Setting up a CST Training Program

How to study for a CST Test

(CST Training Check List and
a Sample Seminar Structure is located at the end.)

How to Prepare to Pass the Test

Self Preparation Steps

1. Prepare a list of Work Element Topics for the Level being tested as a study guide.
2. Identify the areas that need the most attention.
3. Gather together the needed resource materials.
4. Establish a Study Schedule well in advance of the test day.
5. Stick to it!!

Level I

Preparing for Level I

LEVEL I
SURVEY TECHNICIAN CERTIFICATION
POSITION DESCRIPTION, WORK ELEMENTS AND TYPICAL QUESTIONS

Review

WORK ELEMENTS

POSITION DESCRIPTION

Level I Technicians are required to demonstrate knowledge of basic first aid skills and safety requirements. The individual in this position possesses a basic knowledge of field operations and types of surveys as well as familiarity with field equipment and procedures used in these functions. Additional skills required include computational ability, survey note taking, drafting/CAD and map reading. Work Elements further describe the requirements related to this position.

WORK ELEMENTS

Test problems will be taken from the following work elements:

1) *Types of Surveys* (10)
   Knowledge of the different types of surveying and the basic differences between them.
2) *Field Equipment & Instruments* (41)
   Knowledge of the care, cleaning and use of surveying tools and equipment, including field radios. Understand the names, purpose and parts, setup, transport and the need for calibration of various surveying field instruments. Some historical knowledge is required.
3) *Survey Computations* (50)
   Knowledge of mathematics and measurements relating to surveying (including linear, angular, elevations and unit systems conversion).
4) *Control Points: Horizontal & Vertical* (6)
   Knowledge of types of survey control points and their differences.
5) *Field Operations* (21)
   Knowledge of the field duties of a Survey Technician. Such duty areas may include line clearing, establishing points, taping, leveling and compass reading.
6) *Field Notes* (5)
   Knowledge of the basic types of surveying field notes.
7) *Plan Reading* (17)
   Knowledge of the types of surveying maps and the ability to obtain basic information from these maps.
8) *First Aid & Safety* (20)
   Basic knowledge of treatment practices for a variety of medical emergencies. Knowledge of traffic control and safety procedures for surveying and construction operations, including Occupational Safety and Health Administration (OSHA) standards.
9) *Drafting/CAD* (17)
   Knowledge of basic drafting and CAD skills, tools and procedures.
10) *Electronic Instruments* (8)
    Knowledge of the handling, setup and care of electronic instruments and their accessories.
11) *Surveying History* (5)
    Knowledge of the historical development of survey procedures and practices.

Using the Work Elements List as a Study Guide

- **First list the Work Elements for Level I**

  (200 questions)

  - 1. Types of Surveys (10 questions)
  - 2. Field Equipment and Instruments (41 questions)
  - 3. Survey Computations (50 questions)
  - 4. Control Points: Horizontal and Vertical (6 questions)
  - 5. Field Operations (21 questions)
  - 6. Field Notes (5 questions)
  - 7. Plan Reading and Preparation (17 questions)
  - 8. First Aid and Safety (20 questions)
  - 9. Drafting/CAD (17 questions)
  - 10. Electronic Instruments (8 questions)
  - 11. Surveying History (5 questions)

Now make a detailed listing of the components (topics) of each Work Element (Level I)

1. Types of Surveys (10 questions)

   leveling

   traversing

   topographic

   public land surveys

   metes and bounds surveys

   construction surveys

   photo control surveys

   GPS surveys

A detailed listing of the components (topics) of each Work Element (Level I)

2. Field Equipment & Instruments (41 questions)

Care and cleaning of surveying tools, equipment and radios. Know names, purpose, parts, setup, transport and the need for calibration of various surveying field instruments.

- plumb bob
- clearing tools
- total stations
- data collectors
- levels
- compass
- tribrachs
- tripods
- GPS equipment

Some historical knowledge is required

A detailed listing of the components (topics) of each Work Element (Level I)

3. Survey Computations (50 questions)

Knowledge of mathematics and measurements

linear

angular

elevations and

unit systems conversion

A detailed listing of the components (topics) of each Work Element (Level I)

4. Control Points: Horizontal & Vertical (6)

   Knowledge of types of survey control points and their differences.

