



Exam Objectives: Certified Mission Critical Operator (CMCO) MC1-001

INTRODUCTION

The Cleveland Community College Certified Mission Critical Operator (CMCO) certification is validation of the technical knowledge required of foundation-level Mission Critical Operators.

The CMCO certification ensures that the successful candidate is able to perform entry-level operational tasks within a mission critical environment. This includes maintenance, reporting, and incident response.

The skills and knowledge measured by this examination were derived from an industry-wide job task analysis and validated through an industry-wide global survey in Q4 2014. The results of this survey were used in weighing the domains and ensuring that the weighting is representative of the relative importance of the content.

It is recommended that CMCO candidates have the following:

- At least one year's worth of education in a Mission Critical academic program; or
- At least one year's work experience in a Mission Critical environment.

The table below lists the domains measured by this examination and the extent to which they are represented. Certified Mission Critical Operator (CMCO) exams are based on these objectives.

Domain	% of Examination
1.0 Mission Critical Infrastructure	21%
2.0 Safety, Security, and Emergency Response	14%
3.0 Critical Production Space	14%
4.0 Facility and System Documentation	12%
5.0 Networking and Communications	5%
6.0 Real-Time Information Management	17%
7.0 Operations and Procedures	17%
Total	100%

1.0 Mission Critical Infrastructure

1.1 Compare and contrast various types of HVAC systems.

- Refrigerant-based cooling system
 - Air cooled chiller
 - Water cooled chiller
 - Direct Expansion (DX)
 - Pump refrigerant
- Water-based cooling system
 - Pumping systems
 - Primary/secondary
 - Variable primary
 - Cooling tower
 - Heat exchanger
 - Thermal storage
- Alternative technologies
 - Thermal wheel cooling
 - Free-air cooling
 - Air side economization
 - Geo-thermal cooling
 - Evaporative cooling
- 100 percent (%) fresh air technology
 - Exhaust methodology
- Fan systems
- Air handling unit
 - Dedicated outdoor air handling unit
 - Rooftop unit
- Terminal devices
 - Fan Powered Terminal Units
 - Variable Air Volume

1.2 Summarize various power source technologies.

- Utility
 - Multiple source / multiple feed
 - Low vs. medium voltage systems
 - Switching / fail over
- Generator
 - Standby vs. continuous vs. prime ratings
 - Fuel type
 - Fuel oil
 - Natural gas
 - Automatic transfer switch
 - Paralleling switchgear
- Uninterruptible Power Supply (UPS)
 - Double conversion
 - Line interactive
 - Delta conversion
 - Rotary UPS
 - Diesel Rotary UPS
 - Flywheel
 - Load bus synchronization

- Battery
 - Lithium
 - Lead Acid
 - Flooded wet-cell
 - Valve Regulated Lead Acid (VRLA)
 - Nickel Cadmium (NiCad)
- Alternative power sources
 - Fuel cells
 - Solar panels
 - Wind
 - Co-generation
 - Super capacitor

1.3 Compare and contrast various power distribution concepts and equipment.

- Level of redundancy
 - N
 - N+1
 - 2N
 - 2(N+1)
- Dual cord
- Close transition vs. open transition vs. soft loading
 - Static transfer switch
 - Automatic transfer switch
 - Breaker pairs
 - Soft loading closed transition switch
- Tier level/Topology
 - Tier I (Basic)
 - Tier II (Redundancy)
 - Tier III (Concurrent maintainability)
 - Tier IV (Fault tolerance)
- Electrical protection
 - Grounding
 - Over current
 - Protective relays
 - Surge protection / Transient Voltage Surge Suppressor (TVSS)
 - Lightning protection
 - Arc flash protection
 - Zone selective interlock

1.4 Identify basic plumbing concepts and the relationship to core mechanical systems.

- Water treatment
 - Blow down
- Humidification
- Water source
 - Municipal
 - Water storage
 - Reclamation
 - Well

- Floor drains
 - Trap primers
- Make up water
- Water pumps / pressurization
- Natural gas piping
- Backflow preventer
- Filtration

