



# COURSE PLAN AND CURRICULUM FOR CRANE OPERATORS

**40 hours face-to-face classes**



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Veneto SIAV S.p.A.



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## WELCOME - INTRODUCTION

We have created this publication with the intention of providing a modular training course for Mobile Crane Operators trainees and relevant trainers.

*Mobile crane operators operate mobile cranes to lift, move, position and place materials and equipment. They perform pre-operational inspections. They calculate crane capacities, determine load weight, and set up, position and stabilize the crane before the lift. Mobile crane operators have the additional responsibilities of disassembling, traveling and transporting mobile cranes. They may also participate in rigging procedures. They also perform some routine maintenance and housekeeping of the crane equipment such as lubricating and cleaning.*

Mobile cranes are used in many industry sectors. They are very commonly used in the construction of buildings and the assembly of large equipment. They are used in locations such as construction sites, warehouses, factories, mines, oil rigs, refineries, railway yards, ships, windmill farms and ports. Mobile crane operators may be employed by rental companies, construction firms, manufacturers, public utilities, transport sector companies, ship builders, cargo-handlers, airports, railways and mines. This activity occurs all over the world and is a high risk task with many noted examples of serious incidents and accidents. There are identifiable key causes that have been noted through analysis of the well documented cases and many of these causes are preventable through effective training programs. Internationally, there are not currently consistent approaches to crane operator training program content or duration. Leading causes of crane accidents are firstly discussed and identified as areas for inclusion in training programs.

Mobile cranes come in different types such as **crawlers, truck-mounted, rough-terrain and all-terrain**. The boom of the crane may be **lattice** or **telescopic**. Some mobile cranes are fitted with equipment, including piledriver, clamshell, dragline, wrecking ball, magnet and personnel basket, which can perform specialized functions. They may be outfitted with heavy lift attachments, tower attachments and luffing jibs.

Some mobile crane operators specialize in different crane functions. In some cases, an operator may work for years on a single large site, operating a single type and size of mobile crane.

Mobile crane operators working for rental companies may rarely work on the same site more than once and may routinely perform a variety of tasks with different types and sizes of mobile cranes.

The majority of the work in this trade is outdoors. Key attributes for people entering the trade are strong communication skills, mechanical aptitude, mathematical ability, excellent visual and depth perception and a high degree of hand-foot-eye coordination.



The operation of some mobile cranes is physically demanding as is the handling of accessories.

The skills of mobile crane operators are transferable to operating other heavy equipment. With experience, mobile crane operators may move into careers such as business owners, supervisors, trainers and job coordinators.

The conclusions obtained from the Questionnaires and Interviews carried out by the partners of the CRANE 4.0 Project, identified 4 basic questions to be addressed within this Course Plan:

1. **Cranes and their types. The components of the cranes and the technology of the lifting devices.**
2. **Safety regulations in the handling of lifting equipment, both personally and in front of third parties, and fundamentally the safety procedures to be followed during crane work.**
3. **Specific risks and measures to be taken in maintenance operations and crane checks / supervision.**
4. **Issues related to the handling of material cargo.**

Other types of training have also been identified and considered in the Crane Operator Training Curriculum. All curricular elements were modularized to allow maximum flexibility in delivery of the course content, covering different type of skills

Our vision was to create a high-quality course that will not only focus on **job-related skills** but also on **essential ones**

**□ Skills and Knowledge required to conduct crane operations, including lifting loads, and positioning and travelling where is it applicable**