5. Field Operations (21)

   Knowledge of the field duties of a Survey Technician.

   line clearing

   establishing points

   taping

   leveling

   and compass reading

A detailed listing of the components (topics) of each Work Element (Level I)

6. Field Notes (5)

Know basic types of surveying field notes:

- leveling
- traversing
- topographic mapping
- layout
- as-built surveys
- boundary surveys
- profile and cross-section surveys

A detailed listing of the components (topics) of each Work Element (Level I)

7. Plan Reading (17)

Know the types of surveying maps and be able to obtain basic information from these maps.

topographic map reading

scaling distances

understand legend and map symbols

be able to read and follow contours

A detailed listing of the components (topics) of each Work Element (Level I)

8. First Aid & Safety (20)
   - Treatment practices of medical emergencies
   - Traffic control and safety procedures
   - Following OSHA standards
9. Drafting/CAD (17)
   - Know basic drafting procedures
   - Know how CAD works
   - Know what tools are used for drafting

A detailed listing of the components (topics) of each Work Element (Level I)

10. Electronic Instruments (8)
    - Know how to
        - handle
        - transport
        - care for
        - setup
        - know accessories

11. Surveying History (5)
    - Know historical development of survey
        - procedures
        - practices

Level II

Preparing for Level II

LEVEL II
SURVEY TECHNICIAN CERTIFICATION
POSITION DESCRIPTION, WORK ELEMENTS AND TYPICAL QUESTIONS

POSITION DESCRIPTION

In addition to the Level I requirements, **Level II Technicians** are required to demonstrate more detailed knowledge of survey computations, types of surveys and field operations. The individual in this position is familiar with comprehensive field note taking, plan reading and preparation. The field track technician possesses a detailed working knowledge and application of standard field equipment. The office track technician possesses a detailed working knowledge and application of related computer hardware and software. The technician has a basic knowledge of the principles of the profession. Work Elements further describes the requirements related to this position.

WORK ELEMENTS

Test problems will be taken from the following work elements:

1) *Types of Surveys* (F=10; O=10)
Knowledge of the principles of performing basic surveys: leveling, traversing, triangulation, trilateration, public land surveys, metes and bounds surveys, construction surveys, photo control surveys, and GPS surveys.

2) *Field Equipment & Instruments* (F=35; O=15)
Knowledge of the care, cleaning, and use of a variety of surveying tools and equipment, including field radios. Knowledge of the operation, checking, and basic field adjustments on transits, theodolites, total stations, robotic total stations, data collectors, levels, compass, tribrachs, tripods, and GPS equipment. This would include repeating observations. Some historical knowledge is required.

3) *Survey Computations* (F=40; O=55)
Knowledge of trigonometry, geometry, algebra, coordinate geometry, and basic surveying computations. A familiarity with hand-held calculators and micro-computers is important. With either a hand-held calculator or micro-computer software, be able to enter field data and produce positional information (i.e. leveling, traversing, stadia, topographic mapping and construction stakeout). Demonstrate lot, area, and intersection (bearing-bearing, distance-distance, bearing-distance) computations. Knowledge of the reduction and checking of field notes for determination of positions and elevations. Have an elementary comprehension of computer operating systems and GIS.

4) *Control Points: Horizontal & Vertical* (F=10; O=10)
Know how to interpret control point records and data sheets, as well as locate points in the field.

5) *Field Operations* (F=35; O=10)
Under the supervision of a party chief, be able to coordinate field work for a variety of standard types of surveys. Know how to observe the Sun and Polaris for True North determination. Know basic sources of measurement errors. Know principles of staking and stake markings. Know procedures for GPS surveys.

6) *Field Notes* (F=10; O=10)
Know how to keep neat and orderly field notes for standard surveying operations: leveling, traversing, topographic mapping, layout, as-built surveys, boundary surveys, profile and cross-section surveys.

7) *Plan Reading & Preparation* (F=15; O=45)
Knowledge and understanding of the basic plan reading and preparation (i.e. site plans, boundary plans, highway plans, profile and cross sections, horizontal and vertical curves, pipeline plans, foundation plans, and developing existing and finished contours). A basic knowledge of the terminology and principles of drafting, including computer-aided drafting (CAD).

8) *First Aid & Safety* (F=15; O=15)
Basic knowledge of treatment practices for a variety of medical emergencies. Knowledge of traffic control and safety procedures for a variety of surveying and construction operations, including Occupational Safety and Health Administration (OSHA) standards.

9) *Principles of the Profession* (F=10; O=10)
Knowledge of surveying ethics and technical standards. Show responsibility in the profession (i.e. attire, honesty, respect for personal property), awareness of related professional association.

TOTAL NUMBER OF QUESTIONS = 180, TIME = SIX HOURS

Using the Work Elements List as a Study Guide

- **First, List the Work Elements**: for Level II (Field)

  (180 questions)

  - 1. Types of Surveys (F = 10, O = 10)
  - 2. Field Equipment and Instruments (F = 35, O = 15)
  - 3. Survey Computations (F = 40, O = 55)
  - 4. Control Points: Horizontal and Vertical (F = 10, O =10)
  - 5. Field Operations (F = 35, O = 10)
  - 6. Field Notes (F = 10, O = 10)
  - 7. Plan Reading and Preparation (F = 15, O = 45)
  - 8. First Aid and Safety (F = 15, O =15)
  - 9. Principles of the Profession (F = 10, O = 10)

  (Note the number of questions that will be asked in each)

Now make a detailed listing of the components (topics) of each Work Element (Level II)

1. Types of Surveys (F = 10, O = 10)

   Performing the following surveys:

   - leveling
   - traversing
   - triangulation
   - trilateration
   - public land surveys
   - metes and bounds surveys
   - construction surveys
   - photo control surveys
   - GPS surveys

A detailed listing of the components (topics) of each Work Element (Level II)

2. Field Equipment & Instruments (F = 35, O = 15)

Care and cleaning of surveying tools, equipment and radios.

