected by the risks prevention			
i). Auxiliary resources planned for the construction			
j). Machinery planned for the construction			
k). Construction site installations			
l). Characteristics table for the stocks			
6.Activities for risks prevention			
a). Construction plan: determination of work effective timing			
b). Overlaps and incompatibilities in the construction			

c). Number of Team members taking part in the construction			
7. Critical work phases for risks prevention			
8. Risks identification and efficacy evaluation of the adopted protections			
a). Location and identification of the areas where the works involving special risks will be developed			
b). Risks identification and efficiency evaluation of the adopted protections			
9. Collective protections to use.			
10.Individual protection resources to use			
a). Signposting of the risks			
11.Safe working procedures			
12.Machinery and auxiliary resources			
13.Planned Measures in case of accident			
a) First aids			
b).First aids bag			
c) Preventive medicine			
d) Accident victim evacuation			
14. Risks identification for possible later works.			
15.Useful plans and information for possible later works			
16.Adopted system for the level of health and safety control during works			
17.Formation and information about health and safety			
18. Emergency Plan during the assembly and disassembly phases.			
19. Drawings			
20. Appendix			
Notes:			

Source: Blanco & Ortega, 2013

Appendix 12. Guide to training needs evaluation.

Guide to training needs evaluation. Authors: André Blanco M & Adelina Ortega R.	trópika Costa Rica
Objective	
Determinate the knowledge level of the team in safety matters.	
Subjects to be evaluated	

-Safety in loads manual handling. -Electrical installation safety. -Works at heights. -Signposting. -Personal Protection Equipment.
Segments
-Questions and correct answer percentage. -Data analysis

Source: Blanco & Ortega, 2013

Appendix 13. Organization Breakdown Structure (OBS).

Organization Breakdown Structure (OBS). Authors André Blanco M & Adelina Ortega R.	
Objective	
Determinate the organization structure.	
Segments	
-Project manager. -Different departments' coordinators. -Organization departments.	

Source: Blanco & Ortega, 2013

Appendix 14. Risk analysis during the assembly and disassembly process

The risk analysis was made with the Australian's Risk Administration Standard AS/NZS 4360: 1999; the procedure to make it is describe then.

Context: The TEC Team won the opportunity to compete in the international event, Solar Decathlon Europe 2014. The teams had to design the module, receive training for all specific tasks and is required that students of differents disciplines have to be capable of put the module together in 10 days, so, the risk evaluation is a very important part of the project.

Risk identification: The methodology that we used for the risk identification is the integration of:
-Professionals opinions: The data was collected with an interview to the CEO of the Health and Safety department of 5 construction companies.
-TEC Team opinion: We decide that the point of view of the members of the Team is very important due to the knowledge of the specific task that they have to develop in this project.
-SDE regulation: The SDE regulation mention several risk that are in the French Law. We integrated those on the summary chart due to the lack of the frequency.

Risk analysis: For make the risk analysis we define the parameters for every level either for the probability or the impact.

In the next chart we define the parameters for every level of the impact:

Chart 1. Impact's descriptive scale.

Nivel	Descriptor	Detalles
1	Insignificant	-Minor scrapes and/or hits that don't require attention. -2 hours delay on tasks.
2	Minor	-Wounds that at least require the use of first aid kit. -5 hours delay on tasks.
3	Moderate	-Bleeding wounds. -8 hours delay on tasks.
4	Major	-Wounds that require special attention. -12 hours delay on tasks.
5	Catastrophic.	-Dead or hospitalization. -18 hours or more delay on tasks.

Source: Blanco & Ortega, 2013

The qualitative criteria for the probability of each risk are stablished on the chart 2.

Chart 2. Probability's descriptive scale.

Nivel	Descriptor	Descripción
A	Almost certain	Is expected to occur la majority of time.
B	Likely	Probably occurs the majority
C	Possible	Its can occur sometime.
D	Unlikely	Is rare for it to occur.

Nivel	Descriptor	Descripción
E	Rare	Its can only occur in exceptional situations.

Source: Blanco & Ortega, 2013

Risk Evaluation: When the impact level and the frequency is assign to each risk we can determinate de risk analysis, the next chart describes the analysis.

Chart 3. Risk analysis matrix.

Probability	Impact				
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	L	H	H

Source: Australian's Administration Risk Standard. (1999).