<b>Prepare for crane operations</b>	<ul style="list-style-type: none"> <li>• Carry out equipment pre-start and start-up checks in line with workplace procedures</li> <li>• Identify faults or defects and rectify or report within scope of own responsibility and according to workplace procedures</li> <li>• Inspect and confirm lifting gear is attached according to work requirements, equipment specifications, and workplace procedures</li> <li>• Confirm the work area is clear and safe prior to commencing work activity</li> <li>• Confirm ground suitability of work area operating surface for operational use of the crane</li> <li>• Determine appropriate paths for operating the crane and moving and placing load/s in</li> </ul>
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	<p>work area</p> <ul style="list-style-type: none"> <li>• Identify hazards and apply risk elimination/control measures</li> </ul>
<b>Commence crane operations</b>	<ul style="list-style-type: none"> <li>• Position, stabilize and level crane prior to commencement of lift operations</li> <li>• Correctly interpret relevant load charts</li> <li>• Confirm weight of load as being within the lifting capacity and operating radius of the crane</li> <li>• Configure crane for specified lift</li> <li>• Prepare loads for lift in accordance with crane limitations and rigging requirements, and according             <ul style="list-style-type: none"> <li>• to workplace procedures</li> </ul> </li> <li>• Access crane in accordance with manufacturer specifications and safety regulations</li> <li>• Crane controls and functions, including maneuverability, emergency functions, gear and accessories are checked for serviceability and any faults are rectified or reported</li> </ul>
<b>Operate crane within operating capacities of equipment to complete work activity</b>	<ul style="list-style-type: none"> <li>• Perform a test list</li> <li>• Use crane controls and functions to lift and position loads using techniques suited to equipment             <ul style="list-style-type: none"> <li>• capabilities, site and work conditions, and according to workplace procedures</li> </ul> </li> <li>• Monitor and manage equipment performance using indicators and alarms</li> <li>• Monitor hazards and risks during operations, and ensure safety of self, other personnel, plant and             <ul style="list-style-type: none"> <li>• equipment</li> </ul> </li> </ul>
<b>Travel the crane (where relevant to type)</b>	<ul style="list-style-type: none"> <li>• Plan a firm and level route for the crane travel according to workplace procedures</li> <li>• Monitor and manage hazards along the route</li> <li>• Travel the crane in accordance with relevant Standards, manufacturer's guidelines, engineering             <ul style="list-style-type: none"> <li>• specifications and organisational policies and procedures and work requirements</li> </ul> </li> </ul>
<b>Complete crane operations</b>	<ul style="list-style-type: none"> <li>• Shut down crane using the correct sequence of procedures in accordance with manufacturer</li> </ul>



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	<ul style="list-style-type: none"> <li>• recommendations and specifications and site safety procedures</li> <li>• Park up, secure and carry out post operational inspection of equipment in line with workplace procedures</li> </ul>
<b>Conduct housekeeping activities</b>	<ul style="list-style-type: none"> <li>• Clear work area and dispose or recycle materials according to relevant procedures</li> <li>• Manage and/or report hazards to maintain a safe working environment</li> <li>• Complete and file required record keeping, and distribute as required</li> </ul>

<b>Cross-cutting skills directly applied to the field of crane operator</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators must be able to establish close and continuous coordination of the work task with other workers.</li> <li>• Work closely with clients to plan and ensure that their activities are carried out in the safest and most secure manner. They are in close communication with signallers and supervisors to coordinate lifts and load placements.</li> <li>• Working in close coordination with other operators is vital when working multiple cranes at the same time. and multiple crane lifts are performed</li> </ul>
<b>Continuous learning</b>	<ul style="list-style-type: none"> <li>• It is very important for mobile crane operators to stay abreast of crane technologies and regulatory changes that may occur and may require additional certification and continuous learning to ensure compliance and safe working conditions.</li> </ul>
<b>Reading Comprehension</b>	<ul style="list-style-type: none"> <li>• In their daily work, mobile crane operators read and understand various types of texts. These include safety and work procedures, as well as more complex lifting regulations and manufacturers' operating manuals.</li> </ul>
<b>Document Usage</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators must be familiar with regulations relating to lifting, rigging and safe working environments.</li> <li>• They must have the ability to read and interpret manufacturers' specifications and load charts for the crane model they are using.</li> <li>• Depending on the specific site requirements, they may obtain information</li> </ul>