1.5 Explain life safety system elements, their purposes and impact on normal operations.

- Fire detection
 - Fire alarm
 - High sensitivity smoke detection
 - Smoke and heat detection
 - Flame/flash detection
 - Fire alarm control panel
 - Beam detector
 - Laser
- Fire suppression
 - Sprinklers
 - Wet pipe
 - Dry pipe
 - Mist
 - Fog
 - Pre-action
 - Double interlock
 - Single interlock
 - Clean agent
 - Fire extinguishers and types
 - Foam system
- Fire-rated construction
 - Walls
 - Doors
 - Dampers
 - Shutters
 - Penetrations
- Fire pump system
 - Jockey pumps
 - Primary pumps
 - Secondary pumps
 - Transfer switch/controls
- Emergency lighting
- Emergency receptacle identification
- Emergency Power Off (EPO)

2.0 Safety, Security, and Emergency Response

2.1 Given a scenario, implement proper safety techniques in a mission critical environment.

- Personal Protective Equipment (PPE)
- Lock out/Tag out
- Barrier/boundaries
- Machine guarding
- Fall protection and arrest
- Arc flash labels and hazard analysis
- Global Harmonization System
- Confined space access and ventilation

2.2 Given a scenario, execute security methods and best practices.

- Physical security
 - Gates
 - Vehicle barriers
 - Locked doors
 - Special industry classifications
 - Penetrations
 - Access Control Vestibule (e.g. mantrap)
 - Intrusion detection
 - Intercom or radio system
 - Video surveillance
- Access control systems
 - Biometrics
 - Card readers
 - Keypad
 - Key lock

2.3 Identify basic emergency response procedures.

- Incident reporting
- Call tree
- Building or critical area emergency action plan
 - Mass notification methods
- Hazardous material spill procedure
 - Refrigerant leak
 - Fuel leak
 - Battery electrolyte leak
- Severe event preparation and reporting
 - Inclement weather event
 - Internal/external site event
 - National/Regional event
 - Natural disaster

3.0 Critical Production Space

3.1 Explain the importance of common items and best practices that affect various critical environments.

- Component redundancy within the critical space
- Raised access floor
 - Loading
 - Bridging
 - Ramps
- Rack layout/installation
 - Power cabling
 - Labeling
 - Rack power distribution
 - Rack placement
 - Rack cooling
- Best practices
 - Blanking panels
 - Ensure integrity of space
 - Return air plenum
 - Supply air plenum
 - Room envelope
 - Cleanliness
 - Dust
 - Cardboard
 - Pallets
 - Power load balancing
 - Phase balance
 - Redundancy balance
- Alternative technologies
 - Fluid cooled processors
 - Direct Current (DC) power
 - Alternate voltages
 - Compact server cabinets (all-in-one)
- Grounding
 - Signal reference ground grid system
 - Rack grounding
 - Cable tray grounding and bonding
 - Master ground bus bar

3.2 Explain air flow management techniques and strategies.

- Computer room air conditioners / computer room air handler unit
- In-row cooling
- Containment
- Perforated tile placement
- Tile removal limitations
- Return air methodologies
- Hot aisle/cold aisle
- Thermal considerations
- Temperature / pressure control strategies

3.3 Summarize data cable management techniques and cable types.

- Types
 - Fiber
 - Copper
 - Coaxial
 - Category 3 (CAT3)
 - Category 5e (CAT5e)
 - Category 6a (CAT6a)
- Labeling
- Bend radius limitations
- Cable segregation
 - Power, data and fiber
- Cable dressing and placement
- Cable tracing and testing

4.0 Facility and System Documentation

4.1 Compare and contrast various types of record documentation (“as-built”).

- Single line diagram / One line diagram
 - Electrical
 - Mechanical
 - Plumbing
 - Fire protection
- Panel schedules
- Submittals
- Flow diagrams
- Floor plans
- Equipment layout plans
- Equipment schedules
- System architecture diagrams
 - Networking
 - Building Management System (BMS)/ Building Automation System (BAS)/ Supervisory Control and Data Acquisition (SCADA)
- Control diagrams
- Design specifications

4.2 Interpret and explain the contents of various operating and maintenance (O&M) manuals and their associated purpose.

- Shop drawings
- Sequence of operations
- Warranty information
- Seasonal operation
- Preventative maintenance procedures and schedules
- Maintenance procedures
- Troubleshooting procedures