: E= extreme, require immediate attention, H= high, requiere attention from the manager, M= moderate, its require manager responsabilities y L= low, require routine procedures management.

Appendix 15. Risk analysis during the design and materials selection of the module.

The risk analysis was made with the Australian's Risk Administration Standard AS/NZS 4360: 1999; the procedure to make it is describe then.

Context: The TEC Team won the opportunity to compete in the international event, Solar Decatlhon Europe 2014. The teams had to design the module, receive training for all specific tasks and is required that students of different disciplines have to be capable of put the module together in 10 days, so, the risk evaluation is a very important part of the project.

Risk identification: The methodology that we used for the risk identification were the selection of the most critical activities during the design and the materials selection and then analyze the associated risk.

Risk analysis: For make the risk analysis we define the parameters for every level either for the probability or the impact.

In the next chart we define the parameters for every level of the impact:

Chart 1. Impact's descriptive scale.

Nivel	Descriptor	Detalles
1	Insignificant	3 days delay.
2	Minor	1 weeks delay.
3	Moderate	2 weeks delay.
4	Major	3 weeks delay.
5	Catastrophic.	4 or more, weeks delay.

Source: Blanco & Ortega, 2013

The qualitative criteria for the probability of each risk are stablished on the chart 2.

Chart 2. Probability's descriptive scale.

Nivel	Descriptor	Descripción
A	Almost certain	Is expected to occur la majority of time.
B	Likely	Probably occurs the majority
C	Possible	Its can occur sometime.
D	Unlikely	Is rare for it to occur.
E	Rare	Its can only occur in exceptional situations.

Source: Blanco & Ortega, 2013

Risk Evaluation: When the impact level and the frequency is assign to each risk we can determinate de risk analysis, the next chart describes the analysis.

Chart 3. Risk analysis matrix.

Probability	Impact				
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E

Probability	Impact				
	1	2	3	4	5
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	L	H	H

Source: Blanco & Ortega, 2013

E= extreme, require immediate attention, H= high, requiere attention from the manager, M= moderate, its require manager responsabilities y L= low, require routine procedures managment.

Appendix 16. Risk analysis of natural events.

The risk analysis was made with the Australian's Risk Administration Standard AS/NZS 4360: 1999; the procedure to make it is describe then.

Context: Costa Rica have several events that occur constantly due to the fact that is located in the "Pacific's Fire Belt", this is the zone that have more tectonic activity in the whole world, also we are frequently affected by tropical depressions that lead to several events (floods, landslides, etc.).

Risk identification: The identification of the risk was made by interviews applied to experts of the Emergency National Commission, Firefighter's Department and the Meteorological Institution of Costa Rica.

Risk analysis: For make the risk analysis we define the parameters for every level either for the probability or the impact.

In the next chart we define the parameters for every level of the impact:

Chart 1. Impact's descriptive scale.

Nivel	Descriptor	Detalles
1	Insignificant	-Minor scrapes and/or hits that don't require attention. -2 hours delay on tasks.
2	Minor	-Wounds that at least require the use of first aid kit. -5 hours delay on tasks.
3	Moderate	-Bleeding wounds. -8 hours delay on tasks.
4	Major	-Wounds that require special attention. -12 hours delay on tasks.
5	Catastrophic.	-Dead or hospitalization. -18 hours or more delay on tasks.

Source: Blanco & Ortega, 2013

The qualitative criteria for the probability of each risk are established on the chart 2.

Chart 2. Probability's descriptive scale.

Nivel	Descriptor	Descripción
A	Almost certain	Is expected to occur la majority of time.
B	Likely	Probably occurs the majority
C	Possible	Its can occur sometime.
D	Unlikely	Is rare for it to occur.

Nivel	Descriptor	Descripción
E	Rare	Its can only occur in exceptional situations.

Source: Australian's Administration Risk Standard. (1999).

Risk Evaluation: When the impact level and the frequency is assign to each risk we can determinate de risk analysis, the next chart describes the analysis.

Chart 3. Risk analysis matrix.

Probability	Impact				
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	L	H	H

Source: Australian's Administration Risk Standard. (1999).

E= extreme, require immediate attention, H= high, requiere attention from the manager, M= moderate, its require manager responsabilities y L= low, require routine procedures managment.