	from blueprints and engineering and construction drawings.
<b>Writing Facility</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators must give details of the job or respond to requests for technical information.</li> <li>• They may also write longer descriptions and explanations for various reporting and data collection forms.</li> </ul>
<b>Writing Facility</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators must give details of the job or respond to requests for technical information. They may also write longer descriptions and explanations for various reporting and data collection forms.</li> </ul>
<b>Arithmetics</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators use a variety of mathematical skills in their daily work.</li> <li>• These include mathematical and physical concepts such as conversions, geometry, algebraic calculations, measuring and calculating load and lifting requirements.</li> <li>• They use code books, load charts and manufacturers' specifications to further determine procedures, load limits and rigging equipment needed for load lifting.</li> </ul>
<b>Decision making</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators must use decision-making skills to perform work planning and prioritisation. The decisions they make about the sequence of work have implications for everyone on site. and require strong analytical skills to effectively use their equipment.</li> </ul>
<b>Digital technology</b>	<ul style="list-style-type: none"> <li>• Mobile crane operators are increasingly required to interpret electronic data transmitted from LMIs, anemometers and electronic scales to a display located in the crane cab.</li> <li>• Controls for the mobile crane may also involve computerised applications</li> </ul>



Additionally, training activities, already identified and proposed, will be developed through **Virtual Reality (VR)**<sup>1</sup> scenarios, covering aspects of the practical part of the Crane Operator training.

Finally, the types of MOBILE CRANES<sup>2</sup> to be treated in this course and on which the practical part in Virtual Reality will be carried out, will be the **G Truck-mounted cranes**<sup>3</sup>.

## COURSE ACCESS REQUIREMENTS

The course is aimed at entry-level crane operators (newcomers with no knowledge nor training about crane operations) or crane operators who are already performing this job and need to upgrade their level of competences. Trainees access requirements are:

- Academic or general knowledge level: School graduate or school certificate.
- Professional or technical level: No specific knowledge is required.
- Physical conditions: None in particular, except those that impede the normal development of the course.

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<sup>1</sup> As the focus of craftsmen is on transfer of action-oriented knowledge, VR can particularly support their training with its immersive interaction possibilities, especially in terms of action-oriented content, giving them the opportunity to experience the reality of being in an unfamiliar working environment. VR can make the process of explaining complicated concepts less challenging; therefore, it expands teaching possibilities. In addition to that, trainees can be more active in the process and focused on the subject.

<sup>2</sup> A Mobile Crane is the name given to any set consisting of a supporting vehicle, on wheels or on tracks, equipped with its own propulsion and steering systems on whose chassis a boom-type lifting device is attached. It has hydraulic jacks or stabilizers that prevent tipping. When we speak of mobile cranes, we refer to that system or mechanism formed by a vehicle, either by wheels or tracks, and an articulated arm capable of lifting, moving, lowering or turning all kinds of loads. This type of mobile cranes, belong to the family of mechanical shovels, can be found within the characteristics of different transport vehicles, giving rise to a classification of the different types of mobile cranes.

<sup>3</sup> This type of mobile crane is mainly characterized by carrying the crane on a truck, allowing it to move comfortably on the road. Being a larger vehicle and mobile crane, truck cranes contain counterweights for stabilization, as well as various stabilizers to hold the crane in working position with total comfort and maximum safety.





## COURSE GENERAL LEARNING

### OBJECTIVES

- Know and follow the safety regulations in all crane operations.
- Identify each one of the elements that make up the machine, defining its characteristics and operation; as well as carrying out all the inspections and necessary checks to carry out the work with a mobile crane in safety.
- Carry out all the productive cycles characteristic of the mobile crane according to acceptable quality levels and strictly complying with safety regulations.
- Carry out all the maintenance and operations of the mobile crane, both daily and, in the medium and long term.
- Identify each of the elements that make up the machine, defining its characteristics and operation; as well as carrying out all the necessary checks to carry out the works with a crane in full safety conditions.
- Acquire the necessary skills so as to perform specific mobile crane operations using VR.