4.3 Identify the contents and purpose of testing reports.

- Commissioning reports
 - Electrical testing reports
 - InterNational Electrical Testing Association (NETA)
 - Functional Performance Testing
 - Integrated System Testing
- Short circuit, protective device coordination, arc flash study
- Testing, adjusting and balancing reports

5.0 Networking and Communications

5.1 Identify basic networking concepts.

- Basic IP address concepts
 - Private vs. public
 - Numbering schemes
- Domain Naming Service (DNS) concepts
- Network types
 - Corporate networks
 - Building management networks
 - Special purpose networks
 - Supervisory Control and Data Acquisition (SCADA) transmission networks
 - Fire system network
 - Programmable Logic Controller (PLC) / Direct Digital Control (DDC) control networks

5.2 Identify essential networking structures and their purpose.

- Components
 - Router/switch
 - Patch panel
- Locations
 - Manhole / duct bank
 - Service entrance / demarcation point (demarc)
 - Communication room / service closet
 - Main Distribution Frame (MDF) / Intermediate Distribution Frame (IDF)

5.3 Identify various types of communications systems.

- Wired systems
 - Plain Old Telephone Service (POTS)
 - Private Branch Exchange (PBX)
- Wireless systems
 - Radio system
 - Microwave
 - Satellite
 - Cellular
 - Distributed Antenna System (DAS)
 - Wireless Fidelity (Wi-Fi)
 - Wireless Access Point (WAP)

6.0 Real-Time Information Management

6.1 Explain the fundamentals of environmental and system monitoring.

- Critical production environmental conditions
 - Static pressure
 - Humidity
 - Temperature
 - Air flow
- Systems and equipment parameters
 - Water flow
 - Leak detection
 - Moisture detection
 - Indoor air quality
 - Hydrogen concentration
 - Outdoor ambient environment
 - Weather station
 - Corrosion monitoring
 - Battery monitoring
- Metering
 - Power
 - Utility / generator power
 - Conditioned power
 - Branch circuit power
 - Power Distribution Unit (PDU)
 - Floor (Transformer)
 - Remote Power Panel (RPP)
 - Rack/ Cabinet Distribution Unit (CDU)
 - Outlet
 - Water levels
 - Cooling tower basin
 - Make-up water storage
 - Water treatment/chemical levels
 - Fuel
 - Fuel level
 - Fuel quality
 - Gasses
 - Compressed air
 - Nitrogen
 - Medical gas
 - Natural gas
 - Process variables
 - Temperature
 - Pressure
 - Differential Pressure
 - Flow

6.2 Identify common engineering units and conventions.

- Power
 - Kilo-Volt-Ampere (KVA) / Kilowatt (KW)
 - Power factor
 - Power Usage Effectiveness (PUE) / Data center Infrastructure Efficiency (DCIE)
 - Voltage/Current/Frequency
 - Medium vs. low voltages
 - Three phase vs. single phase
 - Alternating Current (AC) vs. Direct Current (DC)
 - Three wire vs. four wire
 - Power density
- Cooling and air flow
 - Ton
 - British Thermal Unit (BTU) / Kilowatt (KW)
 - Gallons per Minute (GPM) / Liters per Minute (LPM)
 - Cubic feet per Minute (CFM)
 - Celsius/ Fahrenheit
 - Head pressure
 - Pounds per Square Inch (PSI)
 - Inches of water column
 - Sensible and latent heat
 - Wet/dry bulb temperature
 - Relative and absolute humidity/dew point
 - Approach temperature
- General measurements
 - Pounds per square foot
 - Pounds per linear foot
 - Loading requirements
 - Torque
 - Foot - pounds
 - Sound / noise
 - Decibels

6.3 Explain common monitoring platforms and controls.

- Platforms
 - Building Management System (BMS) / Building Automation System (BAS)
 - Electrical Power Monitoring System (EPMS)
 - Supervisory Control and Data Acquisition (SCADA)
 - Programmable Logic Controller (PLC)
 - Human Machine Interface (HMI)
 - Meters, gauges and relays
 - Local control systems
- Controls
 - Adjust set point
 - Equipment status
 - On/off schedule
 - Alarm thresholds and reset

- Process control devices
 - Variable Frequency Drive
 - Thermostat
 - Actuator
 - Variable Air Volume
 - Control valves

6.4 Interpret output from system and monitoring reports and explain the overall impact of these reports on a mission critical environment.