The use, operation, checking and adjustment of:

- transits
- theodolites
- total stations
- robotic total stations
- data collectors
- levels
- compass
- tribrachs
- tripods
- GPS equipment

Historical equipment and instrument knowledge is required.

A detailed listing of the components (topics) of each Work Element (Level II)

3. Survey Computations (F = 40, O = 55)

- Trigonometry, geometry, algebra, coordinate geometry
- Use of calculators and computers
- Survey computations associated with:
  - leveling
  - traversing
  - stadia
  - topographic mapping
  - construction stakeout
- Field note reduction and checking
- Using P.C.s (computer literacy)

A detailed listing of the components of each Work Element (Level II)

4. Control Points: Horizontal & Vertical (F = 10, O = 10)

   Gathering information on and locating control points.

   Know agencies who have this data and agencies who set control points.

5. Field Operations (F = 35, O = 10)

   Coordinate field work under the direction of chief of parties

   Sun and Polaris observation

   Sources of measurement error

   Stake out and stake marking

   GPS field observation procedures

A detailed listing of the components of each Work Element (Level II)

6. Field Notes (F = 10, O = 10)

   Keeping notes for:

   - leveling
   - traversing
   - topographic mapping
   - layout
   - as-built surveys
   - boundary surveys
   - profile and cross-section surveys

A detailed listing of the components of each Work Element (Level II)

7. Plan Reading & Preparation (F = 15, O = 45)

   Reading and preparing:

   - site plans
   - boundary plans
   - highway plans
   - profile and cross sections
   - horizontal and vertical curves
   - pipeline plans
   - foundation plans

   Developing existing and finished contours

   Hand and CAD drafting

A detailed listing of the components of each Work Element (Level II)

8. First Aid & Safety (F = 15, O =15)
   - Treatment practices of medical emergencies
   - Traffic control and safety procedures
   - Following OSHA standards
9. Principles of the Profession (F = 10, O = 10)
   - Technical Standards for field operations for Types of Survey (Work Element #1)
   - Ethical standards and issues
   - Professional attitude, demeanor and dress
   - Know the related professional associations

Level III

Preparing for Level III

Using the Work Elements List as a Study Guide (Level III)

- **First, List the Work Elements**: for Level III (Field)
  (150 questions)
  - 1. Types of Surveys (F = 7, O = 7)
  - 2. Field Equipment and Instruments (F = 34, O = 11)
  - 3. Survey Computations (F = 21, O = 21)
  - 4. Control Points: Horizontal and Vertical (F = 8, O =8)
  - 5. Field Operations (F = 30, O = 8)
  - 6. Field Notes (F = 7, O = 7)
  - 7. Plan Reading and Preparation (F = 8, O = 30)
  - 8. First Aid and Safety (F = 11, O =11)
  - 9. Principles of the Profession (F = 7, O = 7)
  - 10. Office Operations (F=7, O=30)
  - Supervisory Skills (F=10, O=10)

  (Note the number of questions that will be asked in each)

Level III

LEVEL III QUALIFICATIONS

Field or Office Route:

3.5 years of progressive surveying experience or 65 transcripted semester hours, or quarterly equivalent, of which 18 semester hours are surveying/engineering related and 2.0 years of progressive surveying experience. Or any combination of education and work experience equivalent to related 3.5 years.

LEVEL III

SURVEY TECHNICIAN CERTIFICATION

POSITION DESCRIPTION, WORK ELEMENTS AND TYPICAL QUESTIONS

POSITION DESCRIPTION

In addition to the Levels I and II requirements, **Level III Technicians** are required to demonstrate a thorough knowledge of survey computations, types of surveys and field operations. The individual in this position is well versed with field note reduction and in depth plan interpretation and preparation. The Level III technician possesses supervisory skills and a detailed working knowledge of standard field and office procedures. The technician had knowledge of the principles of the profession and various technical standards. Work Elements further describe the requirements related to this position.

Test problems will be taken from the following work elements:

1) *Types of Survey s*(F=7, 0=7)

Know the principles and methods used in performing a variety of surveys such as: photo control surveys, state plane coordinate surveys, public land surveys, metes and bounds survey, GPS surveys, construction surveys, and as-built surveys.