### COURSE SPECIFIC LEARNING OBJECTIVES

- Improve workers' adaptability to the labor market and increase their skills according to the industry 4.0 requirements, ensuring their workplace retention and professional development.
- Interact with the selected learning scenarios, thus practicing the content of the face-to-face sessions in a safe and controlled environment.
- Facilitate training in mobile crane operations through VR, increasing the employability of workers in Industry 4.0 and VET teacher's professional development, using effective, open and innovative digital training and pedagogies as well as practical tools.

## COURSE SKILLS MATRIX

### COMMON OCCUPATIONAL SKILLS

- Perform safety-related functions
- Maintain safe work environment
- Use personal protective equipment (PPE) and safety equipment

- Organize work
- Communicate with others
- Use documentation

### **HOISTING CALCULATIONS**

- Determine load weights
- Identify the weight
- Calculate weight
- Calculate crane capacity
- Determine radius and crane configuration
- Perform rigging calculations
- Perform sling angle calculations
- Perform working load limit (WLL) calculations

### **CRANE INSPECTION AND MAINTENANCE**

- Inspect engine systems
- Inspect air / electrical / hydraulic systems
- Inspect chassis / car body and running gear components
- Inspect outriggers and counterweights
- Inspect boom components and attachments
- Inspect hoisting systems
- Check operating controls
- Inspect monitoring and warning systems
- Monitor running lines, hoist lines and standing ropes
- Monitor gauges and warning systems
- Change oil and filters
- Grease crane
- Lubricate wire ropes
- Make minor adjustments and replacements

### **RIGGING**

- Inspect, maintain and store slings and hardware
- Lubricate slings and hardware
- Identify deficiencies in slings and hardware
- Dispose of damaged slings and hardware
- Store slings and hardware



- Follow rigging procedures
- Select required rigging
- Rig load
- Monitor rigging

## **LIFT PLANNING, SITE PREPARATION AND CRANE SETUP**

- Perform pre-lift planning
- Participate in routine, engineered and specialty lift planning
- Evaluate risks and hazards
- Set up crane
- Perform final site inspection
- Position crane
- Complete setup

## **CRANE ASSEMBLY, DISASSEMBLY, AND TRANSPORT**

- Load crane
- Unload and components for transport and components crane and components
- Perform pre- trip planning
- Prepare crane for transport
- Drive cranes
- Install tracks on car body (lattice boom)
- Install house (lattice boom)
- Install outrigger boxes (lattice boom)
- Install boom base (lattice boom)
- Assemble boom and jib (lattice boom)
- Install counterweights (lattice boom)
- Install hoist lines, hook blocks and overhaul ball (lattice boom)
- Remove hoist lines, hook blocks and overhaul ball (lattice boom)
- Disassemble boom and jib (lattice boom)
- Remove counterweights (lattice boom)
- Remove boom base (lattice boom)
- Remove house (lattice boom)
- Remove tracks from car body (lattice boom)
- Remove outrigger boxes (lattice boom)
- Install outrigger boxes (telescopic boom)
- Install main boom (telescopic boom)





- Install hoist lines, hook blocks and overhaul ball (telescopic boom)
- Install counterweights (telescopic boom)
- Install swing-away jibs and inserts (telescopic boom)
- Remove swing-away jibs and inserts (telescopic boom)
- Remove counterweights (telescopic boom)
- Remove hoist lines, hook blocks and overhaul ball (telescopic boom)
- Remove main boom (telescopic boom)
- Assemble specialty equipment and attachments
- Disassemble specialty equipment and attachments