- Normal state vs. abnormal state
- Alarm condition
- Trending
- Predictive results
- Mitigate risks/failures
- Integration of information across multiple systems to provide overall status
- Effects of local failures on other mission critical systems
- Verify corrective actions

7.0 Operations and Procedures

7.1 Given a scenario, execute proper change management procedures.

- Restricted change periods / blackout dates
- Maintenance windows
- Switching windows / cutover windows
- Methods of procedures
 - Dry run / testing
 - Switch tag
 - Back-out / contingency plan
 - Tool / materials inventory
 - Pre / post change documentation
- Permit to work / End user approval
- Hot work permit
- Energized work
- Double custody switching (e.g. two person rule)
- Standard Operating Procedure (SOP), Emergency Operating Procedure (EOP) and Preventive Maintenance (PM)

7.2 Explain common organizational structure concepts.

- Chain of command
- Escalation path
- Organizational chart
- Client - contractor relationships
- Vendor management

7.3 Explain the importance of security procedures.

- Authorization procedures
- Site access rules
- Escorting vendors/visitors
- Material shipping/receiving and inspection
- Security patrolling / fire watch
- Confidentiality policies
- Sensitivity of equipment, information, and mission
- Awareness of cyber security best practices

7.4 Identify general and industry specific regulatory, standard and compliance organizations/associations.

- Uptime Institute
- Occupational Safety and Health Administration (OSHA)
- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- American National Standards Institute (ANSI)
- Telecommunications Industry Association (TIA)

Acronym List

Acronym	Definition
AC	Alternating Current
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ATS	Automatic Transfer Switch
BAS	Building Automation System
BMS	Building Management System
BTU	British Thermal Unit
CAT3	Category 3
CAT5e	Category 5e
Cat6a	Category 6a
CDU	Cabinet Distribution Unit / Cooling Distribution Unit
CFM	Cubic feet per Minute
COAX	Coaxial
CRAC	Computer Room Air Conditioner
CRAH	Computer Room Air Handler
DAS	Distributed Antenna System
DC	Direct Current
DCIE	Data center Infrastructure Efficiency
DDC	Direct Digital Control
DNS	Domain Naming Service
DRUPS	Diesel Rotary UPS
DX	Direct Expansion
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agency
EPMS	Electrical Power Monitoring System
EPO	Emergency Power Off
FACP	Fire Alarm Control Panel
FERC	Federal Energy Regulatory Commission
FPTU	Fan Powered Terminal Units
GHS	Global Harmonization System
GPM	Gallons per Minute
HHS	Department of Health and Human Services
HIPAA	Health Insurance Portability and Accountability Act
HMI	Human Machine Interface
HSSD	High Sensitivity Smoke Detection
HVAC	Heating Ventilation and Air Conditioning
IAQ	Indoor Air Quality
ICC	International Code Council
IDF	Intermediate Distribution Frame
IP	Internet Protocol
ISA	International Society of Automation
ISO	International Standards Organization

ITIL	Information Technology Infrastructure Library
KVA	Kilo-Volt-Ampere
KW	Kilowatt
LEED	Leadership in Energy and Environmental Design
LPM	Liters per Minute
MDF	Main Distribution Frame
MOP	Method of Procedure
NEC	National Electrical Code
NERC	North American Electric Reliability Corporation
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NiCad	Nickel Cadmium
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
P&ID	Process and Instrumentation Diagram
PBX	Private Branch Exchange
PDU	Power Distribution Unit
PLC	Programmable Logic Controller
PM	Preventative Maintenance
POTS	Plain Old Telephone Service
PPE	Personal Protective Equipment
PSI	Pounds per Square Inch
PUE	Power Usage Effectiveness
RPP	Remote Power Panel
SCADA	Supervisory Control and Data Acquisition
SOP	Standard Operating Procedure
STS	Static Transfer Switch
TIA	Telecommunications Industry Association
TVSS	Transient Voltage Surge Suppressor
UPS	Uninterruptible Power Supply
USGBC	United States Green Building Council
VAV	Variable Air Volume
VFD	Variable Frequency Drive
VRLA	Valve Regulated Lead Acid
WAP	Wireless Access Point
Wi-Fi	Wireless Fidelity