2) *Field Equipment & Instruments* (F=34, 0=11)

Extensive knowledge of proper field procedures, knowledge of the care, cleaning and use of a variety of surveying tools and equipment, including field radios. Know how to operate, check, and perform basic field adjustments on rods, compass, transits, levels, tribrachs, theodolites, total stations, robotic total stations, data collectors, tripods, and GPS equipment. Some historical knowledge is required.

3) *Survey Computations* (F=21, 0=21)

Have extensive knowledge of trigonometry, geometry, and algebra as related to traverse, inverse and intersection computations. Be capable of performing horizontal and vertical traverse adjustments, area and quantity computations, and horizontal and vertical curve computations.

•

Level III (cont.)

-
- **4) *Control Points: Horizontal & Vertical* (F=8, 0=8)**
- Know when to use, how to obtain, how to interpret control point records and data sheets, as well as locate points in the field.
-
- **5) *Field Operations* (F=30, 0=8)**
- Have a knowledge of a wide variety of surveying field operation methods including but not limited to; traversing; triangulation; trilateration; observation of the Sun and Polaris for True North determination; repeating observations and precision measurements using steel tapes and theodolites; construction layout methods and procedures. Know procedures for GPS surveys.

- **6) *Field Notes* (F=7, 0=7)**
- Know how to create, reduce, and check orderly field notes for standard surveying operations such as but not limited to: leveling, traversing, topographic mapping, construction layout, as-built surveys, boundary surveys, profile and cross section surveys.
-
- **7) *Plan Reading & Preparation* (F=8, 0=30)**
- Have a knowledge and understanding of plan reading and preparation (i.e. site plans, boundary plans, highway plans, profiles and cross sections, horizontal and vertical curves, pipeline plans, foundation plans, and developing existing and finish contours).

Level III (cont.)

- **8) *First Aid & Safety* (F=11, 0=11)**
- Basic knowledge of treatment practices for a variety of medical emergencies. Have a general knowledge of traffic control and safety procedures for surveying and construction operations including Occupational Safety and Health Administration (OSHA) standards.
- **9) *Principles of the Profession* (F=7, 0=7)**
- Have a knowledge of ethics and the various technical standards of groups such as ALTA, NGS, NSPS, ACSM, BLM, and ACSE. Show responsibility in the profession (i.e. attire, honesty, respect for personal property) and awareness of related professional associations.
- **10) *Office Operations* (F=7, 0=30)**
- Using hand calculations or micro-computer software, be able to enter field data and produce positional information (i.e. leveling, traversing, as-built surveys, topographic mapping). Have a knowledge and familiarity with general applications of computer aided drafting (CAD). Have knowledge of microcomputer operating system and hardware peripherals.
- **11) *Supervisory Skills* (F=10, 0=10)**
- Have a basic knowledge and familiarity with: client contacts, dealing with the public and governmental agencies, field crew management, scheduling, equipment and supplies management. Have a knowledge of general company policies as they relate to field and office operations, office work flow procedures, and field and office problem solving techniques. Also have a knowledge of proper record keeping, time keeping, and job charges. Be able to coordinate and supervise field work, staking and stake marking for a variety of standard types for survey. Have a general familiarity with local and state land use regulations as they relate to lot site development.
- **TOTAL NUMER OF QUESTIONS= 150, TIME = SIX HOURS**

NEXT

1. Study and Review Schedule
2. Take Practice Exam(s)
3. Review Test Taking Strategies
4. What to Bring to the Exam

Study/Review Schedule

- Now use the detailed topic list from the Work Elements to set up a Study Plan.
- Back off the time available from the scheduled Examination date.
- Divide up the topics (by importance) with the time available.

Study and Review

- **Assemble a resource study library**
- **Become fast at looking up surveying terms in index**
- **Review Typical Formulas (See Formula Sheets)**
- **Know your books – and know what is in them**

Take Practice Exams

- Use the sample CST exams from NSPS
  (25% of the real thing)
- Use chapter problems in text books
  (those with answers in the back)
- Use “Survey Problems” books
- Time yourself
- List the areas where you need more study

Test Taking Strategies Review

TESTING STRATEGIES

- Remember to review in the weeks before the test
- Don’t “cram.” Be careful of your diet and sleep…especially as the test draws near
- If possible, take the day before the test off and do nothing but relax
- Arrive on time…and ready
- Choose a good seat. Get comfortable and relax
- Bring the complete kit of **“tools”** you’ll need

TESTING STRATEGIES

- Listen carefully to all directions
- Apportion your time intelligently with an **“exam budget”**
- Approach the test confidently, take it calmly
- Read all directions carefully. Twice if necessary. Pay particular attention to the scoring plan.
- Look over the whole test before answering any questions.
- Start right in, if possible. Stay with it. Use every second effectively.

TESTING STRATEGIES

- Do the easy questions first; postpone harder questions until later.
- All CST Program questions are currently weighted the same.
- Determine the pattern of the test questions. If it is hard-easy, etc., answer accordingly.
- Read each question carefully. Make sure you understand each one before you answer. Re-read, if necessary.