## CRANE OPERATIONS

- Configure load moment indicator (LMI)
- Mobilize crane on jobsite
- Operate friction drive crawler-mounted lattice boom cranes
- Operate friction drive truck-mounted lattice boom cranes
- Operate hydraulic drive crawler-mounted lattice boom cranes
- Operate hydraulic drive truck-mounted lattice boom cranes
- Operate crawler-mounted telescopic cranes
- Operate rubber-mounted telescopic cranes
- Operate piledriver
- Perform duty cycle operations
- Secure crane for short-term
- Secur crane for long-term



# MOBILE CRANE OPERATOR COURSE UNITS

## MODULE 1 - Safety/Tools and Equipment

Learning Units (LU) indicative time: (5 hours)

- LU 1. 1 - Safety
- LU 1. 2 - Communications for hoisting
- LU 1. 3 - High voltage electrical fundamentals
- LU 1. 4 - Tools and equipment

### To be achieved upon learning outcome completion

- Knowing the specific risks that originate in the work carried out with mobile cranes as well as the preventive measures and safety systems to be adopted for them.
- To learn about the legislation on health and safety at work in the countries of the Consortium (Romania, Malta, Greece, Spain) and the regulations concerning lifting equipment.
- Understand and know how to correctly use the procedures established for starting and stopping the crane corresponding to the beginning and end of the working day. Forbidden or dangerous manoeuvres.
- Know the manoeuvre signalling codes.
- Know the limits of use of the lifting equipment.
- Know the work instructions related to the work itself and/or the place where it is used: check the state of the ground and proximity dangers. Installing truck crane stabilisers. Placing safety notices and cordoning off the working area.
- Know the emergency response procedures.

## MODULE 2 – Rigging

Learning Units (LU) indicative time: (6 hours)

- LU 2. 1 - Wire rope
- LU 2. 2 - Rigging hardware
- LU 2. 3 - Introduction to rigging and hoisting
- LU 2. 4 - Sling configurations
- LU 2. 5 - Advanced rigging and hoisting
- LU 2. 6 - Reeving operations

### To be achieved upon learning outcome completion

This module aims at specifying the competences required to perform advanced rigging, including planning and preparing for work, conducting operational checks, safely and effectively performing advanced rigging activities for a range of tasks.

This module should be complemented with national regulatory requirements. After the completion of the module, the learner will be able to:

- Plan and prepare for rigging operations.
- Verify problems and equipment faults and demonstrate appropriate response procedures.
- Efficiently and safely perform advanced rigging operations.

## MODULE 3 - Load Charts and Load Weight Calculations

Learning Units (LU) indicative time: (4 hours)

- LU 3. 1 - Determining Crane load weights
- LU 3. 2 - Crane Capacity
- LU 3. 3 - Load Charts
- LU 3. 4 - Practical rules for use and safe handling of loads
- LU 3. 5 - Load Calculations

### To be achieved upon learning outcome completion

- To introduce learners to different means and devices of securing loads
- To be able to calculate load estimates, and the best environments for handling loads
- To understand the best practices in safety of handling of loads, the importance of hand-eye coordination, and avoidance of hazards.

## MODULE 4 - Pre-operational Checks, Inspections and Maintenance

Learning Units (LU) indicative time: (5 hours)

- LU 4. 1 - Engines and drive systems
- LU 4. 2 - Mechanical systems
- LU 4. 3 - Hydraulic systems
- LU 4. 4 - Continual checks

### To be achieved upon learning outcome completion

- Understanding the types of technical checks;
- Understand the documents required for the commissioning of mobile cranes to apply the rules imposed in the operation of the cranes to avoid accidents;
- Recognising the effectively plan mandatory and regular checks and inspections
- to understand the specific terminology for the safe use of cranes;
- knowledge of the components of cranes that undergo periodic technical inspections;
- knowing the additional checks, depending on the complexity of the crane, the operating regime and the environmental conditions in which it operates.
- understanding the main components of a hydraulic systems of the crane