TESTING STRATEGIES

- Think! Avoid hurried answers, guess intelligently.
- Watch your watch and **"exam budget"** - but do a little balancing of the time you devote to each question.
- Get all the help you can from **"cue"** words.
- Rephrase difficult questions for yourself.
- Choose the **"best"** of all the possible answers.

(Very Important)

TESTING STRATEGIES

- Choose the **"best"** of all the possible answers.

(Very Important)

See Example below

10. The reason most survey instruments go out of level is:

1. settlement of the tripod
2. kicking the tripod
3. putting a hand on the instrument
4. walking around the instrument

TESTING STRATEGIES

- Refresh yourself with a few well-chosen rest pauses during the test.
- Use controlled association to see the relation of one question to another.
- Answer all questions.
- Now that you're a "cool" test-taker
  - stay calm and confident throughout the test.
  Don't let anything throw you.
- Edit, check and proofread your answers.
- Be a "bitter ender," stay working until you are asked to leave.

TESTING STRATEGIES

Challenge any questions you feel are erroneous

What Do I Bring to the Exam

What to Bring to the Examination

- Remember that this is an OPEN BOOK exam
  Recommended type of books to bring:
  - Dictionary (NSPS Definitions of Surveying and Associated Terms)
  - Basic Surveying text(s)
  - Boundary Surveying text(s)
  - Basic First Aid Book (Red Cross)
  - Survey Standards
    - ALTA/NSPS
    - FGCS

    (see bibliography/references in back of CST Program Book)

Selecting Appropriate Study Material

See CST Program Book Recommended Bibliography

BIBLIOGRAPHY/REFERENCES

FUNDAMENTAL SURVEYING TEXTS

Elementary Surveying, Wolf and Ghilani Surveying, Evett
Surveying, Moffit/Bossler
Surveying Solved Problems, Van Sickle

OTHER SURVEYING TEXTS

Surveying: Theory and Practice, Anderson and Mikhail
Land Survey Review Manual, Buckner
Surveyor Reference Manual, Harbin
GPS for Land Surveyors, Van Sickle
Land Surveying Computation, Buckner
Introduction to Geodesy: The History and Concepts of Modern Geodesy, Smith
Land Surveyor's Formulas with Applications, Keen
Getting started with Geographic Information Systems, Clarke

BOUNDARY

Brown's Boundary Control and Legal Principles, Robillard and Wilson
Evidence and Procedure for Boundary Location, Robillard and Wilson
The Real Elements of Boundaries and Adjacent Properties, Skelton
Land Survey Descriptions, Wattles
A Guide to Understanding Land Surveys, Estopinal

PUBLIC LAND

Manual of Instruction (BLM)
Restoration of Lost and Obliterated Corners and Subdivision Corners 1883-1974
Land Survey Systems, McEntyre

NATIONAL SURVEY STANDARDS

Minimum Standard Detail Requirements for and Classifications of ALTA/ACSM Land Title Surveys,
Standards & Specifications for Geodetic Control Networks, Federal Geodetic Control Committee, http: //www.ptialaska.net/~aspls/ssscn.pdf
Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, Federal Geodetic Control Committee, http: //www.ngs.noaa.gov/FGCS/tech_pub/GeomGeod.pdf
Minimum Standards for Surveys (Individual States)

DRAFTING AND COMPUTERS

Surveying Drafting, Wattles
Latest AutoCad or CADD Text

CONSTRUCTION

Measuring Practice on the Building Site, Vanderberg
Manual on Construction Layout, NSPS/ACSM
Surveying with Construction Applications, Kavanaugh
Construction Surveying and Layout, Crawford

ROUTE SURVEYING

Route Location and Design, Meyer and Gibson

FIRST AID AND SAFETY

First Aid & Safety Handbook, American Red Cross
OSHA Title 29, Chapter XVII, Part 1926, Occupational Safety and Health Standards for the Construction Industry with Amendments (latest version)

DICTIONARIES

American College Dictionary, Random House (or any other college dictionary)
Glossary of the Mapping Sciences, 1994, ASCE, ACSM and ASPRS
Definitions of Surveying and Associated Terms, ACSM

NOTE:

You should review the work elements for which you will be testing. If there are areas in which you feel you need additional study, you should be able to find one or two possible books from this list to assist you. Many of these books or others like them are quite often available at public libraries or may be borrowed from acquaintances in the field.

This is an open book test. These and other materials can be brought into the testing facility

At a minimum examinee should bring:

1) A Fundamental Surveying Text (with unit conversion charts)

2) A First Aid & Safety Manuel

3) A Surveying and Mapping Dictionary

Bring books that you are familiar with and try to have one from each category

Take an inventory of what you have and review them as part of your study program

Other Items to Bring

- Formula Equation Lists
  (bound, not loose leaf)
- Your review notes (bound, not loose leaf)
- Calculator and an extra calculator as backup
- Extra Batteries
- Straight Edge, Scales, Protractors

Sample Formula Sheets

FORMULA SHEET
#1

GENERAL

1 meter = 3.2808333 ft.
1 mile = 5,280 ft.
1 acre = 43, 560 $ft.^2$
1 Gunter chain = 66 ft.
1 hectare = 2.471 acres

$$\frac{\text{Error}}{\text{Total Distance Measured}} = \frac{1}{X}$$

TAPING

$C_1 = \frac{l_1 - l}{L}$

$C_t = K\ (t_1 - t)\ L$ $\qquad K = 0.00000645$

$C_P = \frac{(P_1 - P)\ L}{}$ $\qquad E = 29{,}000{,}000\ \#/IN^2$

$C_s = -\frac{W^2_{us} L_{us}}{24\ (P_1)^2}$ or $-\frac{w^2\ L_p^3}{24\ (P_1)^2}$

$C_{sl} = -\frac{h^2}{2L}$ [approximate]

$C_{sl} = -L\ (1 - \cos \alpha)$ [exact]

$C_a = -\frac{d^2}{2L}$

LEVELING

Elv BM + BS = HI

HI - FS = Elv of TP or BM

Σ BS - Σ FS = Elv BM at Start
- Elv at Finish

$$\frac{E}{\sqrt{m}} = K$$

K < 0.017 : 1st order
K < 0.035 : 2nd order
K < 0.050 : 3rd order
K $\geq$ 0.050 : 4th order

$E_c = 0.0239\ F^2$
$E_r = -\ 0.0033\ F^2$

$D = \frac{BS - FS_{avg} + BS_{avg} - FS}{2}$

Correction Per Set Up =
$\frac{\text{- Total Error in Level Run}}{\text{\# of Set Ups}}$

TRIG. LEVELING

V = (Slope Dist.) (Cos ZA)
H = (Slope Dist.) (Sine ZA)
V = (Slope Dist.) (Sin VA)

TRAVERSE

Angular Closure = Σ Measured Interior Angles - $[(N-2)(180^o)] \leq$ L.C. $\sqrt{N}$

Latitude of a Line (North-South Component) = Length x Cosine of Bearing Angle

Departure of a Line (East-West Component) = Length x Sine of Bearing Angle

Error of Closure of Traverse $Ec = \sqrt{(E_l)^2 + (E_d)^2}$

Precision of Traverse = $\frac{\text{Error of Closure}}{\text{Perimeter Distance}}$

Balancing Latitude and Departures (Compass Rule)

Correction to Departure of a Line = $-\frac{E_d}{\text{Perimeter Dist.}} \times$ Length of Line

Correction to Latitude of a Line = $-\frac{E_l}{\text{Perimeter Dist.}} \times$ Length of Line

Double Meridian Distance

DMD of First Line = Departure of First Line

DMD of Other Lines = DMD of Preceeding Line
+ Balanced Departure of Preceeding Line
+ Balanced Departure of Line Itself

Double Area

Double Area = (DMD of Line) (Balanced Latitude of Line)

Sum of North Double Areas: (Sign +) = Σ NDA

Sum of South Double Areas: (Sign -) = Σ SDA

Double Area of Traverse = Σ NDA + Σ SDA

Area of Traverse = $\frac{\text{Double Area of Traverse}}{2}$

FORMULA SHEET #3

Working with Rectangular Coordinates of Traverse Stations

Latitude of Line AB = $Y_b - Y_a$

Departure of Line AB = $X_b - X_a$

Length of Line AB = $\sqrt{(Dep)^2 + (Lat)^2} = \sqrt{(X_b-X_a)^2 + (Y_b-Y_a)^2} = \sqrt{(\Delta X)^2 + (\Delta Y)^2}$

$$= \frac{\text{Departure}}{\text{Sine Bearing Angle}} = \frac{\text{Latitude}}{\text{Cosine Bearing Angle}}$$

Bearing Angle of Line AB = $\text{Tan}^{-1} \frac{\text{Departure}}{\text{Latitude}} = \text{Tan}^{-1} \frac{X_b-X_a}{Y_b-Y_a} = \text{Tan}^{-1} \frac{\Delta X}{\Delta Y}$

AREA

$$\sum_{i=1}^{i=n} Y_N (X_{N-1} - Y_{N+1}) = DA$$

1 Acre = 43,560 $ft.^2$

1 Hectare = 10,000 M^2

1 $Yard^3$ = 27 $ft.^3$

Trapezoidal: $A = b \frac{h_1}{2} + h_2 + h_3 + ... + \frac{hn}{2} = \frac{b}{2} (h_1 + hn + 2 (h_2 + h_3 ... h_{n-1}))$