## MODULE 5 - Mobile Crane Set-up

Learning Units (LU) indicative time: (6 hours)

- LU 5. 1 - Crane setup
- LU 5. 2 - Assembly and disassembly (lattice boom crane)
- LU 5. 3 - Assembly and disassembly (telescopic boom crane)
- LU 5. 4 - Safety during assembly and disassembly
- LU 5. 5 - Transportation
- LU 5. 6 - Pre-lift planning
- LU 5. 7 - Worksite Preparation

### To be achieved upon learning outcome completion

- Understanding the right crane setup;
- Be confident with gravity, balance and leverage main functioning in lifting actions;
- Be aware of ground conditions;
- Understand the main features of the lattice boom crane and how to assemble and disassemble;
- Understand the main feature of the telescopic boom crane and how to assemble and disassemble;
- Be aware of the safety requirements during assembly and disassembly;
- Be aware of the transport regulation in order to comply with national legislation and not to damage roads and the mobile crane;
- Recognising the main risks when planning a job and be able to classify them;
- Recognise which types of lift require the support and supervision of specialised personnel as “critical lifts”;
- Recognise the risks involved in setting up the right worksite and soil conditions

## MODULE 6 - Mobile Crane Operations

Learning Units (LU) indicative time: (14 hours)

- LU 6. 1 - Lifting theory and forces
- LU 6. 2 - Introduction to crane operations
- LU 6. 3 - Introduction to mobile cranes
- LU 6. 4 - Hydraulic telescopic boom operation
- LU 6. 5 - Operating drive lattice boom cranes
- LU 6. 6 - Hydraulic drive lattice boom operation

### To be achieved upon learning outcome completion

- Providing students with the necessary knowledge to be able to carry out all operations and load transport with self-propelled mobile cranes safely, as well as the maintenance and conservation of the machinery according to the plan established by the manufacturer.
- To inform and raise awareness of the risks involved in the handling of this equipment.
- To provide knowledge of the strategies, procedures and techniques necessary to develop good driving, crane positioning and assembly and disassembly of jibs with technical and safety guarantees.
- To provide knowledge of the signals made by the Signaller or Rigger during the handling of the load.
- To provide knowledge of the different types of cranes and the different operations that can be carried out by each of them.
- To explain how the load is calculated and what the load limits are.
- Introduce the operation of hydraulically operated lattice boom cranes, including both crawler and truck-mounted cranes.
- To provide knowledge of the elements that make up the machine, its components and how to carry out the inspections and checks necessary for the execution of work with a mobile crane in full safety conditions.
- establish references for the practical handling of the different types of cranes.

# TRAINING ACTIVITIES THROUGH VIRTUAL REALITY

## ACTIVITY 1: Safety/Manoeuvring signalling codes

Use of controls, handling aids and control equipment. Execution of maneuvers (empty and load description of the specific steps of start and stop procedures). Description of forbidden or dangerous maneuvers.

## ACTIVITY 2: Worksite preparation and crane setup

Verify that the site where the crane will operate is suitable and that the environmental conditions of operation are ideal. Check the state of the ground, verify that access to the site is easy and that the climatic conditions are such as to allow safe lifting actions. Park the truck mounted mobile crane at the work site. Preparatory activities for the use of the crane relating to the driving position.

## ACTIVITY 3: Lifting movements and rigging

Determine the weight of the load and if the setup is adequate for the lift. Take the necessary steps to right the crane in an emergency situation.

## ACTIVITY 4 Module 4 - Crane inspection

Mobile crane monthly inspection: fill in the monthly inspection checklist. Pre-operational checks of mobile crane.

## FINAL TEST AND EVALUATION CRITERIA

Participant assessment models:

- **Theoretical assessment:** 1 test after each module to evaluate the content of the trainings.
- **Practical assessment:** in the Virtual Reality Labs after the completion of the theoretical part.