Simpson's One-third Rule: $A = \frac{b}{3} [h_1 + h_n + 2 (\Sigma h \text{ other odd}) + 4 (\Sigma h \text{ even})]$

Circular Areas: Area of circle = πR^2

Area of sector = $\pi R^2 \frac{\Delta}{360} = RL/2$

Area of segment = Area of sector - 1/2 R^2 Sine Δ

Area of fillet = RT-sector

VOLUMES

$$Ve = \frac{L}{27}\left(\frac{A_1 + A_2}{2}\right)$$

$$V = \frac{A}{27x4}\left(\Sigma h_1 + 2\Sigma h_2 + 3\Sigma h_3 + 4\Sigma h_4\right)$$

$$Vp = \frac{L}{27}\frac{1}{6}\left(A_1 + 4Am + A_2\right)$$

$$Vc.s. = \frac{A_1 + A_2}{2}\ C.I.$$

HORIZONTAL (CIRCULAR) CURVE FORMULAS

$$R = 5729.58/D$$

$$L = 100\ (I/D) = (R)\ (\Delta \text{ in radians})$$

Superelevation: $e = \frac{V^2}{15R}$

$$T = R \operatorname{Tan} (I/2)$$

$$E = R\ (\operatorname{Sec} I/2 - 1) = R\ (\operatorname{Exsec} I/2)$$

$$LC = 2\ R \operatorname{Sin} (I/2)$$

$$M = R\ (1\text{-}\operatorname{Cos} I/2) = R\ (\operatorname{Versin} I/2)$$

$e = FT/FT$

$v = MPH$

"d/2" = .3 C D or $\delta_s = \frac{C\ D}{200}$

Sub Chord $C_s = \frac{2\ R \operatorname{Sin} (\delta_s)}{2}$

VERTICAL (PARABOLIC) CURVE FORMULAS

$X = (g_1 L) / g_1 - g_2$

Tangent offset at station = $\left(\frac{Xa}{L/2}\right)^2$ (Offset V)

$M = (g_2 - g_1)\frac{L}{8}$

$Ypvc = Elv\ PVI - (L/2)(g_1)$

$Yp = Ypvc + g_1 x + \frac{rx^2}{2}$ $\quad r = \frac{g_2 - g_1}{L}$

Sight Distance

$S = \frac{2L(h_1 + h_2)^2}{g_1 - g_2}$ for $S \leq L$ OR $S = \frac{L}{2} + \frac{(h_1 + h_2)^2}{g_1 - g_2}$

STADIA FORMULAS

$H = KS \cos^2 \alpha$

$V = KS (1/2 \sin 2\alpha)$

$H = KS \sin^2$ (Zenith ∠)

$H = KS \cos^2 \alpha + 1$

$V = KS (1/2 \sin 2\alpha)$

Elev. Diff = V - h + hi

STATE PLANE COORDINATE FORMULAS (TRANSVERSE MERCATOR)

$X_p = X' + K$

$X' = H \cdot \lambda'' \pm ab$

$(T - t) = \frac{(Y_2 - Y_1)(2X'_1 + X'_2)}{6 \rho_o{}^2 \sin 1''}$

$Y_p = Yo + V \cdot \left(\frac{\Delta\lambda}{100}\right)^2 \pm C$

Where: $\frac{1}{6 \rho_o{}^2 \sin 1''} = 0.7853 \times 10^{-10}$ in N.H.

$\Delta\lambda = \lambda\ cm - \lambda\ pt$

$\Delta\alpha'' = \Delta\lambda'' \sin\phi + g$

$L_S = L_M \left(\frac{R_E}{R_E + h}\right)$

$R_E = 20{,}906{,}000'$

$L_G = L_S$ (Scale Factor)

$L_G = (L_M)$ (Grid Factor)

Geodetic Azimuth = Grid Azimuth + $\Delta\alpha$ + Second Term

A Sample Resource

Only units 2, 3, 5, 6, 7, 8, 9, 10, 12 & 13

Caltrans

LS/LSIT VIDEO EXAM PREPARATION COURSE

WORKBOOK

EDITED BY

L.E. Luke Wilson

State of California
Department of Transportation
Division of Engineering Management
Office of Engineering Technology
Geometronics Branch

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- Office Engineers
- Office of Photogrammetry

Caltrans

Caltrans > Land Surveys Home > **Workbook TOC**

LS/LSIT Video Exam Preparation Course Workbook

This course is designed to help future land surveyors to prepare for the Land Surveyor in Training Examination (LSIT) and the California Land Surveyor Exam (LS). The course includes a set of videos and a workbook. Each Unit in the workbook corresponds to a video. To get the most out of the course be sure to read the Introduction first.

The following Course files are Adobe Acrobat (*.pdf) files. Each chapter can be downloaded.

The video files that accompany the Courses are wave files (*.wmv). Microsoft Media Player is necessary to view the videos. Although surveying technology has changed dramatically since this study course was developed in the early 1990s, the basic principles, concepts and math have remained the same.

To download the chapters or videos, right click on the chapter name and select 'Save Target as' from the popup choices. The video files are quite large and may take several minutes to download.

Use this Page as a clickable Table of Contents

CST SAMPLE EXAMS

Starting with Level I Sample Exam is recommended for those examinees that are unsure of themselves.

Get appropriate Sample Exams from:
https://cstnsps.com/sample-tests/

LEARN CST

Learn CST site is simply one tool available to students to help them prepare for the NSPS CST examination.

https://learncst.com/

It is a sad fact that
too many people are
limited by their training
or experience, rather
than being unlimited
by their imagination

J.J. Pahl

Case Study
Sample Seminar Structure

Sample Seminar Structure

DCALS Seminar May 25th, 2007 CST Work Element Classes	class time minutes	instructor phone email address	instructor phone email address
1) Survey History, Types of Surveys, Control Points	50	Jon Russell 301-670-0840 jrussell@mhgpa.com	Chas Langelan 202-289-4545 clangelan@amtengineering.com
2) Field Equipment & Instruments, Electronic Instruments	100	Joe Snider 301-948-5100 joe.snider@verizon.net	Jerry Schuessler 301-468-9400 jschuessler@burnip.com
3) Survey Computations	120	Jim Whitehead 301-932-8043 jwhitehead@atcsplc.com	Mike Bazis 301-593-8005 rckelly@caytel.net
4) Field Operations, Field Notes	60	Ken West 301-654-7907 kwest@westgroup.com	
5) Plan & Map Reading, Plan Preparation	60	'Pete' Randy Petersen 202-289-4545 rpetersen@amtengineering.com	Chas Langelan 202-289-4545 clangelan@amtengineering.com
6) First Aid and Safety	45	Tom Yoakum 301-260-0090 tyoakum@mercadoeng.com	
7) Drafting/CAD	45	Ameha Eshete Gary Faulhaber 703-273-6820 garyfaulhaber@ccl-eng.com	
total time	480		

Expanded on subsequent slides

CST Training and Testing Check List

- ☐ Read the CST Program Book.
- ☐ Decide to provide CST Training and Testing and get support from your organization. Depending on the number of people in your organization and the number of people you will be testing you might need several trainers. So at this time assemble your instructional team.
- ☐ Contact your State Society or NSPS Governor and ask if someone can visit and present the CST Program to your survey staff. The NSPS Governor is the "acting" CST State Coordinator until another person within the State Society can take his or her place.
- ☐ Week 1 - Schedule a meeting with your survey staff and using the CST PowerPoint presentation explain the CST Program and Benefits. Distribute the CST Program Book and ask the candidates to read it before the next meeting.
- ☐ Week 2 - Schedule a second meeting with your survey technician staff at which you will show them how to evaluate which CST Level Exam they should attempt based on experience and education. At this meeting each candidate would fill out a draft copy of the application. They should also receive and take home the 3 CST Sample exams. Ask them to take the exam that they feel qualified to pass and ask them to take it in a simulated exam environment using reference material, calculator and with a time restraint. Ask them to score the exam and if they fail ask them to back up one exam and take it and score it. If they passed the first exam ask them to attempt the next higher level. The goal is to have them identify which exam they should prepare for. Ask them to report back their scores (confidentially) to you along with the CST Level they feel they should prepare for and take. Ask them also to fill out and return to you a final version of their CST application.
- ☐ Week 3 - Review the applications and sample text scores and confirm that each candidate has chosen the appropriate CST Level to prepare for. Arrange to meet with each candidate separately to discuss their application and sample text results. Confirm that you agree that they have chosen the appropriate CST Level or convince them otherwise.
- ☐ Week 4 - Based on your evaluation of your candidates, develop a plan and schedule for training.
- ☐ Week 5 - Start your training program. Tell your candidates that your training program is expected to last 12 to 15 weeks. Plan on two to three hours of classroom instruction with two to three hours of homework each week. The homework should consist of some reading coupled with numerous practice questions. Have them turn in the homework but return it to them to use as reference material.
- ☐ Weeks 6 through 10 - Continue training and decide when you want to administer the exam. If your candidates are progressing well and understanding the study material then adjust the exam date accordingly. You should get your applications and fees to NSPS 30 days prior to the exam date. Line up your proctor(s), fill out the necessary proctor forms and reserve your test site.
- ☐ Weeks 11 through 20 - Continue training but start to mix in test taking skills and strategies.
- ☐ Week 21 - Take and pass the CST exam.

CST Training and Testing Check List

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CST Training and Testing Check List

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CST Training and Testing Check List

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- Weeks 11 through 20 - Continue training but start to mix in test taking skills and strategies.

- Week 21 - Take and pass the CST exam.

GET CERTIFIED

Questions